Policy Brief on NSTIP-2022

Review and Recommendations on Pakistan's National Policy on Science, Technology and Innovation 2022

Pakistan Academy of Sciences

3-Constitution Avenue, Islamabad, Pakistan

(April, 2025)

Compiled by PAS Scientific Advice to Government Unit

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Edited & Composed by: Dr. Sara Qaisar (*PoP*), Director SAG-Unit, PAS

Assisted by: Laiba Nadeem (Tech. Assistant, SAG-Unit, PAS)
Elizay Hayat Khan (Tech. Assistant, SAG-Unit, PAS)
Ali Ahsan (Technical Officer, PAS Editorial Section)

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FOREWORD

First of all, I would like to thank the Planning Commission of Pakistan for the award of PSDP Project titled "Upgradation and Capacity Building of Pakistan Academy of Sciences (Natural and Social Sciences)" in the year 2020 to the Pakistan Academy of Sciences through the Higher Education Commission (HEC) of Pakistan. As a key sub-component of this PSDP Project, the Academy established a dedicated Scientific Advice to Government (SAG) Unit—also referred to as the PAS Policy Unit—to undertake the critical task of reviewing and evaluating the existing national policies in the domain of natural sciences to compile Policy Briefs containing recommendations for the upgrade of the policies and to streamline procedures for their effective implementation in support of national priorities for socioeconomic development in the country.

Science and technology are the cornerstones of a nation's progress, and their effective integration into policy is essential for sustainable development and socioeconomic growth. Recognizing this imperative, the Scientific Advice to Government (SAG) Unit of the Pakistan Academy of Sciences (PAS) took a bold and necessary step toward bridging the gap between national challenges and appropriate policy responses under the above said PSDP Project of the Academy. Among the earliest initiatives of the PAS Policy Unit was the review and upgradation of the National Science, Technology, and Innovation Policy (NSTIP 2022), recognizing its fundamental importance in shaping the future of Pakistan. This effort reflects the Academy's long-standing tradition of policy engagement, as is evident from its rich history of organizing national and international panel discussions, conferences, and seminars on key issues ranging from Science and Technology, Educational Reforms, Energy, Agriculture, Water Resources and Water Security, Nutrition and Food Security, One Health, Biotechnology, Impact of Glacier Melting and Climate change, Environmental Management, and more. These events, dating back to the 1970s and continuing through the 2025, underscore the Academy's consistent role in contributing to national discourse and policy direction.

The Fellows and Members of Pakistan Academy of Sciences (PAS), distinguished scholars and scientists from various disciplines of natural and social sciences, bring to this endeavor not only their academic excellence but also a strong sense of national service. Through the SAG Unit, they are now positioned to provide timely, research-informed, and impartial advice to various ministries and government departments on a wide range of issues as and when required.

This document is a testament to PAS' renewed commitment to policy-driven science and science-informed policymaking. It represents a meaningful collaboration between the scientific community and relevant institutions of the Government of Pakistan, aimed at addressing complex national challenges through evidence-based strategies and innovative solutions. The establishment of the SAG Unit marks a significant milestone in institutionalizing scientific advice for governance in Pakistan, and this publication is an important step toward a more resilient, prosperous, and knowledge-driven future for the country.

Dr. Kauser Abdulla Malik
HI, SI, TI
President PAS

INTRODUCTION TO PAKISTAN ACADEMY OF SCIENCES

The Pakistan Academy of Sciences **(PAS)** is an autonomous, supreme scientific body of distinguished academicians and scientists in the country. It was **established** as an apex body to promote higher studies and scientific research in the domain of pure and applied sciences in Pakistan and to provide a platform for interaction among academicians, scientists and technologists for socio-economic uplift of the country. It was **inaugurated on Feb. 16, 1953 by Honourable Khawaja Nazimuddin, the then Prime Minister of Pakistan**. Highly acclaimed professionals in the domain of natural sciences and allied discipline join the Academy as its Fellows and/or Members. Presently, the Academy has on its roll some **87 Pakistani** Fellows, **37 Foreign** Fellows, and **30 Pakistan national** Members who have been elected by the General Body of the Academy. These Fellows & Members act as a **pool of highest scientific talent** in the country. Some of these Fellows are also recipient of international awards such as Obeda Prize, Mustafa (PBUH) Prize in Science and Technology, Alkhawarzmi Prize, and many others. The Academy also publishes and assist in the publication of Scientific Proceedings, Journals, Transactions, Monographs, Policy Briefs, Books and other scientific literature. Presently, the Academy is publishing Flagship Science Journals in the domains of "Physical & Computational Sciences" and "Life & Environmental Sciences". The Academy also hosts a **Scientific Advice to Government (SAG)-Unit/Policy Unit** for review, upgrade and compilation of **Policy Briefs** of national concern. The Academy has **signed MoUs with 21 Academies of Sciences worldwide** for collaboration in the field of S&T. With the assistance of MoFA/GoP, the Academy has recently signed MoUs with the National Academy of Sciences of Tajikistan in July, 2024; and National Academy of Sciences of Belarus in Nov., 2024. As such, the **Pakistan Academy of Sciences serves as the Academic and Scientific Face of Pakistan on the world map of Academies of Science**.

ADVISORY COMMITTEE FOR SCIENTIFIC ADVICE TO GOVERNMENT (SAG)-UNIT AT PAKISTAN ACADEMY OF SCIENCES

Prof. Dr. Kauser Abdulla Malik (***H.I., S.I., T.I.***)

Fellow PAS
President, PAS
Convener Advisory Committee
Dean of Science, F.C. College University, Lahore
Email: kauser45@gmail.com

Prof. Dr. Anwar ul Hassan Gilani (***H.I., S.I.***)

Fellow PAS
Former Chairman, PCST, Islamabad
Former VC, The University of Haripur, KP
Consultant HEC (PR & I/QA)
Email: ahgilani5@gmail.com

Prof. Dr. Iqrar Ahmad Khan (***H.I, S.I.***)

Fellow PAS
Vice Chancellor, Agriculture University, Faisalabad
Ex-VC/ Director COP Department of Centre for Advanced Study in Agriculture & Food Security, University of Agriculture, Faisalabad
Email: iqrar@uaf.edu.pk

Dr. Ather Osama

Managing Partner, INNOVentures Global (Pvt) Ltd.
Founder, Pakistan Innovation Foundation
Former Member (Science), Planning Commission of Pakistan, Islamabad; Science Policy Maker
Email: athar.osama@gmail.com

Prof. Dr. Mudassir Asrar

Member Baluchistan Public Service Commission
Meritorious Professor
Policy making at GoP Level of 25 National Policy Documents
Former Chairperson Pakistan Council for Science and Technology,
Distinguished Professor ASAB, NUST, Islamabad
Email: mudassir.asrar@gmail.com

Maj. General (Retd.) Aamer Ikram ***H.I. (M)***

Fellow PAS
Advisor Health FF
Former CEO, National Institute of Health, Islamabad
Email: maahin1@yahoo.com

Prof. Dr. Waheed Akhtar (***S.I.***)

Fellow PAS
Scientist Emeritus, School of Biological Sciences, University of The Punjab, Lahore
Email: mwa.sbs@pu.edu.pk

Prof. Dr. Muhammad Aslam Baig (***H.I, S.I., T.I.***)

Fellow PAS
Secretary General, PAS (ex-officio member)
Former Chairman Physics Dept. & Dean of Science, QAU, Islamabad, Former Dir. ALPD & Advisor Tech. NCP, President Science Council of Asia
Email:sec.gen@paspk.org

Dr. Riffat M. Qureshi

Director Administration, PAS
Former Chief Scientist and Director Coordination, PINSTECH/PAEC, Islamabad
Former Director CAAD and Technical Advisor, National Centre for Physics (NCP), Islamabad
Email: admin@paspk.org

Dr. Sara Qaisar

Director Policy Unit, PAS
Former Chief Scientist and
DG, Nanoscience & Technology Department,
KRL, Rawalpindi
Email: dir.policy@paspk.org

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Glossary of Abbreviations

AI	Artificial Intelligence
CPEC	China-Pakistan Economic Corridor
GDP	Gross Domestic Product
HE	Higher Education
ICT	Information and Communication Technology
IP	Intellectual Property
KFU-EIT	Khwaja Fareed University of Engineering & Information Technology
KRL	Khan Research Laboratories
MoST	Ministry of Science & Technology
NESCOM	National Engineering and Scientific Commission
NMI	National Metrology Institute
NSTIP	National Science, Technology and Innovation Policy
PAF-IAST	Pak-Austria Fachhochschule Institute of Applied Sciences and Technology
PAS	Pakistan Academy of Sciences
PCSIR	Pakistan Council of Scientific and Industrial Research
PESTLE	Political, Economic, Social, Technological, Legal and Environmental
PIDE	Pakistan Institute of Development Economics
PINSTECH	Pakistan Institute of Nuclear Science and Technology
PNAC	Pakistan National Accreditation Council
PSDP	Public Sector Development Program
PSF	Pakistan Science Foundation
PSQCA	Pakistan Standards and Quality Control Authority
RBMs	Results Based Monitoring
R&D	Research and Development
SAG	Scientific Advice to Government
SDGs	Sustainable Development Goals
STI	Science, Technology and Innovation
SUPARCO	Space and Upper Atmosphere Research Commission
SWOT	Strengths, Weaknesses, Opportunities and Threats
UN	United Nations

EXECUTIVE SUMMARY

Science, Technology, and Innovation (STI) form the backbone of a country's progress, economic growth, societal development, and global competitiveness. Pakistan is a country blessed with immense potentials, yet it is struggling in the formulation of a good national STI policy and especially in efforts and success for implementation of the policy.

Starting in 1984, Pakistan has formulated five STI policies. Ironically, despite having stressed upon the significance of STI, all policies have faced implementation issues leading to unrealized goals. This persistent challenge highlights the urgent need for a robust framework that ensures effective implementation of various clauses of the policy w.r.t. its execution, and delivers tangible outcomes.

The National Science Technology and Innovation Policy-2022 (NSTIP-22) is the last of the government approved National Science Technology and Innovation (NSTI) policies. It is a comprehensive document based on 61 policy statements, reflecting upon the efforts of all its contributors. The policy aptly discusses scientific innovation in the context of global competitiveness, and its role in societal development. It also refers to the contemporary idea of knowledge based economy, and covers aspects related to capacity building, science popularization and science diplomacy among others. There is a brief discussion on the emerging and frontier technologies for innovation in research, as well as, the concept of Smart Cities. The last chapter of NSTIP-22 gives policy implementation, co-ordination and monitoring mechanisms. However, the NSTIP-22 suffers from a number of shortcomings, as has been highlighted by the PESTLE and SWOT analyses (*Section 5, this document*). While the policy also mentions UN SDGs, the absence of tangible goals based on ground realities, makes the NSTIP-22 seem more of a wish list, rather than a tactical planning document. The NSTIP-22 has been reviewed in context of the above by the Scientific Advice to Government (SAG)-Unit or Policy Unit recently established at the Pakistan Academy of Sciences (PAS), focusing to identify gaps in its structure, building on its strengths, and deciphering the threats leading to policy non-implementation.

Despite aspirations to transform Pakistan into a knowledge-based economy, lack of clarity in policy documents coupled with, inadequate resource allocation, and governance issues have limited Pakistan's ability to utilize its scientific and technological potential in overcoming its national challenges. An Ishikawa analysis reveals that a good NSTIP for Pakistan stands on 6 pillars, namely policy clarity, capacity building, quality control, science popularization, adequate finances, and most importantly effective implementation. Each of these is essential to reap the benefits of a good policy. Foremost, a good policy write-up must be concise, yet comprehensive enough w.r.t. its legal framework to be actionable. It should align with national goals to ensure a broader strategic impact and be self-executing to minimize ambiguity and enhance implementation. Policies should be easy to understand and directly

guide action without requiring excessive interpretation. Innovation in science and technology is driven by the scientific standing of researchers and the availability of necessary infrastructure. Reforms are needed at both the higher education and primary levels. In parallel, vocational education should be revamped to enhance entrepreneurship and innovation skills in alignment with industry needs. The policy should support indigenous development through technology transfer and reverse engineering, making use of the scientific diaspora, and the science diplomacy channels to accelerate technological advancements. Ensuring the credibility of laboratory results is equally crucial, requiring rigorous calibration, standardization, and quality control at every stage of development. Accreditation frameworks must be strengthened, and private sector investment should be encouraged to bridge the gap between research and industry. Additionally, promoting a science culture and promoting digital literacy can generate community awareness and strengthen the foundation for innovation. To sustain scientific progress, budget allocation for STI should be increased to 1-1.5% of GDP, with robust monitoring mechanisms ensuring the timely release and efficient utilization of funds. Other funding sources, such as private sector investments, global ventures, multilateral institutions, and international organizations, should also be explored. Resource optimization should be prioritized by encouraging the shared use of research facilities and ensuring meticulous selection and procurement of costly equipment. Implementation is the last remaining pillar, without which policies goals cannot be met. Thus, proper mechanisms should be devised to ensure adequate monitoring and evaluation of the different goals, while also taking into consideration, accountability at all levels to track progress and address shortcomings. Section 9 of this Document outlines salient recommendations for revisions in the National Science, Technology, and Innovation Policy (NSTIP) - 2022.

1. Preamble

As a part of its approved **PSDP Project titled: "Upgradation and Capacity Building of Pakistan Academy of Sciences (Natural and Social Sciences)"** in the year 2020, the Pakistan Academy of Sciences (PAS) assumed the task to initiate work regarding review and upgrade different national policies**.** Considering Science and Technology being the backbone of any country, the NSTIP 22 was chosen as the priority policy to be reviewed by the Scientific Advice to Government (SAG) Unit for upgradation.

Countries are shifting towards knowledge-based economies to achieve sustainable growth, global competitiveness, and resilience by leveraging innovation, creativity, and intellectual capital. A well-structured Science, Technology, and Innovation (STI) Policy is crucial for addressing societal challenges, driving economic growth, and strengthening national resilience. By promoting innovation, supporting R&D, and developing human capital, STI policies enable countries to adapt to rapid technological changes and position themselves as key players in the global knowledge economy. However, equally important is a robust policy implementation mechanism. Key Performance Indicators (KPIs) for STI vary across countries, but common indicators include R&D expenditure, patent filings, scientific publications, high-

tech exports, and innovation index rankings. China leads globally in patent filings, followed by the USA and Japan. Both, China and the USA, dominate in research publications while China, Japan, Malaysia are emerging as leaders in high-tech exports.

There is a need for evidence-based, mission-oriented policies that address domestic challenges alongside global objectives like the UN's Sustainable Development Goals (SDGs). In general, developed nations focus on high-tech industries, sustainability, and global competitiveness, while developing countries prioritize technology transfer, digital inclusion, and socioeconomic challenges. Irrespective of its geographical location, each country has its own national priorities based on its domestic innovation capability, standard of living and global challenges. For Pakistan these lie in addressing its water scarcity crisis, the energy conundrum, climate mitigation, and the development of emergent technologies such as the artificial intelligence (AI), nanotechnology, quantum computing, etc.

Although Pakistan is categorized as a developing nation on the basis of its low per capita income, underdeveloped industrial base, a relatively low level of affluence etc., it has the capacity and potential to rise above several contemporary nations, being the only Islamic country among the declared nuclear states. Pakistan's strategic commissions serve as a prime example of achieving defined goals despite the absence of formal policy documents, successfully overcoming significant challenges. With the right ingredients i.e. highly skilled manpower, robust infrastructure, collaborations leading to Transfer of Technologies (ToTs), reverse engineering, spillover effects, and specialized training, these commissions have consistently delivered results. Supported by adequate financial resources, they have thrived even in the face of international embargoes and external hostilities.

It is time, the government starts recognizing the importance of STI for national economic development, and prioritizes the development of strong policies to promote the integration of science, technology and economic growth. It also needs to focus on addressing issues that jeopardize the effective implementation of policies, the foremost being the changed priorities each time the government changes.

2. Scientific Advice to Government (SAG)-Unit at Pakistan Academy of Sciences

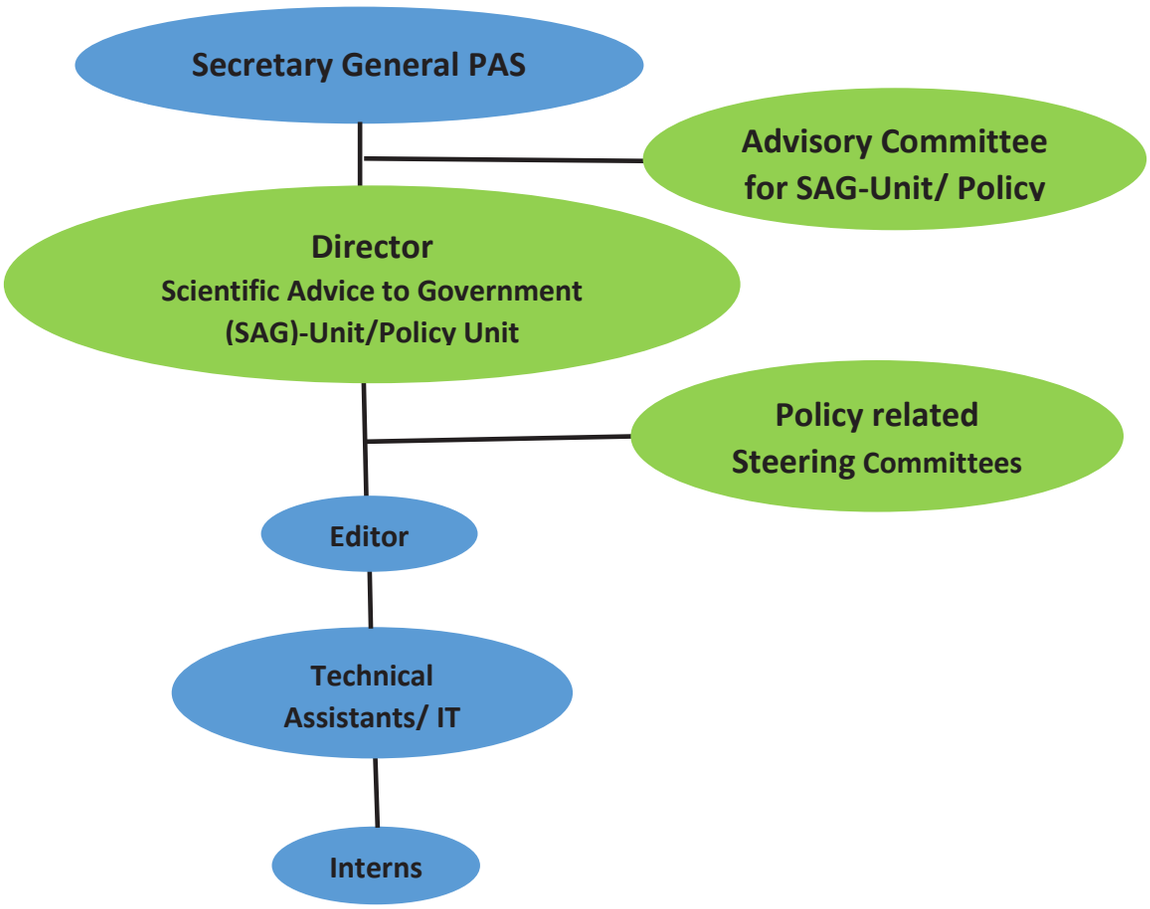
In Pakistan, there is a preceives gap between the challenges being faced by the country and the policy response to combat these challenges. The Pakistan Academy of Sciences comprises of Fellows and Members who are top of the line scholars in various field of natural sciences and are fully capable to play a vital role in the review of existing policies and/or developing new policies in relation to national Sustainable Development Goals (SDGs). In the past, PAS has also worked on review/recommendations for upgradation of various National Science Policies, such as the following:

1. Joint Panel Discussions on National Science Policy I. Food, Agriculture & Minor Forest Industries (25-27 Jan, 1975) by PAS and National Science Council
2. Joint Panel Discussions on National Science Policy II. Mineral Resources (25-27 Jan, 1975) organized by PAS and National Science Council
3. Joint Panel Discussions on National Science Policy VI. Health and Medicine (25-27 Jan, 1975) organized by PAS and National Science Council
4. Joint Panel Discussions on National Science Policy VIII. NUTRITION (25-27 Jan, 1975) organized by PAS and National Science Council
5. International Conference on Management of Environment, Feb. 17-19, 1975, Part I, Proceedings and Recommendations, Pakistan Academy of Sciences, Islamabad
6. Proceedings of Seminars and Policy Briefings on Environmental Pollution and Climate Change, 21-22 October, 1991 (A Brief Report), sponsored by Climate Institute, Washington, D.C.; Pakistan Academy of Sciences; Pakistan Atomic Energy Commission; and Pakistan Council of Scientific and Industrial Research (1994).
7. Research and Development in Pakistan, Review (1947-89) and Future Perspective, by PAS and PCST (1991-92).

After award of the PAS/PSDP Project in the year 2020, the Pakistan Academy of Sciences envisaged to establish a "Scientific Advice to the Government (SAG) Unit (also referred to as PAS Policy Unit) of experts for compilation of Policy Briefs/Policy Reviews for provision of Scientific Advice on issues of national interest and concerns as and when required by the Government of Pakistan for the stability, prosperity and socioeconomic development of the country. The mandate of the Scientific Advice to Government (SAG)-Unit/Policy Unit is to **offer impartial policy reviews, Policy Briefs and Recommendations for upgrades of existing policies and/or compilation of fresh policy documents** for various Ministries of the Government of Pakistan in collaboration with PAS Fellows and PAS Members and also on issues and plans referred to the Academy by the government of Pakistan from time to time**.** As such, the main objective of the SAG-Unit/Policy Unit is to compile policy reviews, policy briefs in the domain of natural sciences such as Science and Technology, Educational Reforms, Conventional and Renewable Energy, Industrial Growth and its Linkage with Academia and Scientists, Water Security, Preservation of Clean Drinking Water Resources, Small and Large Dam Safety, Agriculture Security, Food Security, Industrial Growth, Environment and Climate Change, Clean air, Science Diplomacy related International Affairs, Disaster Management, etc.

In its organizational structure, the SAG-Unit comprise of 4 offices (equipped with advance level computing, printing and scanning facilities) that are occupied by experts, resource persons, and interns who are recruited on contract basis for policy related specific tasks. The mandated outputs of the HR program of the "SAG-Unit" is to compile about 3-4 "Policy Briefs/Outputs" per year on issues of vital national concern to be indicated by the GoP in the

domain of natural sciences. The SAG-Unit formally started functioning w.e.f. 1st July 2024, after the appointment of its required Human Resource. The **organizational structure of the PAS SAG-Unit/Policy Unit** is illustrated in the following organogram.



The SAG-Unit/Policy Unit consists of the following five type of resource persons and scientific/technical staff to execute and manage various tasks and functions of the Unit:

Advisory Committee (AC): The Advisory Committee for the SAG-Unit is comprised of no less than 5 eminent scientists (qualified policy researchers with background in natural sciences) from inside and/or outside Pakistan with relevant experience to help Governments understand and utilize scientific advice. President Pakistan Academy of Sciences (PAS) in consultation with the PAS Council and HEC is responsible to constitute the Advisory Committee to advise the Academy and the Director SAG-Unit on establishing processes and norms for operation of the "SAG-Unit and compilation of Policy related documentation. Further, the scientific advice provided by the Advisory Committee is to be documented and provided to all stake-holders after initiation of the SAG-Unit. The PAS Council in its meeting held on 28th September, 2024 reconstituted the Advisory Committee (AC) for the "Scientific Advice to Government (SAG)-Unit /Policy Unit" created at Pakistan Academy of Sciences in line with the requirements of PAS/PSDP Project titled: "Upgradation and Capacity Building of Pakistan Academy of Sciences (Natural and

Social Sciences). The reconstituted Advisory Committee comprises of the following eminent scientists and professionals:

1. Prof. Dr. Kauser Abdulla Malik (H.I, S.I., T.I.), Fellow PAS (Convener Advisory Committee) President, Pakistan Academy of Sciences, Islamabad and Dean of Science, F.C. College University, Lahore
2. Prof. Dr. Anwar ul Hassan Gilani (H.I., S.I.), Fellow PAS, Former Chairman, Pakistan Council for Science and Technology, Islamabad, Former VC, The University of Haripur, KP, Consultant HEC (PR & I/QA)
3. Prof. Dr. Iqrar Ahmad Khan (H.I, S.I.), Fellow PAS, VC, Agriculture University, Faisalabad, Ex-VC/ Director COP Department of Centre for Advanced Study in Agriculture & Food Security, University of Agriculture, Faisalabad
4. Dr. Ather Osama, Science Policy Maker, Managing Partner, INNOVentures Global (Pvt) Ltd. and Founder, Pakistan Innovation Foundation, T6-2/6, NHS Phase 4, PNS Karsaz, Karachi, Former Member (Science), Planning Commission of Pakistan, Pak Secretariat, Islamabad, Philanthropist
5. Prof. Dr. Mudassar Asrar, Member Baluchistan Public Service Commission Meritorious Professor, Former Chairperson Pakistan Council for Science and Technology, Distinguished Professor ASAB, NUST, Islamabad
6. Maj. General (Retd.) Aamir Ikram H.I. (M), Fellow PAS Advisor Health FF, Former Executive Director, National Institute of Health, Park Road, Islamabad
7. Prof. Dr. Waheed Akhtar (S.I.), Fellow PAS, Scientist Emeritus, School of Biological Sciences (SBS), University of The Punjab, Lahore
8. Prof. Dr. Muhammad Aslam Baig (H.I, S.I., T.I.), Fellow PAS, Secretary General, PAS, Former Chairman Physics Dept. & Dean of Science, QAU, Islamabad, Former Director ALPD & Advisor Technical NCP, President Science Council of Asia
9. Dr. Riffat M. Qureshi, Director Administration, PAS, Former Chief Scientist and Director Coordination, PINSTECH/PAEC, Islamabad, Former Director CAAD and Technical Advisor, NCP, Islamabad

Director Scientific Advice to Government (SAG)-Unit: The task of the Director SAG-Unit/Policy Unit is to manage operation of the SAG-Unit and to establish links with various Ministries/Establishments of the GoP in matters related to Policy Documentation and to steer/supervise the overall activities and functioning of the Unit for “Scientific Advice to the Government”.

Editor: The task of the Editor is to facilitate compilation, editing and printing of (i) policy related documentation for “Scientific Advice to Government” Unit; as well as flagship journals in the domain of natural sciences PAS Newsletters.

Technical Assistants with Expertise in IT: The task of the Technical Assistants is to assist Director SAG-U in compilation of policy documentation related matters and to maintain sustainable operation and maintenance of IT infrastructure, and provision of ICT related services at PAS Secretariat.

Interns: The task of Interns is to support the task for collection and analysis of baseline information and data for review of existing policies and for compilation of new policies.

3. Strategy Adopted to Upgrade Policy

A two-pronged strategy was adopted to enable effective upgradation, implying that the policy was reviewed by SAG Unit of PAS, as well as relevant experts outside of PAS (scientists from academia and strategic commissions, research organizations economists and policy making institutes). This was followed by a workshop aiming to brainstorm its different aspects. For its part, the SAG Unit carried out a detailed country comparison study, besides consulting several government documents, previous versions of NSTIPs, Pakistan Vision 2025, UN SDGs 2030 and miscellaneous articles on policy writing, implementation and importance of indicators. Outside of PAS, a number of stakeholders were approached and contributed by sharing their views on the existing policy. Information gathered by the SAG Unit, and feedback received by reviewers was compiled in the form of a document consisting of two tables; one presents the gaps identified in NSTIP-22 (*Annex-I*) and the other identifies major reasons for the failure to implement STI policies (*Annex-II*), while ensuring alignment with national development goals. Where feasible, both tables also incorporate appropriate suggestions to overcome the aforementioned gaps. This compilation was shared with all reviewers well in advance of the scheduled NSTIP-22 Workshop, so as to facilitate their active participation in the event.

4. Brainstorming in Workshop Session

The objective of the workshop was to provide all stakeholders a brainstorming opportunity to give NSTIP-22 a mutually agreed upon, revised shape. The daylong event was held on 22nd October 2024 at the PAS Video Conferencing Room, and was attended by 22 stakeholders from different sectors, and eminent fellows. Joint Secretary, MoST and Member Finance, PSF were also requested to attend the event. President of PAS welcomed the participants of the workshop and praised their efforts in contributing to this national cause. The Secretary General, PAS gave an introduction to PAS activities and also highlighted the importance of PAS SAG Unit. Director, SAG Unit, gave the strategy for deliberations on NSTIP-22 and also summarized the same, stating that it is a comprehensive document, covering a variety of aspects such as CPEC, SDGs, and emergent areas like AI etc., but on the downside, it lacks a proper implementation framework and is vague in many aspects. Director SAG also presented

the outcome of Ishikawa Analysis *(Section 5)* for formulating a good NSTIP, identifying six fundamental factors on which NSTIP depends. These formed the basis of major brainstorming fin the workshop.

Here, it may be mentioned that amongst other factors, all participants were of the view that the revised policy document should be based on fewer but realistic Policy Statements *(Section 7).* Outcome of the NSTIP-22 Workshop deliberations, have been documented in the form of Minutes attached in Annex-II (this document).

Pictorial Glimpses of the Workshop

5. Policy Analysis

Policy analysis plays an important role in helping to define the goals of a proposed policy and in identifying similarities and differences in expected outcomes, based on past and present conditions. NSTIP-22 was subjected to 4 different analyses namely Ishikawa, PESTLE, SWOT and Pareto. Brief discussion of the results obtained is given in the ensuing paragraphs.

a) Ishikawa Analysis

An Ishikawa analysis (also called a Fishbone diagram) is a visual tool that helps identify the multiple potential root causes of a problem across different categories, offering a broader qualitative overview of possible contributing factors without necessarily pinpointing a single root cause. Ishikawa analysis of an NSTIP-22 policy is given in the Fishbone diagram (Fig. 1).

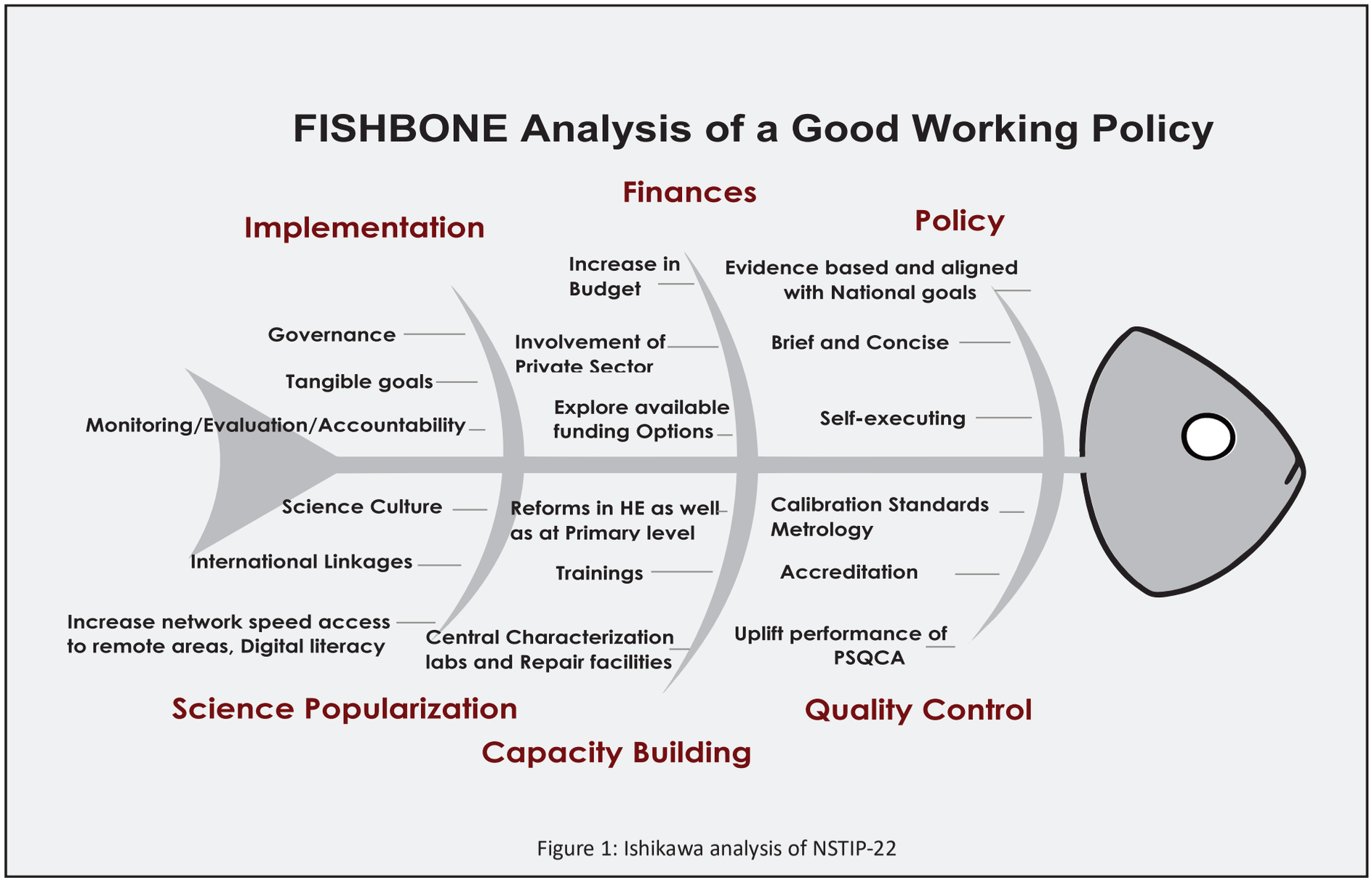


Figure 1: Ishikawa analysis of NSTIP-22

On the basis of this analysis, NSTIP pillars and recommendations on how to incorporate the same in STI policy, are given in Table 1.

Table 1: Overview of Policy Pillars and Recommendations

Pillars	Recommendations
Policy	Brief, concise and aligned with national goals and UN SDGs
Capacity Building	Focus on improving standard of education, training of HR, indigenous development, infrastructure development
Quality Control	Effective integration of PSQCA and improving performance of standardization laboratories
Science Popularization	Mechanism to involve remote areas (clusters, digital literacy etc.)
Implementation	(1) Address governance issues by establishing an authoritative Scientific Council under direct control of PM (2) Define tangible short, mid and long term goals to ensure effective monitoring
Finances	Increase budget allocation to 1-1.5% of GDP. Involvement of private sector and miscellaneous financing options

b) PESTLE analysis

A PESTLE analysis for assessing a policy examines the external factors impacting a policy decision, and helps in identifying potential challenges in implementing a new policy or revising an existing one. Herein, the effects of 6 external factors namely political, economic, social, technology, legislation and environment on NSTIP-22, have been determined. The same are tabulated below:

Table 2: PESTLE analysis of NSTIP-22

Factors	Possible impacts
Political	Although, the government backs S&T policies with commitments to increase investment in STI, yet political instability leading to change in government affect long-term policy continuity and commitment

Economic	Limited funding for R&D hampers the ability to execute the policy's objectives. Private sector involvement remains low. Rising cost of inflation and budget cuts, also strain funding
Social	Lack of public awareness about the importance of STI leads to less societal support for government investments. Insufficient emphasis on STI curricula also curtails the development of a skilled workforce
Technology	Pakistan faces a challenge in adopting advanced digital technologies, though initiatives like AI and digital R&D focus are part of the policy. Weak academia-industry linkage also result in lack of commercialization of innovations
Legislation	Weak enforcement of IP laws discourages local innovation. IP protections are not robust enough to foster research-based startups. Slow regulatory approvals for new technologies and start-ups, also limit innovation momentum
Environment	The policy recognizes the importance of sustainable technology, yet its implementation in environmental research and innovation is slow. There is a growing need for innovation in RE, but the policy lacks adequate focus

c) SWOT analysis

A SWOT analysis takes into account internal factors such as **S**trengths & **W**eaknesses, as well as external factors such as **O**pportunities & **T**hreats. As such, the SWOT analysis helps to identify areas for improvement, so that strengths can be built upon and weaknesses addressed while seizing opportunities, and mitigating threats.

Table 3: Detailed SWOT analysis of NSTIP-22, and proposed recommendations

Factors	**NSTIP-2022**	**Recommendations**
Strengths	Focusses on R&D, AI, digital transformation, and industry-academia collaborations. Targets key sectors like agriculture, energy, climate, and healthcare	Formulate evidence based, mission oriented policy aligned with UN SDGs and national goals such as climate change adaption and mitigation, water scarcity, energy crisis, AI development etc.
	Encourages public-private partnerships to enhance innovation	Create simplified government procedures to attract private sector investment, including preferential tax policies and patent rights sharing

Weaknesses	Bureaucratic delays and slow policy execution due to inefficiencies in the system.	Reduce red tape by creating a Scientific Council under PM control, similar to models in Iran (Supreme Council) and Turkey (TUBITAK)
	Policy write-up is vague and has unnecessary details. There are no tangible goals based on ground realities. Too many policy statements (61 in all) make it difficult to focus on any one	Policy should be brief and concise, with a clear focus on its deliverables. Introduce RBMs with short, mid and long term goals. Reduce policy statements to make them realistic
	Poor industry-academia linkage limits research commercialization	Highlights legal gaps preventing academia-industry collaboration, and recommend incentives like tax benefits and industry-sponsored R&D
	Weak intellectual property laws, discouraging innovation	Enforce IPs, tech transfer offices, and an entrepreneurial academia model
	Brain drain, as skilled researchers move abroad for better opportunities	Develop a mechanism to introduce strong incentives to retain local talent, including better salaries, research grants, and industry placements
	Meagre funding (merely 0.4% of GDP)	Strive to get an increase in the science and innovation budget to 1.5% of GDP.
Opportunities	Successful science diplomacy may help engage the international scientific community to promote innovation in the country	Use science diplomacy and diaspora engagement to benefit from Pakistani researchers abroad besides obtaining ToTs etc.
	Integration with UN SDGs to align with global research	Focus on goal-based research projects, but also ensure at least 30% of research is investigative, rather than demand-driven
	Expanding STEM education to strengthen the workforce for future industries	Introduce reforms in vocational and higher education, and introduce industry-aligned curricula. Also, focus on faculty training. Reforms in HE will help raise the innovation index of the country, by improving indigenous development skills, scientific

		research infrastructure and standardization facilities
	Start-ups in AI, biotechnology and RE	Focus and support spin-offs to create new research companies, like in other contemporary countries
Threats	Political instability, leading to policy shifts and implementation failures.	Adopt legislative measures to ensure continuity regardless of government changes
	Economic downturns, affecting R&D investments	Create diversified funding sources, including private companies, multilateral institutions, and international organizations
	Security and cybersecurity risks, impacting digital transformation efforts	Use digital literacy for broader outreach
	Global competition, with stronger innovation policies in rival nations	Adapt best practices from around the world
	Slow adoption of emerging technologies in local industries	Develop Technology Transfer Offices and Techno Poles (innovation hubs) to accelerate adoption at regional levels

Table 4: Summary of SWOT analysis

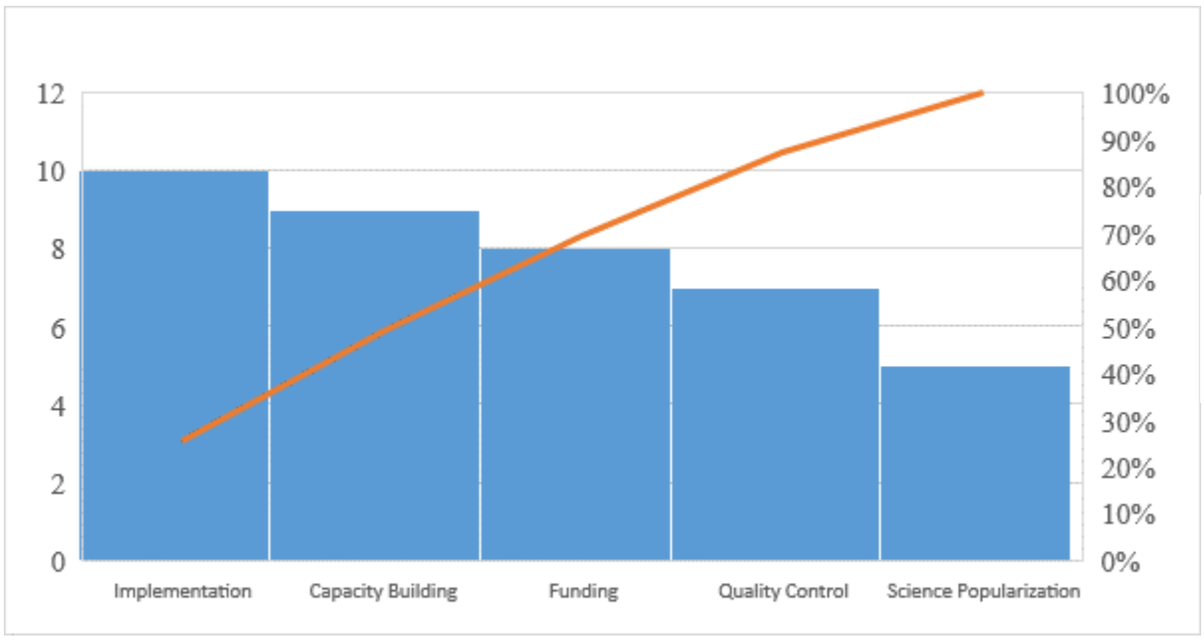
Factor	**NSTIP-22**	**Recommendations**
Strengths	Government commitment, R&D focus, PPP initiatives	Evidence-based, mission-driven, structured implementation
Weaknesses	Funding gaps, bureaucracy, weak IP laws	Establish a scientific council, ensure IP enforcement, and devise a mechanism to retain talent
Opportunities	Global partnerships, startup ecosystem, STEM growth	Diaspora engagement, spin-off policies, and industry-aligned education
Threats	Political instability, weak digital adoption, economic constraints	Legislative protection, diversified funding, and technology transfer hubs

d) Pareto Chart

The Pareto bar chart helps visualize the most critical factors by ranking them in descending order of significance. It is based on the Pareto principle, which states that 20% of effort produces 80% of results. Based on the Ishikawa, PESTLE and SWOT analysis, key issues in NSTIP- 22 (other than policy write-up), can be ranked in terms of their impact on national innovation.

1. Implementation
2. Capacity Building
3. Funding
4. Science Popularization
5. Quality Control

Figure 2: Pareto analysis of NSTIP-22



As per the Pareto bar chart (Fig. 2), policy implementation has the highest impact (80%), making it the most critical area. Capacity building (75%) follows closely, highlighting the need for reforms in HE to ensure talent development. The cumulative curve (red line) shows that the top 2 factors contribute to about 80% of the total impact. Based on this analysis, prioritizing effective implementation and capacity building will yield the highest returns in advancing Pakistan's innovation ecosystem.

6. Country Comparison

Comparative analysis of Pakistan's STI policy with those of 10 other countries comprising of developing and developed Countries was done to identify the similarities and differences with the latter. An obvious contrast is the very low GDP % allocated to S&T by the Pakistani government, even lower than that of Bangladesh. Another eye-opener is the second- lowest global standing (91st) of Pakistan. A comprehensive table is presented here:

Table 5: Country comparison for STI Policies

Parameter/ Country	Pakistan	India	Bangladesh	Iran	Thailand	Malaysia	Turkey	Japan	China	USA
Governing Body	Ministry of Science and Technology, Higher Education Commission	Department of Science and Technology, Ministry of Science and Technology, Council of Scientific and Industrial Research	Ministry of Science and Technology, Bangladesh Council of Scientific and Industrial Research, University Grants Commission	Supreme Council of the Cultural Revolution, Vice Presidency for Science, Technology,	Ministry of Higher Education, Science, Research and Innovation, National Science and Technology Development Agency	Ministry of Science, Technology and Innovation	Scientific and Technological Research Council of Turkey, Turkish Academy of Sciences, Ministry of Industry and Technology, Presidency of Strategy and Budget	Ministry of Education, Culture, Sports, Science and Technology, Japan Science and Technology Agency	Ministry of Science and Technology, Chinese Academy of Sciences	National Science Foundation, White House Office of Science and Technology
Policy write-up	Lengthy and vague	Often lengthy and bureaucratic	Generally clear and focused	Detailed but sometimes vague in execution	Concise and practical	Generally clear and focused	Concise and focused	Lengthy but clear	Broad and detailed, sometimes complex	Clear and well-defined
National Goals	Basic research; agriculture, emergent areas (AI, quantum etc.)	Digital economy, self-reliance, and sustainable development	Advancing industry through digital innovation and tech self-reliance. Promoting STEM,	Self-sufficiency, defense technology, and knowledge-based economy	Industrial upgrade, digital economy, and global competition	Digital transformation, industrial diversification and green economy	Defense innovation; digital transformation	Aging population solutions, high-tech innovation, and global competitiveness	Technological self-sufficiency, global innovation leadership, and military modernization	Economic competitiveness, technological leadership, national security, and climate resilience

			sustainability, and research collaboration.							
Implementation	Political instability and bureaucratic hurdles besides unclear goals delay effective implement-ation	Partially self-initiating, but slow implementa-tion	Bureaucratic hurdles and limited industry-academia collaboration slow down execution	Heavy government reliance slows implementa-tion	Industry and academic collaboration drive execution	Strong emphasis on startups and industry-driven execution	Bureaucratic delays and long-term coordination issues slow execution	Rigid bureaucracy and slow adaptation to disruptive technologies can cause delays	Rapid execution through centralized control	Decentralized, market-driven innovation ecosystem ensures rapid execution and global leadership
Capacity building programs	Special Technology zones, Science and Technology Parks, Centers of Excellence	Atal Innovation Mission, National Research Foundation	National Science and Technology Policy, Hi-Tech Parks, Digital Bangladesh Initiative, Innovation Hubs	Comprehensi ve Scientific Roadmap, Nano-technology Initiative	Thailand 4.0, Science Park Development	National Policy on STI, Malaysia Startup Ecosystem	Hi-Tech incentive and youth-led innovation hubs	Moonshot R&D Program, Society 5.0	Made in China 2025, AI National Strategy	National AI Initiative, CHIPS and Shence Act

Science Popularization	Limited Few NGOs, Science fairs Government initiatives.	Strong ISRO outreach, Science fairs Widespread educational programs	Active STEM education through museums, Science fairs, Media Outreach	Moderate Government-backed science centers	Growing Science museums, School programs, Annual national science week	Active Science centers, Government campaigns, STEM education	Growing Science fairs, TÜBİTAK initiatives, Public lectures	Advanced JAXA outreach, Science museums, Integration in popular culture	Extensive Large-scale science museums, Government-driven campaigns, Tech expos	Leading NASA outreach, Science museums, TV shows, Widespread STEM initiatives
Global Standing Index (KPI)	**91st**	39th	106th	64th	41st	33rd	37th	13th	11th	3rd
Funding GDP% @2023	**0.4%**	0.8%	0.6%	0.6%	1.2%	1.5%	1.0%	3.3%	2.5%	3.1%

It is apparent from the Table that USA, Japan, and China invest the most in R&D, and also have long-term innovation strategies, with US taking the lead. Also, most countries have dedicated capacity-building strategies.

7. Proposed Policy Statements

Based on policy analysis and brainstorming in Workshop, the following 22 Policy Statements are proposed for the revised NSTIP-22 document:

1. To develop a comprehensive evidence-based and mission-oriented policy leading to a knowledge based economy. The policy will adopt a 3-pronged approach, focusing simultaneously, on capacity building, strengthening of local technology, and innovation at par with global development.
2. To carry out a policy analysis of the R&D ecosystem in the country and identify its weaknesses.
3. To propose and work towards the establishment of a Supreme Council (as in *Iran and Turkey) to address governance issues related to bureaucratic delays.
4. To suggest legislative measures for the uplift of S&T in the country.
5. To take a structured approach in identifying Pakistan-specific national needs, and align research with key challenges (water scarcity, energy crisis, climate challenge, agriculture problems etc.) and the UN SDGs 2030.
6. To develop appropriate monitoring and evaluation frameworks based on tangible short, medium and long term goals, leading to timely implementation of policy goals.
7. To make contingency planning a part of the national implementation plan.
8. To persuade the government to increase budget allocated to NSTI research, and develop a strategy to ensure the prudent use of funds. In parallel, explore all possible funding options in the public and private domain, both, within and outside the country.
9. To undertake measures for capacity building by ensuring quality education, vocational trainings and upgradation of research infrastructure.
10. To enhance the standard of education by introducing higher education reforms, focusing on the all aspects related to institutes, faculty and curricula etc.
11. To establish technology hubs consisting of Science and Technology Parks, incubators etc.
12. To create a mechanism for, and promote the sharing of equipment and research facilities, so as to avoid duplication of equipment and undue burden on the national economy.
13. To develop a system of ensuring the routine maintenance, troubleshooting and repair of equipment installed at academic and research institutes.

14. To focus on gradual self-reliance by promoting indigenous development supported by reverse engineering and transfer of technology.

15. To identify channels through which technology spillovers may occur, and how these may be put to productive use.

16. To develop a culture of brain-gain by providing healthy incentives to scholars abroad.

17. To create an ecosystem of science popularization, also reaching-out to far flung rural areas.

18. To promote science and technology co-operation with developed countries in areas of national interest, and those related to the UN SDGs.

19. To create liaisons with the international scientific community by taking advantage of Pakistani diaspora.

20. To develop a civil-military linkage so as to translate research in the open sector into applications in the defense area.

21. To upgrade the existing national data repository and ensure its availability at all research organizations and academic institutes.

22. To ensure the need to carry out quality control of developed systems/products, and effectively integrate the role of Pakistan Standards and Quality Control Authority (PSQCA), Pakistan Accreditation Council (PNAC), National Metrology Institute (NMI) etc. In parallel, also endeavor to improve the performance of these organizations.

8. Implementation Challenges and Solutions in NSTIP

The implementation and monitoring of STI policies face several critical issues. An impactful STI policy requires a robust monitoring and evaluation system to ensure that policies achieve their intended goals and adapt to changing circumstances. All stakeholders and PAS experts agreed unanimously that implementation gaps in NSTIP policy were a result of governance issues, lack of clarity in policy goals, ineffective progress monitoring and funding issues besides deep rooted corruption in the system. Listed below are the proposed solutions to combat the major challenges facing NSTIP-2022:

(a) Governance Issues

- Legislation to sustain policy goals irrespective of political change.
- Establishment of a Scientific Council under the Prime Minister's direct control to streamline decision-making and avoid inter-ministerial conflicts.

- Entrusting leadership of steering committees should to young and dynamic scientists rather than ministers.
- Development of self-executing policies to minimize reliance on direct government interventions.

(b) Lack of Clarity in Policy Goals

- Policies must be mission-oriented and aligned with national needs and Sustainable Development Goals (SDGs).
- Stakeholders from diverse sectors should be involved in policy design, implementation, and evaluation.
- A phased implementation outline should be included to help policymakers and investors prioritize actions.

(c) **Ineffective Progress Monitoring**

- Developing robust monitoring frameworks with clear metrics and Key Performance Indicators (KPIs).
- Enhancing transparency and accountability in evaluating procedures.
- Conducting regular reviews to identify and address gaps, with input from employees and stakeholders.
- Introduce Results based Monitoring (RBM) system, to assess progress over shorter intervals with well-defined milestones and long-term targets.

(d) Funding Issues

- Increasing budget allocations and ensuring prudent utilization of resources.
- Promoting research financing through local and international donors.
- Encouraging competitive grants to maximize impact.
- Building research capacity despite limited resources and infrastructure.

Stakeholders at the NSTIP workshop were of the view that the Scientific Advice to Government (SAG)-Unit established at PAS should share and take up the science policy related matters at the highest level of the government through the Ministry of Planning, Development and Special Initiatives (Government of Pakistan) so as to increase the visibility of scientific issues at the most relevant forum for immediate remedial actions. Also, an annual report should be provided to both the President and the Prime Minister to keep them aware of the essential requirements of different bodies of the Government of Pakistan for developments in the country's efforts for research and innovation.

9. Suggested Revisions for National Science, Technology, and Innovation Policy (NSTIP) - 2022

NSTIP-22 provides a broad vision for science, technology, and innovation but lacks detailed execution plans. Incorporating recommendations for NSTIP-22, such as the establishment of

a Scientific Council for policy oversight, legislative protection for continuity, tax rebates to the industry to enhance collaboration with academia, diaspora engagement for brain drain reduction and results based monitoring system, will ensure policy implementation and ensure long-term sustainability. The following section outlines the salient recommendations for revisions in the National Science, Technology, and Innovation Policy (NSTIP) - 2022:

1. Vision & Mission

To establish Pakistan as a globally competitive knowledge-based economy by fostering innovation, research, and technology-driven growth, aligning with national challenges and UN Sustainable Development Goals (SDGs).

2. Governance & Implementation Framework

2.1 *Policy Stability & Legislative Protection*

- Establish a Scientific Council under the Prime Minister's Office, modeled after Iran's Supreme Council and Turkey's TUBITAK, ensuring continuity regardless of government changes.
- Enact legislative protection to ensure NSTIP implementation across administrations, safeguarding it from political shifts.

2.2 *Bureaucratic Efficiency & Execution*

- Streamline policy execution by reducing bureaucratic delays through a one-window approval system for research grants, startup funding, and technology commercialization.
- Create an Independent Technology Oversight Board (ITOB) to track and evaluate NSTIP's implementation, ensuring accountability and measurable progress.

3. Research & Development (R&D) and Innovation

3.1 *Increased R&D Funding*

- Allocate 1.5-2% of GDP for science, technology, and innovation.
- Implement strict fund monitoring to ensure timely release and efficient utilization.
- Introduce performance-based funding where R&D institutions receive additional grants based on measurable contributions.

3.2 *Industry-Academia Collaboration*

- Bridge the gap by legally mandating private sector participation in national R&D projects.
- Provide tax incentives, patent access, and co-ownership of research outcomes for industries investing in academia.
- Establish Technology Transfer Offices (TTOs) at universities to facilitate commercialization of research.
- Promote entrepreneurial academia by allowing professors to work on startup ventures alongside teaching.

4. Education & Capacity Building

4.1 *STEM Education & University Reforms*

- Revamp curricula to align with industry needs, ensuring graduates are industry-ready.
- Introduce two university streams:
    1. Basic Science Universities (research-focused)
    2. Technology-Oriented Universities (producing skilled technologists for industries)
- Implement mandatory faculty training in industry settings (30–40% of university faculty must have industrial experience).

4.2 *Vocational & Entrepreneurship Training*

- Upgrade vocational institutes to focus on practical skill development.
- Encourage technology-driven entrepreneurship, integrating business courses with STEM education.

5. Indigenous Technological Development

5.1 *Technology Localization & Self-Reliance*

- Identify imported technologies and enable local production through R&D investments.
- Support reverse engineering and technology adaptation using expertise from the Pakistani scientific diaspora.
- Establish Strategic Research Commissions to oversee the development of local tech solutions.

5.2 *Infrastructure & Equipment Modernization*

- Develop Centralized Research Labs to prevent duplication and ensure optimal resource utilization.
- Introduce a National Equipment Maintenance Fund, modeled after Singapore's A-Star Center, to keep high-end research facilities operational.

6. Science Popularization & Public Awareness

6.1 *Digital Literacy & Tech Outreach*

- Promote digital literacy in remote areas through Tech Hubs and Science Outreach Programs.
- Establish regional innovation clusters (Techno Poles) based on local industry needs.

7. International Collaboration & Diaspora Engagement

7.1 *Science Diplomacy*

- Strengthen ties with global research institutions for technology transfer.
- Create incentive programs for Pakistani scientists abroad to return and contribute to national innovation.

7.2 *Diversified Funding Sources*

- Encourage partnerships with multilateral institutions (World Bank, UNESCO, etc.).
- Attract venture capital and private R&D investment through regulatory reforms.

8. Intellectual Property Rights (IPR) & Legal Reforms

- Strengthen IPR enforcement to protect innovations and incentivize inventors.
- Encourage industries to commercialize patents through relaxed licensing agreements.
- Introduce a Patent Commercialization Fund to help startups bring innovations to market.

9. Quality Control & Standards

- Enhance Pakistan Standards and Quality Control Authority (PSQCA) to ensure international compliance.
- Implement third-party quality assessments to certify new technologies before market launch.

10. Monitoring, Evaluation & Future Roadmap

10.1 *Measurable Targets & Periodic Reviews*

- Define short (5 years), medium (10 years), and long-term (15 years) goals aligned with SDGs.
- Conduct bi-annual policy reviews to assess impact and refine strategies.

10.2 *Contingency Planning*

- Develop rapid response mechanisms for global scientific and technological shifts.
- Implement a policy continuity safeguard to prevent disruptions during government transitions.

It is concluded that after incorporation of the above mentioned suggestions in the NSTIP - 2022, the revised version of the NSTIP will not only address the previous weaknesses but will also ensure a result-driven, sustainable policy for the national progress. By integrating structured implementation mechanisms, Introducing HE reforms, securing funding, and enhancing industry academia collaboration, the revised NSTIP can help Pakistan stand amongst global leaders in science, technology, and Innovation.

Acknowledgments

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Sr. No	***Stakeholders Approached***	
1.	*MoST*	Dr. Zaheer Shah, Joint Scientific Advisor (P&C)
2.	*PAF-IAST*	Prof. Dr. M. Mujahid, Rector
3.	*KFU-EIT*	Prof. Dr. Amir Azam, VC
4.	*NUST*	1. Brig. Prof. Dr. M. Irfan, Principal& Dean SCEE 2. Prof. Dr. Javed Iqbal, IGIS, SCEE 3. Associate Prof. Dr. Ali Tahir HoD IGIS, SCEE 4. Prof. Dr. Faheem Khokhar, Director C-CARGO, IESE, SCEE 5. Prof. Dr. Muhammad Arshad, Associate Dean IESE, SCEE
5.	*PCSIR*	Dr. Mirza Habib, Member Finance PSF Attended
6.	*PIDE*	Dr. Usman Qadir, Senior Economist
7.	*PAEC*	Dr. Usman Khurshid, Director Science, PINSTECH
8.	*KRL*	Dr. M. Arif, Director, Member Science Office
9.	*NESCOM*	Dr. Najam-us-Saqib, DDG
10.	*SUPARCO*	Mr. Ameen Islam, Director, International Liaison
11.	*PAS*	1. Prof. Dr. Kausar Abdullah Malik, President 2. Prof. Dr. M. Aslam Baig, Secretary General & PSDP Project Director 3. Prof. Dr. Waheed Akhtar, Professor Emeritus SBS, PU, Fellow 4. Maj. Gen. Amir Ikram, ex-ED NIH, Fellow 5. Dr. Riffat Mahmood Qureshi, Director Administration 6. Dr. Sara Qaisar, Director SAG Unit

ANNEX - I

Compilation of Feedbacks by the Workshop Participants

Sr.	Identified Gaps	Suggestions/Remarks
Common		
1	Implementation issues	Discussed in detail in the Workshop
2	Limited role of private sector	• Simplify government procedures to encourage private sector investments in academia/R&D centers • Incentivize industry by (a) introducing a preferential tax system to promote R&D investment (b) access to IP, patents, and licensing from joint research (c) early access to innovative ideas and prototypes via university incubators for commercialization • Incentives for academia (a) universities receive additional grants or industry funding for research (b) access to industry tools, software, internships, and job placements for students (c) industry-funded scholarships support students in relevant fields
3	Absence of mechanisms to create linkages with industry	• Explore all viable options (PPRPs, collaborations, Technology Transfer Offices, Quintuple/Triple Helix models etc.) • Create consortia for collaboration on key areas like agriculture, healthcare, RE, AI, nanotechnology etc. • Launch national programs offering joint grants to universities and industries for projects with commercial and social value • Involve industries in curriculum design and vocational training to ensure graduates have relevant skills and practical experience

4	Inadequate budget	• Engage private companies through CSR initiatives to invest in R&D (Engro Corporation, Fauji Fertilizer etc.) • Explore global venture funds and multinational corporations for technology funding (Sequoia Capital, Microsoft, Huawei etc.) • Tap international government funding from EU (Horizon Europe), USAID, and China's Belt and Road Initiative program • Utilize funding from multilateral institutions such as the World Bank and Asian Development Bank, for sustainable development and innovation projects • Leverage NGO funding from various international organizations (Gates Foundation, Rockefeller Foundation, Wellcome Trust etc.)
5	Poor education standard	Reforms by HEC and Ministry of Education
Strategic Commissions		
	a) PAEC	
1	Promotion of researchers should be linked to bringing new industry based projects, bringing funding and producing useful products	----------
2	Incentives to researchers who help scientifically or technically to add value in the products and help in export enhancement	----------
3	University jobs should be on contract basis with attractive salaries	----------
4	Attention to theoretical fields also (Physics, Chemistry, Mathematics) otherwise these areas will run dry. Progress of these could be assessed by their published work in well reputed journals	----------
5	Adopt syllabus which is being taught in highly ranked international universities	----------
6	S&T culture should be implemented at school levels through various programs	----------
7	In industry, qualification of manpower should be regulated through Ministry of Labor and Industry	---------- ----------
8	Also include nuclear science, nuclear engineering, pharmaceuticals, radiopharmaceuticals, biological sciences, medical and medicinal sciences, energy conversion, storage technologies, stem cell science, advanced engineering materials, robotics and automation, autonomous vehicles etc.	Chapter 7 not important, because once policy is implemented important fields will appear in universities

	b) KRL	
1	Pakistan has an agriculture based economy which is prone to climate change effects. Adaptation of latest ecofriendly agricultural technologies for high yield crops, should also be emphasized in general and specific to most affected areas	----------
2	Some industrial set-ups may be pooled and nominated in specific fields for young scientists to get internships, funding and jobs later	----------
3	Some approachable funding/guideline platform should be devised for early level entrepreneurs who want to convert their ideas into products. As most of the incubators supports the young entrepreneurs only when they have achieved breakeven point for their idea into product/business, on risk free business basis	----------
4	Additive Manufacturing may be considered for addition in the main category separately, instead of covered in subcategory of 3D printing	----------
5	Proposed major activities/targets such as constitutional amendment for legal cover, establishment of national academy of STI management information system, and establishment of technology parks in five universities may be further deliberated with clear roadmaps and timeline for effective implementation	----------
	c) NESCOM	
To be received		
	d) SUPARCO	
1	Include specialized space technology courses within the curricula of HE institutions/ universities across Pakistan	----------
2	Establish CoEs in Space Science, Technology and Applications at leading campuses, fostering collaboration with industry and international partners with practical training components and interdisciplinary programs to ensure a well-rounded education that meets the evolving needs of the space sector	----------
3	Space technology parks and innovation incubators should also include space corners for sharing/ exchange of knowledge, and	----------

	fostering the research and development related to space innovations	----------
4	Encourage growth of a domestic space industry by providing incentives for public-private partnerships and facilitating the commercialization of space technologies. A vibrant space industry can contribute significantly to the economy and create job opportunities.	----------
5	Conduct public awareness campaigns to highlight the importance of space technology and its impact on society. Public support is crucial for the sustained investment and development of the space sector	----------
6	Government to invest in development of more advanced space science technology and its applications. Encourage research into next-generation space domain	----------
Experts/ Stakeholders		
	a) Dr. M. Mujahid (Rector, PAF-IAST)	
1	Develop strategies for capacity building of HR catering to the needs of current and future industry	----------
2	Teachers/trainers must be encouraged to spend time in industry, and some proportion of inducted teachers (30-40 %) must have industrial working experience in every field/discipline	----------
3	Skill-augmented education must be provided at all levels and every discipline, enhancing practical knowledge and psychomotor training (including industrial attachments)	----------
4	Encourage product-oriented R&D, and a larger proportion of funds be allocated for such purpose	----------
5	Universities could be categorized into 2 separate streams (1) Basic Science and (2) Technology oriented (producing industry-ready graduates contributing to Technology Parks)	----------
	b) Dr. Amir Azam (VC, KFU-EIT)	
1	The appointment procedure and rotation of the Heads of national R&D Organizations needs more deliberation (homegrown vs imported, tenure etc.)	----------
2	Create working groups adopting a bottom-up or hybrid approach	----------

3	Restructuring/reforming of underperforming organizations	----------
4	Article 1.1.4 *vis a vis* role of government in providing right environment needs to be discussed	----------
5	Revise standing of Pakistan in Global Innovation Index (non-documented/non-registered innovations etc. go unaccounted)	----------
6	Demand-driven research has its pros and cons, and should thus be elaborated	----------
7	Policy implementation should give greater detail (Policy Statement number 61)	----------
8	Replace evidence-based decision-making system with perception-based system	----------
9	The constitution and membership of NCST and EC NCST needs more discussion	----------
10	Deliberations are required on Industry ready HR (4.1.4)	----------
11	Include ethical framework for technologies like AI, genomics, STEM cells etc.	----------
	c) Dr. Muhammad Irfan (Principal & Dean SCEE, NUST)	
1	Include contribution of schools, colleges and technical training centers	----------
2	Include details about the Governments' plan on re-structuring Pakistan's Exclusive Economic Zones (EEZs) into the likes of SEZs and STZs	----------
3	Prioritize establishment of a National Spatial Data Infrastructure (NSDI)	----------
4	Consider incorporating Sustainable Development Goals (SDGs) and the significance of a Spatial Decision Support System (SDSS) for the integration of datasets, and accessibility to private and international sectors for enhanced revenue generation	----------
5	Lack details on how emerging technologies particularly the Generative Pre-trained Transformers (GPT) could be effectively integrated into Pakistan's STI strategy	Suggest detailed mechanism
6	Quality assurance i.e. framework for the coherent accreditation of practitioners, laboratories, research centers	• Establish of CoEs for various thematic areas of S&T in the country • Ensure compliance with standard research ethics

7	Establish framework for the deployment of RE systems for agricultural productivity	----------
8	Promotion of indigenization in technological development	Identify imported ingredients, components, or products used by various companies in their manufacturing process and encourage/facilitate their local production. Provisions, infrastructure, and mechanisms should be set up for the local production of such ingredients
9	Give component-wise breakdown and year-wise change in the budget, tax incentives, and subsidies as a step towards global competitiveness	----------
10	Emphasize need for energy management for civil and industrial infrastructures	----------
11	Update ranking of the national universities mentioned in the current NSTI policy, according to current year	----------
12	Give a clear roadmap for sustainability while incorporating emerging needs of environmental impacts/ climate change	----------
13	Introduce the term entrepreneurship in all relevant objectives	
14	Current economic challenges for the local industry should be more comprehensively addressed	Solutions to these emerging challenges should be proposed by consultation with the stakeholders of industry
15	Emphasize the importance of Geographic Information Systems (GIS) as mainstream area alongside Space Technology	----------
	d) Dr. Sarwat Ismail (Member Science, PCSIR)	
1	Need for greater alignment between educational outcomes and industry needs	Translate policy objectives into tangible improvements in the education system
2	Development of HR	Need for greater alignment between educational outcomes and industry needs
3	Indigenous development	Build the capacity to conduct research, particularly in the face of limited resources and infrastructure, and better coordination among various governmental agencies to support indigenous innovation and product development
4	Global competitiveness	Current state of the STI infrastructure may require substantial upgradation to meet these aspirations
	e) Dr. Usman Qadir (Senior Research Economist, PIDE)	
1	Maintain databases of science at universities, not ministries	----------
2	NIS is for prosperous countries and does not capture the social and political realities within the developing countries	Identify country specific national goals

3	Place adequate number of professors in all existing universities to enhance knowledge	----------
4	The focus of measures to train, develop and retain competent manpower revolve around monetary reward - recognition of scientists has been silent for long	A learning environment must be encouraged in academic institutions to produce quality graduates
5	Retention of skilled manpower, especially in academic institutions	Block role of politics in placement of skilled manpower at key positions
6	Focus on measures to improve productivity which will in turn improve competitiveness and efficiency	----------
7	Identify future trends for scientific innovation	PIDE Reform Agenda highlights areas where economy needs to focus
8	Focus on using S&T to improve the nation's competitiveness and efficiency	----------
9	Introduce performance-based incentives to private sector to show tangible results of R&D investment	----------
10	E-textiles etc. is wishful thinking since the country can as yet not compete with other producers	----------
11	Space technologies, nanotechnology and other emerging technologies require access to metallurgical and other underlying skills which the country lacks	----------
12	Promoting science diplomacy is meaningless when participating in international conferences and moots, or inviting foreign collaboration, is made such a burden that scientists prefer not to do it	----------
13	Policy implementation coordination unit is not needed since there is no mention of any other policy	----------
14	Certain data used in policy is out of date	Update data
15	Promote cities in general in the country, so economic activity flourishes and moves towards smart cities when the economy has matured	More research is needed on such approaches before adopting them
16	Policy Statement 16: not clear what will happen to existing staff operating under different service and salary structures if	Increasing salary across the board will place an additional financial burden on the government and the economy- where is the fiscal space and how will it be financed? 15.2. Curtailing salaries on the other

	a uniform service and salary structure for S&T organizations is adopted. 15.1.	hand will create resistance and ill-will among affected individuals and adversely affect any efforts to foster a culture of R&D
17	When reviving the National Commission for Science and Technology (NCST) the body should be headed by a scientist or person familiar with science and technology rather than a politician	----------
18	Pakistan is already participating in global education systems. 22.1. This is already in place - students from Pakistan go abroad and foreign students come to Pakistan	Introduce monitoring and evaluation of these programs
19	Industry-ready human resource will require closer interaction between private sector and academia – the interaction exists but must go beyond signing MoUs	So far there is a disconnect between industry demands and supply created by universities in the country. It would make more sense for the policy to address these gaps
20	Give recognition to scientists for their work; when you celebrate scientists and scientific careers, then more individuals will be interested in pursuing a career in the sciences	----------
21	Forums have already been established to enhance linkages, but their efficacy is not known	It would be more efficient to review existing forums, conduct M&E and enhance these forums before establishing new ones
22	Give industry incentives to invest in R&D, thereby encouraging a culture of R&D to evolve	----------
23	Introduce mechanism to ensure effective and efficient use of appropriate equipment, not just to acquire the latest technology. It is not necessary that the latest technology is the appropriate one for Pakistan	----------
Policy Unit, PAS		
1	Need to define goals clearly	Formulate evidence based and mission-oriented policy with goals aligned to national needs (agricultural technology, RE sources, smart grid technologies, climate challenge, water crisis etc.) and SDGs
2	Understated importance of standardization	Stress upon the need to carry out quality control of developed systems/products. Effectively integrate the role of Pakistan Standards and Quality Control Authority (PSQCA), Pakistan Accreditation Council (PNAC), National Metrology Institute (NMI) etc. In parallel, also endeavor to improve the performance of these organizations
3	Include mechanism to address lack of available infrastructure for research	Shared use of research/analytical facilities. Centralized labs for material characterization headed by team on deputation from Commissions

4	Provide mechanism to ensure characterization equipment at academia etc. are fully functional	Incorporate role of Commissions in repair and periodic maintenance of analytical equipment
5	Elaborate and stress importance of indigenous technology development	Support indigenous development though ToTs, and reverse engineering making use of scientific diaspora and science diplomacy channels, to ensure rapid development of technology
6	Technology spillovers not discussed	Identify channels through which technology spillovers may occur, and how these may be taken advantage of
7	Foreign exposure of researchers	Increase the number going abroad, while also ensuring their return by taking appropriate legislative measures
8	Elaborate vocational education, innovation skills etc.	Revamp vocational education, upgrade entrepreneurship and innovation skills and strengthen role of industry in training and research activities
9	Need to focus on digital literacy to support technology driven initiatives	Arrange provision of 5G network, also giving accessibility to far-flung areas and remote villages
10	Commercialization strategy not mentioned	Define role of STEDEC etc.
11	No mention of contingency planning	Include contingency planning (natural disasters, out of order equipment, delayed release of funds etc.)

ANNEX - II

Implementation Issues in NSTIP-22

Sr. No	Issues	Proposed solutions
1	Governance issues	
(i)	Political instability	There must be a long-term commitment (legislation) from the government and stakeholders to follow through on the policy's goals, regardless of political changes
(ii)	Inappropriate hierarchy and red tapism	Establish a Scientific Council under direct control of PM. Policy statements and directives on matters related to other ministries cannot be controlled by MOST The policy locus must belong at the highest level of the government (effective policy making and implementation will require proper scrutiny and rationalization by the cabinet before approval to avoid duplication of effort and emergence of turf wars between Ministries over resources) Steering committee should be led by a young energetic scientist and not a minister Self-executing policy. Policy must focus, to the extent possible, on actions that do not require direct governmental / bureaucratic involvement or repeated decision-making
2	Lack of clarity in Policy goals	
	Inconsistency in roadmaps or action plans	Policy must be mission oriented. Align goals with national needs and SDGs Involve a wide range of stakeholders in policy design, implementation and evaluation Add a comprehensive outline of the phases in which the policies will be implemented, to provide a comprehensive visualization of priority actions to policy makers vis-à-vis guidelines to potential investors
3	Ineffective progress Monitoring	
	Weak legal and regulatory evaluation framework	Incorporate robust monitoring frameworks Introduce transparency and accountability to measure the compliance and performance of procedures by establishing clear metrics and KPIs Review data and feedback regularly, and identify any gaps, issues, or opportunities for improvement. Involve employees in the review process, and solicit their input and suggestions. Monitoring over shorter periods with milestones and targets stretched over longer periods, instead of progress monitoring based on award of grants
4	Funding	
	Inadequate funding and its timely release	Increase budget allocation, Prudent use of available funding Facilitate increased research financing by local and international donors Competitive grants, Build the capacity to conduct research, particularly in the face of limited resources and infrastructure

ANNEX - III

Ref. No. SAG/PAS/ Workshop 1/24 30th October, 2024

Subject: Minutes of Meeting of Workshop on Upgradation of National Science Technology & Innovation Policy (NSTIP)

Meeting held on: 22nd October 2024
Venue: Video Conference Room, PAS

Reviewers and Stakeholders:

Sr.	Name & Designation	Organization	Remarks
Non-Strategic Sector			
1	Dr. Zaheer Shah, Joint Secretary	MoST	Did not attend
2	Prof. Dr. M. Mujahid, Rector	PAF-IAST	
3	Prof. Dr. Amir Azam, VC	KFU-EIT	
4	Brig. Prof. Dr. M. Irfan, Principal& Dean SCEE	NUST	
5	Prof. Dr. Javed Iqbal, IGIS, SCEE		
6	Associate Prof. Dr. Ali Tahir HoD IGIS, SCEE		
7	Prof. Dr. Faheem Khokhar, Director C-CARGO, IESE, SCEE		
8	Prof. Dr. Muhammad Arshad, Associate Dean IESE, SCEE		Attended
9	Dr. Sarwat Ismail, Member Science	PCSIR	Did not attend
10	Dr. Mirza Habib, Member Finance	PSF	Attended
11	Dr. Usman Qadir, Senior Economist	PIDE	Did not attend
Strategic Commissions			
12	Dr. Usman Khurshid, Director Science, PINSTECH	PAEC	Attended
13	Dr. M. Arif, Director, Member Science Office	KRL	
14	Dr. Najam-us-Saqib, DDG	NESCOM	
15	Mr. Ameen Islam, Director, International Liaison	SUPARCO	
PAS			
	1) Scientists		
16	Prof. Dr. Kausar Abdullah Malik, President		Virtual Attendance
17	Prof. Dr. M. Aslam Baig, Secretary General & PSDP Project Director		Attended
18	Dr. Sara Qaisar, Director, SAG Unit		
	2) Co-opted Advisors		
19	Prof. Dr. Waheed Akhtar, Fellow PAS, Professor Emeritus SBS, PU		Attended
20	Maj. Gen. Amir Ikram, Fellow PAS, ex-ED NIH		
21	Dr. Riffat Mahmood Qureshi, Director Administration		

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	3) Interns	
2	Ms. Laiba Nadeem	Attended
23	Ms. Elizay Hayat Khan	
24	Mr. Aneeq Fazal	
25	Mr. M. Rashid	

The objective of the workshop was to provide all stakeholders a brainstorming opportunity to give NSTIP-22 a mutually agreed upon, revised shape. The President of PAS welcomed the participants of the workshop and praised their efforts in contributing to this national cause. The Secretary General, PAS gave an introduction to PAS activities and also highlighted the importance of PAS SAG Unit. Director, SAG Unit, gave the strategy for deliberations on NSTIP-22 and also summarized the same, stating that it is a comprehensive document, covering a variety of aspects such as CPEC, SDGs, and emergent areas like AI etc., but on the downside, it lacks a proper implementation framework and is vague in many aspects. Director SAG also presented the outcome of a Fishbone Analysis for formulating a good NSTIP, identifying six fundamental factors on which NSTIP depends. These were also the focus of major discussions in the workshop.

The outcome of the deliberations on different aspects of NSTIP-22 are given below, and form the basis of Policy Recommendations:

1. **Policy write-up**

Formulation

Policy must be evidence based and mission-oriented (goals aligned to national challenges and UN SDGs). It should consist of input from varied stakeholders (scientists, economists, common man, law personnel, NGOs etc.), and all relevant government documents should be consulted before drafting begins.

Write-up

Should be brief and clear in all aspects, with no vague or redundant parts. Also, to the extent possible, it should be self-executing in nature.

2. **Implementation**

Governance

Governance issues related to policies are a result of political instability, as well as red tapism. In order to address these, legislative measures must be undertaken to ensure the policy is implemented irrespective of the government at the helm. Bureaucracy hurdles may be taken care of by establishing a Scientific Council under direct control of PM (as the Iranian Supreme Council and the Turkish government's TUBITAK).

Monitoring/Evaluation

National challenges and UN SDGs should be identified to set tangible short, medium and long term goals, with an effective mechanism to monitor their progress. Some of the issues being faced by Pakistan are water scarcity, energy crisis, climate change, agriculture issues, space ventures etc. Other areas necessitating research are overcoming challenges related to antibiotic resistance, commonly prevalent infectious diseases etc. The Pakistan Engineering Council and Pakistan Medical Commission, and similar other bodies can contribute in developing quantifiable goals for academia and industry.

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Contingency planning should also be undertaken to ensure the timely achievement of goals.

3. Funding

The budget allocation for Science and Innovation should be increased to 2% of GDP. At the same time, appropriate monitoring mechanisms should ensure the timely release of funds, as well as their wise use.

Role of Private Sector

There is a legislative gap that prevents effective collaboration between academia, industry, and regulators. Private sector does not support long-term innovation and R&D. It prefers trade secrets over intellectual property, and is disinterested in the outcome of innovations, which may take months. In order to overcome these challenges, government procedures should be simplified to encourage the investment of private sector in academia/R&D. Also, different mechanisms to incentivize academia, as well as industry, should be introduced. Industry may be offered preferential tax, access to IP, patents etc. Likewise, academia maybe provided with additional grants or industry funding for research, internships, and/or industry-funded scholarships and job placements in pertinent industries. Additionally, all viable options such as PPRPs, collaborations, Technology Transfer Offices, Quintuple/Triple Helix models etc. may be used to create public private partnerships.

Miscellaneous financing

Different options to tap funding from private companies, global ventures, multilateral institutions and international organizations must also be considered.

4. Capacity Building

Education

There is a need of reforms in both the Higher Education sector as well as the primary level. HEC should devise a policy to check the mushrooming of below standard universities. Specialized degrees are essential to ensure strong expertise in a chosen field. Also, it is essential to align programs with industry needs.

The curricula should be aligned with industry requirements. New knowledge areas have been integrated into engineering programs. The Pakistan Engineering Council has played a commendable role by including Industry Advisory Boards to shape the curriculum.

Applied sciences should align with national SDGs, focusing on integrating these goals into thesis projects. Excessive focus on demand-driven research could be damaging, as it limits innovation and exploration. At least 30% of research should allow researchers to pursue topics of their interest, thereby fostering creativity.

Efforts should also be made to revamp vocational education, upgrading entrepreneurship and innovation skills. Pakistan is producing engineers, but not enough technologists who have practical, hands-on skills.

Faculty training

Teachers/trainers must be encouraged to spend time in industry, some of them (30-40 %) must have industrial working experience in every discipline. Skill-augmented education must be provided at all levels and every discipline, enhancing practical knowledge and psychomotor training (including industrial attachments). Universities could be categorized into 2 separate streams (1) Basic Science and (2) Technology oriented (producing industry-ready graduates contributing to Technology Parks).

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Universities should have mandatory training units, ensuring that faculty and students receive hands-on experience with modern technologies and research methodologies. Induct technically skilled faculty or arrange industrial training of existing faculty to bridge the gap between academic knowledge and practical industry skills.

The role of *entrepreneurs as professors* may help bridging academia with entrepreneurial ventures, bringing real-world business insights to students.

Equipment infrastructure

Include mechanism to address lack of available infrastructure for research. Shared use of research/analytical facilities. Avoid duplication of essential characterization equipment and at the same time ensure meticulous selection and procurement of costly sophisticated equipment. Centralized labs for material characterization headed or supported by experts from strategic commissions can be the perfect solution.

Create mechanism to ensure characterization equipment at academia etc. are fully functional. Incorporate role of strategic commissions in repair and periodic maintenance of analytical equipment. Introduce a system to identify scientists/engineers dedicated to maintaining equipment rather than publishing papers (model of A-Star Center in Singapore could be considered).

Indigenous development

Support indigenous development though ToTs, and reverse engineering making use of scientific diaspora and science diplomacy channels, to ensure rapid development of technology. Identify imported components and/or products used by various companies in their manufacturing process to enable their local production. Strategic Commissions can assist in such projects.

Identify channels through which technology spillovers may occur, and how these may be taken advantage of. The spin-off policy could help create multi-million-dollar companies, following models like Saudi Arabia.

5. Quality Control

Stress upon the need to carry out quality control of developed systems and products. Effective integration of the role of Pakistan Standards and Quality Control Authority, Pakistan Accreditation Council, National Metrology Institute etc.is essential. Furthermore, efforts should be made to improve the performance of these organizations.

6. Science Popularization /Outreach

Community awareness and engagement are critical, but often lacking, especially in far-flung areas and remote villages. Digital literacy should be widely implemented to support technology driven initiatives.

Technological clusters should be created according to regions, and technologies should be distributed accordingly. Such technological innovation hubs are also referred to as *Techno poles.*

Along the course of the deliberations, Director, SAG Unit highlighted the fact that the NSTIP of all countries are aligned with their national goals and have a proper implementation framework, as against NSTIPs in Pakistan. Co-opted advisors, Professor Dr. Waheed Akhtar

and General Dr. Amir Ikram pointed out that the core issue with all national policies is their non-implementation and gave valuable suggestions to help upgrade the existing policy. Professor Dr. Waheed Akhtar also remarked that there is a need to identify issues in underperforming organizations and incorporate reforms, instead of merging or dissolving them.

Towards the end, all stakeholders and PAS experts agreed unanimously that PAS should take up science policy related matters at the highest level of government so as to increase the visibility of scientific issues at that forum. Also, an annual report should be provided to both the President and PM to keep them aware of the developments in the country's research and innovation.

Submitted for information of all concerned.

Sd//

(Sara Qaisar)
Director, SAG
PAS

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Pakistan Academy of Sciences

A. 3 Constitution Avenue, G-5/2, Islamabad, Pakistan

B. School of Physical Sciences, (Undergraduate Block),
Quaid-e-Azam Campus, University of The Punjab, Lahore, Pakistan

Tel: +92 51 920 4843, +92 51 920 7140
Email: sec.gen@paspk.org - editor@paspk.org