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Impact of STI Policy on Innovation Creation by HEIs In Pakistan: Exploring from the Triple Helix Model (THM) Perspective

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Abstract: *An innovation-based economy is crucial for a country's global competitiveness and sustainable growth. However, the impact of Pakistan's Science, Technology, and Innovation (STI) policy on innovation and technology creation within Higher Education Institutions (HEIs) remains underexplored. This study examines the impact of Pakistan's STI policy on innovation in HEIs by analyzing views of academia, industry, and government using the Triple Helix Model (THM). Forty in-depth, face-to-face interviews were conducted with Directors and CEOs of prominent export-oriented industries, Entrepreneurs, Offices of Research Innovation and Commercialization (ORIC) Directors, and Senior Government Officials in Sialkot, Faisalabad, Lahore, Rawalpindi, and Islamabad. Participants provided their perspectives on the factors influencing innovation and technology creation. The government participants assert that it provides financial resources to researchers and innovators to support their research efforts, encourage innovation, and facilitate the development of new products. Meanwhile, HEI stakeholders assert their role in fostering innovation and diffusion through applied research. However, industries believe that academic research is often not effectively transferred to industry and lacks commercial value. Conclusion: The analysis highlighted areas where Pakistan's STI policy has been ineffective. The findings of this study will aid the Ministry of Science and Technology (MoST) in reviewing and formulating a more effective STI policy strategy to achieve its innovation objectives and boost Pakistan's economy.*

Key Words: Economy, Innovation, MoST, Policy, STI, HTM

Introduction

Science, technology, and innovation (STI) are fundamental drivers of prosperity and global competitiveness. Thought-out STI strategies are crucial in the formulation and dissemination of novel technologies, products, and knowledge, enabling the economy to grow and develop socially in a sustainable manner. The long-term growth in all economic models requires innovations and technology development. Therefore, STI is a crucial aspect of the modern world when combined with national development (Mormina & Pinder, 2018).

The escalating competitive environment presents significant challenges for organizations worldwide, making innovation indispensable for driving economic growth, enhancing and maintaining high performance, and developing competitiveness among firms (Gopalakrishnan & Damanpour, 1997). Innovation serves as a key driver for addressing issues related to quality, quantity, and efficiency. It allows companies to create more value by developing new products, improving processes, and introducing innovative business models. With this in mind, innovation can be defined as an organization's ability to

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generate new value propositions for its customers and stakeholders (Dervitsiotis 2010). It also plays a strategic role in shaping corporate strategies, understanding customer needs, and enhancing the quality of products and services (Kim et al., 1998).Therefore, it is imperative for nations to cultivate both the capacity and the culture to innovate and develop.

In the current global business environment, where social, economic, and technological changes are constant, an effective STI policy is crucial. Developed countries actively engage in innovation creation through innovation policies, government institutions, and research and development (R&D) organizations (Moon & Bretschneider, 1997). Correspondingly, developing countries must formulate effective STI policies that offer incentives and create an enabling environment for Higher Education Institutions (HEIs) and industry, thereby supporting both social and economic development (Şener & Sarıdoğan 2011).

Well-designed STI policies stimulate economic growth, foster social change, and enhance the capacity to generate, share, and utilize knowledge (Ertl et al. 2007). Empirical evidence links national growth trajectories to the quality of their STI policy frameworks (Taiyyeba et al. 2022).

Past studies have examined how STI affects aggregate economic performance (Hazem Ali et al., 2020) explored the impact of STI policy in Pakistan, with a primary focus on macroeconomic outcomes rather than university-led innovation (Hazem Ali et al., 2020). Research specifically investigating STIs' influence on innovation creation within Pakistan's HEIs remains limited. This gap is particularly important given the government's introduction of the National STI Policies in 2012 and 2022. To date, no study has qualitatively examined how these policies have shaped innovation and technology creation from the perspectives of the three key actors in the THM: academia, industry, and government.

Addressing this gap, the present research employs forty face-to-face interviews with senior managers from ORIC, leaders of export-oriented firms, government officials involved in STI, and representatives of financial institutions. Guided by a THM lens, the study asks: How have Pakistan's recent STI policies affected the capacity of HEIs to create and transfer innovation and technology, and what institutional or policy adjustments are required to strengthen these outcomes? By providing evidence grounded in stakeholder experience, the study contributes to scholarship on innovative systems in emerging economies and offers actionable recommendations for the Ministry of Science and Technology (MoST). Strengthening THM interactions is essential if Pakistan is to evolve toward a knowledge-based economy in which academia, industry, and government collaborate to generate the innovations needed for twenty-first-century development.

Overview of Science Technology Innovation (STI) in Pakistan

Pakistan is the fifth-largest country in the world by population, located in South Asia, covering an area of 770,880 km² (Worldometer, 2025b). Pakistan ranks 34th globally in terms of area and is endowed with rich mineral resources. With a population of approximately 254.84 million, Pakistan's gross domestic product (GDP) was 337.91 billion U.S. dollars in 2023 (Worldometer, 2025a). Pakistan's economy is ranked as 33rd out of 39 countries in the Asia-Pacific region, with overall performance below both global and regional averages. According to the South Asia Economic Forum, Pakistan's rank is 6th out of the 7 countries (Foundation, 2025).

In 1947, Pakistan's science and technology infrastructure was minimal, consisting of only one university, a college of agriculture, one research institute, and three laboratories (Hassan & Khan, 2008). In 1953, the Pakistan Council of Scientific and Industrial Research was established. Some other organizations, like the Pakistan Agriculture Research Council (PARC) and the National Agriculture Research Centre (NARC), were established to provide innovative solutions to the problems faced by the agriculture sector and raise production. After recognizing the importance of science and technology, the government of Pakistan established different research institutions and councils of Science and Technology (S&T).

Pakistan's first innovation policy surfaced in 1984, which emphasized technological development consistent with national needs and constructed an institutional framework to spur S&T development in the country (Jamali et al. 2022). This was supported by funding from international organizations, including the United Nations Industrial Development Organization (UNIDO), the World Food Program (WFP), and the World Intellectual Property Organization (WIPO) (Shahab, 2011). In 1993, a National Technology Policy was launched but could not be fully implemented. The establishment of the Higher Education Commission (HEC) in 2002 further strengthened oversight of HEIs (Hassan & Khan, 2008). The government also initiated the Science, Technology, and Innovation Program in 2008 (Mian et al., 2011).

In 2012, Pakistan formulated its second national STI policy. It was the first time that the Pakistan government formally recognized innovation as the long-term strategy to promote economic growth and to foster S&T capacity. The policy aimed to enhance R&D institutions, promote the commercialization of indigenous research, foster collaboration among academia, research organizations, and industry, and stimulate economic development. HEC supported this vision by facilitating Business Incubation Centers (BICs) in public universities to nurture researchers and entrepreneurs (Malik et al., 2021). Progress continued with the formulation of the National Science, Technology & Innovation (NST&I) Policy 2014-2018 (Taiyyeba et al. 2022).

In 2021, MoST drafted the latest STI policy, which was approved in January 2022. The policy objectives included: stimulating human capital to drive innovation, transforming knowledge into products, indigenous technology development, enhancing applied research, strengthening industrial-academia linkages, and promoting technology-based innovation and entrepreneurship. It also focused on supporting technology- and innovation-based startups, access to networks, and funding and tax incentives. Furthermore, the policy also envisioned that the government of Pakistan would establish an innovation fund and provide fiscal incentives to attract venture capital, technology clusters, quality and standards, etc.

While STI policies have facilitated research funding for HEIs, BICs, and publications, this study seeks to critically examine the impact of these policies on applied research, innovation, and technology transfer to industry.

The Triple Helix Model (THM) of Innovation and the Role of Stakeholders

The term 'innovation' traces back to the 5th century B.C. from the Greek word 'Kainos', meaning 'new', and is defined as introducing novel ideas, methods, or products (Oxford Learner's Dictionaries, 2025). Given its multidimensional nature, innovation encompasses product innovation, process innovation, management systems, and organizational innovation (Spillan 2013). Thus, innovation is not merely the creation of new ideas but involves the entire process through which these ideas are generated and implemented.

A dynamic interaction between the productive sector and science and technology infrastructure, supported and guided by the government, is vital for national development (Albornoz et al., 1994). This interplay among the three key sectors, academia, industry, and government, forms the basis of the 'Triple Helix Model of Innovation' (THM), conceptualized by Etzkowitz and Leydesdorff. The model highlights the reciprocal linkages and collaborative dynamics among these actors to leverage knowledge for innovation, marking a transition from an industrial to a knowledge-based society and positioning the THM as a central strategy for the 21st century (Leydesdorff & Etzkowitz, 1996).

Within this framework, universities have moved from being on the sidelines to playing a more active role in areas like technology development, knowledge transfer, business incubation, and entrepreneurship. This shift has made them key contributors to both regional and national economic growth (Etzkowitz, 2003; Leydesdorff & Etzkowitz, 1996). Additionally, a critical dimension of the THM's effectiveness lies in how stakeholders perceive and engage with it. The involvement and support of government officials, industry professionals, and academics are vital to putting the model into practice and ensuring its long-term impact (Etzkowitz, 2003). Stakeholder perspectives offer valuable insights into policy support, regulatory challenges, and the practical application of research outputs.

Engaging stakeholders not only fosters robust innovation ecosystems but also enhances the socio-economic impact of THM, aligning it with broader goals of sustainable development and social well-being (Carayannis & Campbell, 2012). In the context of Pakistan, integrating stakeholder perceptions into the STI policy framework is pivotal for unlocking the full potential of the THM in promoting innovation creation and diffusion.

Methodology

An interpretive and inductive approach was adopted to explore innovation creation within HEIs in Pakistan. Qualitative methods were employed, and purposive nonprobability sampling was used, based on the nature of the research and the researchers' judgment, as guided by Czernek Marszałek and McCabe (2024). This approach enabled the selection of information-rich participants who offered relevant insights.

Sampling

Since the Triple Helix philosophy involves collaboration and overlap among university-industry-government, data were collected through in-depth face-to-face interviews with 40 participants from THM stakeholders in major business hub cities of Lahore, Sialkot, Faisalabad, Rawalpindi, and Islamabad. Participants were identified as experts based on their involvement and decision-making roles in university-industry-government linkages. Purposive sampling was used to select experienced top management officials to participate in the study. The primary aim of this approach was to reach out to individuals with relevant knowledge and urge them to voluntarily and actively contribute to the interviews, ensuring the provision of unbiased and accurate data. The authors selected officials from renowned universities, industries, and government organizations to gather significant insights from experienced participants working with HEIs, government bodies, and public sector institutions, representing key informants, Tables 1 and 2, (Campbell et al., 2020).

Table 1

Profiles of Selected Respondents from Industry, HEIs, and Government Institutions

No	Industry Name	District	Industry Type	Designation
1.	Millat Tractors Ltd.	Lahore	Agriculture Machinery Manufacturing	Head of Industrial Product Division
2.	Breeze Fans Concerns	Lahore	Electrical Equipment Manufacturing	Entrepreneur and Director
3.	Mitchells' Food	Lahore	Food Manufacturing	Quality Head
4.	Rafhan Maiz Products	Faisalabad	Food Manufacturing	Plant Manager
5.	Fauji Food Industry	Lahore	Food Manufacturing	Manager-Research & Innovation
6.	Khawaja Sports Industries	Sialkot	Sports Goods Manufacturing	CEO
7.	Qadri Groups	Lahore	Steel Manufacturing	Director Production,
8.	Mughal Iron & Steel Industries Ltd	Lahore	Steel Manufacturing	Senior Manager
9.	Surgical Instruments	Sialkot	Surgical Instruments Manufacturing	Dean CEO, QSA Surgical Ltd.
10.	Kausar Textile Ltd.	Faisalabad	Textile & Garments Manufacturing	Owner/Entrepreneur
11.	Sadaqat Ltd.	Faisalabad	Textile & Garments Manufacturing	Director-Production & Sale
12.	Interloop	Faisalabad	Textile & Garments Manufacturing	General Manager-Research & Innovation
13.	Nadeem Engineering	Faisalabad	Engineering Services	CEO/ Entrepreneur
No.	**Academic Name**	**District**	**Academic Type**	**Designation**
14.	EME College, Lahore	Lahore	Engineering	Head of Department
15.	Kinnaird College University	Lahore	General	Director ORIC
16.	Forman Christian College, University (FCCU)	Lahore	General	Director ORIC

No.	Government/Institutes	District	Institute Type	Designation
17.	University of Engineering and Technology (UET), Lahore	Lahore	Engineering	Director ORIC
18.	Education University	Lahore	General	Director ORIC
19.	University of Engineering and Technology (UET), Peshawar	Peshawar	Engineering	Manager ORIC
20.	Lahore College Women University	Lahore	General	Assistant Director ORIC
21.	University of Veterinary Animal Sciences, Lahore.	Lahore	Veterinary	Director ORIC
22.	University of Agriculture Faisalabad (UAF)	Faisalabad	Agriculture	Director ORIC, Manager Innovation & Commercialization, and Manager Research Management
23.	University of Management and Technology (UMT)	Lahore	General	Director General
24.	FAST University	Lahore	Engineering	Faculty and Innovator
25.	Mirpur University of Science and Technology (MUST)	Azad Kashmir	Engineering	Director ORIC
26.	Government College University Lahore	Lahore	General	Director ORIC
27.	CMH Lahore Medical College	Lahore	Medical	Director ORIC
28.	Forman Christian College, University (FCCU)	Lahore	General	Manager ORIC
29.	National University of Sciences and Technology (NUST)	Islamabad	Engineering	Pride of Performance, Chairman, National Center of Robotics & AI
30.	National University of Sciences and Technology (NUST)	Islamabad	Bioengineering	Faculty and Innovator
No.	**Government/Institutes**	**District**	**Institute Type**	**Designation**
31.	Lahore Chamber of Commerce & Industry	Lahore	Institute	Director Technical
32.	Rehman Medical Institute	Peshawar	Institute	Dental Surgeon
33.	Fatima Memorial Hospital and College	Lahore	Hospital	Senior Faculty
34.	Zarai Taraqiati Bank Ltd.	Gujrat	Bank	Vice President
35.	Small and Medium Enterprise Development Authority (SMEDA)	Lahore	Institute	Provincial Chief
36.	National Bank of Punjab (NBP)	Lahore	Bank	Senior Relations Manager, and Senior Vice President
37.	Pakistan Science Foundation, Islamabad Industrial Program	Islamabad	Institute	Additional Manager R&D
38.	State Bank Punjab (SBP)	Faisalabad	Bank	Manager
39.	Higher Education Commission (HEC)	Islamabad	Institute	Assistant Director R&D
40.	Bank of Punjab (BOP)	Lahore	Bank	Branch Manager

Source. Developed by the author for this study.

Table 2

Summary of Respondents from HEIs, Industry, and Government Institutions

No.	Sample Profile of Academicians	No. of Samples	Percentage
	Engineering	7	41.18%
	General Academic	7	41.18%
	Veterinary	1	5.88%
	Agriculture	1	5.88%
	Medical	1	5.88%
	Total	17	100%
No.	**Sample Profile of Industry**	**No. of Samples**	**Percentage**
	Textile & Garments	3	23.08%
	Food Manufacturing	3	23.08%
	Steel Industry	2	15.38%
	Engineering & Electrical	1	7.69%
	Engineering Services	1	7.69%
	Agricultural Machinery	1	7.69%
	Sports Goods	1	7.69%
	Surgical Instruments	1	7.69%
	Total	13	100%
No.	**Sample Profile of Government Office/Institutes**	**No. of Samples**	**Percentage**
	Institutes	5	50%
	Hospitals	1	10%
	Banks	4	40%
	Total	10	100%

Source. Developed by the author for this study.

Data Collection

The primary data were collected using in-depth, in-person interviews. The interview protocol was developed in light of the THM postulated by Leydesdorff and Etzkowitz (1996). The questions were framed under the guidance of qualitative research experts and modified after incorporating the views of the experts. The interviews were recorded on an electronic device. The interviews were followed by open-ended questions to further explore the phenomenon from the respondent's perspective and to address the issues of the self-made validity of the questionnaire (Leydesdorff & Etzkowitz, 1996). Ethical protocols were followed throughout the study, and the identity and profile of the participants were coded to maintain their confidentiality.

The Questionnaire Development

The participants were informed about the THM and STI policy and then asked the questions (Table 3).

Table 3

Research Questions for Interview

Research Questions	
Incentives and Support for Innovation	▸ What types of incentives are provided to universities and firms for the creation of innovation? ▸ How many incentives are provided to researchers and innovators for startup acceleration? ▸ What is the role of government policies in supporting innovation within universities and industry? ▸ Which financial institutions provide support for innovative activities?
Government and Industry-University Collaboration	▸ Which government organizations, forums, or platforms support industry-university collaboration? ▸ Are there collaborative links and facilities between industry and universities? ▸ Does the university collaborate with knowledge creation institutes and industry for research purposes?

Research Questions	
Research Quality and Utilization	‣ How would you rate the quality of research conducted at the university? ‣ To what extent does the industry trust the quality of research/innovation conducted at the HEIs/universities in Pakistan? ‣ Is university research utilized by the industry? ‣ How many patents based on university research are currently utilized by the industry?
Technology Transfer and Capacity	‣ What is the level of the university's engagement in technology transfer? ‣ What is the capacity of the university to generate new technologies? ‣ What is the capacity and contribution of the university in creating entrepreneurial talent? ‣ Are there ORICs in universities effectively organizing innovation activities?
Industry Engagement	‣ Are researchers at the university linked with industry for collaborative projects and research? ‣ Are there R&D innovators within the industry linked to the university?

Source. Developed by the author for this study.

Analytical Process

The thematic analysis of the qualitative data was carried out as previously explained by Braun and Clarke (Braun & Clarke, 2006). Responses were stored on a digital voice recorder and transcribed. After transcription, a scheme of coding was developed to identify the themes. The first cycle of coding was indicative of the study's research questions. The codes were re-identified as the key themes to confirm the coherence. For this reason, NVivo 14 computer software was used. Thematic analysis was conducted on the data collected.

Findings

Thematic analysis revealed key trends and correlations in the impact of STI policies (1984, 2012, and 2022) on innovation and technology creation. The participants' views and experiences highlighted the contributions of HEIs to innovation and technology creation. The collected data underwent thematic analysis, leading us to conclude the impact of STI policies based on the findings, Table 4, Figure 1, 2 & 3.

Theme 1: Incentives to Universities and Firms for the Creation of Innovation

Of the total, 37 participants (92.5%) believed that there are no incentives for universities and firms to create innovation. They noted that HEC's shift from rewarding patents to publications has led researchers to focus more on publishing than on applied research. Consequently, the number of publications in international and national journals has increased, but most of the research is confined to academic publications (Dawood Mamoon 2021). Notably, none (0%) agreed that incentives exist, while 3 participants (7.5%) didn't respond. This finding indicates that most of the research being carried out in Pakistani HEIs is to fulfill academic requirements and for publications. It is not related to practical application and does not meet the needs of the industries. Consequently, STI policies seem ineffective in fostering innovation and technology.

Theme 2: Role of Government Policy that Supports Innovation in the University and Industry

Thirty-three participants (82.5%) expressed the opinion that government policies do not support the creation of innovation and technology. None (0%) agreed that the policies were supportive, while 3 participants (7.5%) gave no response. This indicates that STI policies are not effectively visible in industries.

Theme 3: Government Organizations' Platforms/Forums that Facilitate and Support Industry-University Collaboration

Twenty-seven participants (67.5%) responded that there is no platform or forum where academia, industry, and government can connect to collaborate on creating innovation and technology to address industry problems. None (0%) agreed that such a platform exists, while 13 (32.5%) participants gave no response.

Theme 4: Trust in the Quality of Research Output of Universities

Fourteen participants (35%) responded that they did not trust the quality of the research output from universities. 13 participants (32.5%) noted that only a few reputable universities, such as the National University of Sciences and Technology (NUST) and Lahore University of Management Sciences (LUMS), produce high-quality research. Additionally, 13 participants (32.5%) gave no response. The findings suggest a consensus that university research output lacks quality and is not trusted by the industry.

Theme 5: Research Output Utilized by Industry

Eighteen participants (45%) said that the research output of Pakistani universities is not utilized by the industry, while 5 (12.5%) believed it is being utilized. The survey revealed that reputable HEIs, such as NUST, LUMS, University of Agriculture, Faisalabad (UAF), and University of Veterinary & Animal Sciences (UVAS), have engaged in applied research, some of which has been commercialized. This suggests that positive outcomes are more attributed to university leadership and ranking rather than the STI policy. Additionally, 17 participants (42.5%) gave no response.

Theme 6: Collaboration with Industries

Twenty-nine participants (72.5%) believe there is no university-industry collaboration, while 4 (10%) said they do collaborate through projects awarded by HEC. A few participants noted that HEC and other organizations' funding is often used to balance grants rather than fostering collaboration, indicating that STI policies do not effectively contribute to university-industry collaboration. Additionally, 7 participants (17.5%) gave no response.

Theme 7: Resource Allocation and Facilities

Sixteen participants (40%) believe that resource allocation for research and innovation activities is adequate, while 22 (55%) said that resources are inadequate. Additionally, 2 participants (5%) gave no response, reflecting a mixed response to the adequacy of resource allocation.

Theme 8: Engagement in Technology Transfer

Twenty-three participants (57.5%) shared that there is no technology transfer from HEIs to the industry, while 15 (37.5%) said that technology transfer is rare. This indicates that STI policies have not contributed effectively to the creation and transfer of technology from universities to industry. Additionally, 2 participants (5%) gave no response.

Theme 9: Researchers Linked with Industry

Twenty-one participants (52.5%) believe that university researchers are not linked with the industry, while 14 (35%) said that researchers are linked. Overall, academia is generally not well-connected with industry, with interactions mainly for educational purposes or securing HEC-funded projects. Researchers often establish industry connections through personal contacts. 5 participants (12.5%) gave no response.

Theme 10: Number of patents based on university research

Thirteen participants (32.5%) opined that there are no patents filed by universities, while 27 (67.5%) said that there are very few patents from universities. Overall, the number of patents filed by universities is negligible.

Table 3

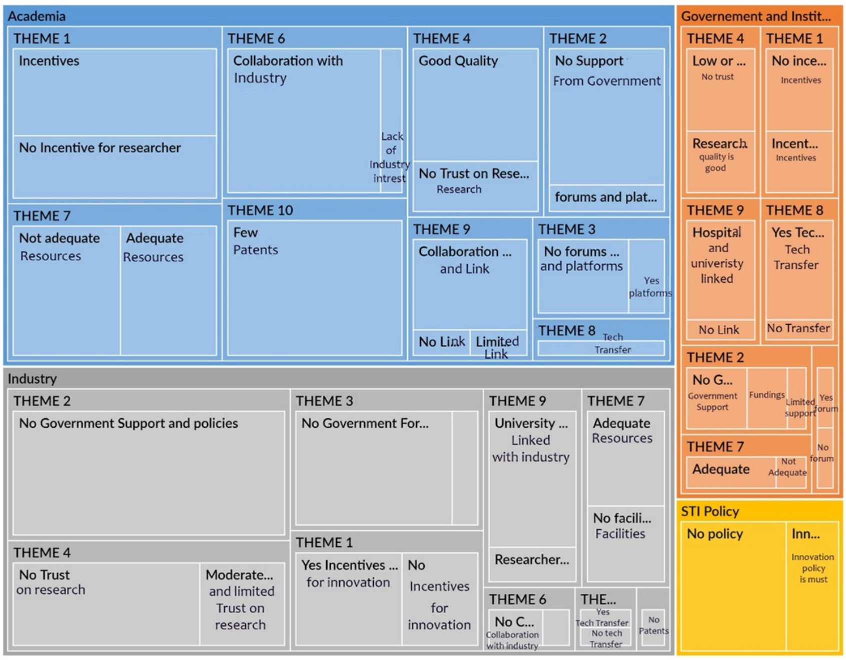
Views of Respondents (n=40)

No.	Themes for Analysis	Response Category	HEIs (17)	Industries (13)	Govt (10)	Total (40)	Percentage %
1	Incentives to universities and firms for the creation of innovation	Yes	0	0	0	0	0%
		No	15	12	10	37	92.5%
		No Comment	2	1	0	3	7.5%
2	Role of Government policy that supports innovation in universities and industry	Yes	0	0	0	0	0%
		No Policy	15	12	6	33	82.5%
		No Comment	2	1	4	7	17.5%
3	Government organizations/ platforms/forums that facilitate and support industry-university collaboration	Yes	0	0	0	0	0%
		No Forum	11	10	6	27	67.5%
		No Comment	6	3	4	13	32.5%
4	Research Quality/Trust in the research output of universities	No	8	0	6	14	35%
		Good	9	0	4	13	32.5%
		No Comment	0	13	0	13	32.5%
5	Research output utilized by the industry	Yes	5	0	0	5	12.5%
		No	2	10	6	18	45%
		No Comment	10	3	4	17	42.5%
6	Collaboration with industries	No	13	10	6	29	72.5%
		For Funding	0	0	4	4	10%
		No Comment	4	3	0	7	17.5%
7	Resource allocation & facilities	Adequate	9	4	3	16	40%
		Not Adequate	8	7	7	22	55%
		No Comment	0	2	0	2	5%
8	Engagement in technology transfer	No	9	11	3	23	57.5%
		Rarely	8	0	7	15	37.5%
		No Comment	0	2	0	2	5%
9	Researchers linked with the industry	Yes	7	0	7	14	35%
		No	8	10	3	21	52.5%
		No Comment	2	3	0	5	12.5%
10	Number of patents based on university research	None	8	0	5	13	32.5%
		Very Few	9	13	5	27	67.5%
		No Comment	0	0	0	0	0%

Source. Developed by the author for this study.

Figure 1

Hierarchy Chart of Themes Derived from the Questionnaire, Generated using NVivo 14 Software



Note. The size of each box represents the frequency of the corresponding theme, with larger boxes indicating more commonly discussed themes.

Figure 2

Word Tree Map, Illustrating How Various Concepts Expressed by Respondents Branched into Thematic Clusters

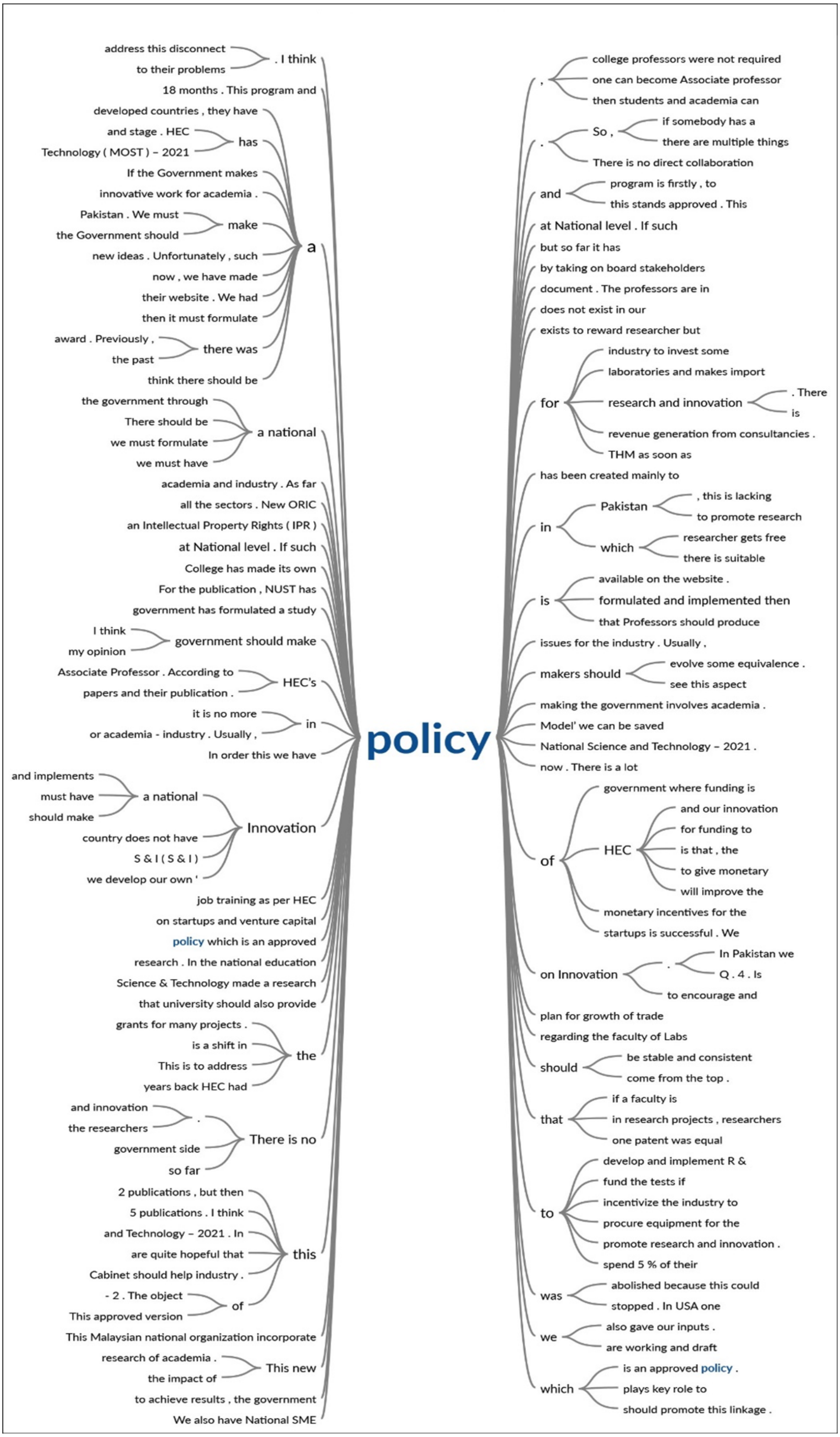


Figure 3

The word Cloud of the Findings Displaying the Most Frequently Used Terms by the Participants during Interviews

Note. Larger fonts represent higher word frequency, indicating dominant themes that emerged from the analysis, while smaller fonts reflect less frequent but still relevant concepts.

Discussion

Innovation is crucial for a country's competitiveness, productivity, and economic growth (Ahmed and Mahmud 2024). However, despite Pakistan's evolving STI policy (1984, 2012, and 2022), progress in fostering an innovative environment remains limited (Mian et al. 2011). This study explores the impact of STI policies from the perspective of THM stakeholders. Among 40 participants from HEIs, industry, and government, 92.5% believe universities lack incentives to innovate, and 82.5% feel government policies fail to support innovation. Additionally, 35% find university research theoretical and outdated, with many criticizing the quality of research and curricula, arguing that universities produce job seekers rather than innovators, while 67.5% noted a scarcity of patents filed by HEIs. Furthermore, 45% opinioned that the industry doesn't utilize university research, and 37.5% observed minimal technology transfer.

A critical concern echoed by many respondents was the absence of institutional forums or structured platforms that facilitate meaningful collaboration between academia and industry. As a result, researchers often pursue projects based on personal interests rather than industry demand, which further widens the gap between academic output and practical application (Haq et al., 2014). One participant remarked:

> *"The standard of quality of research of universities is not up to the mark, and there is a dire need to improve it... Universities are not contributing to the creation of innovation and technology."*

Another participant observed:

> *"Our universities are weak in research and need improvement. Therefore, the research output is not contributing to the creation and diffusion of innovation."*

Additionally, 55% of respondents identified inadequate resources for research and innovation. These findings align with the previous study that attributed limited innovation success in countries like Pakistan and Mexico to financial constraints and weak university-industry collaborations (Mian et al., 2011).

Despite initiatives by organizations such as HEC, the Pakistan Science Foundation (PSF), and the National ICT R&D Fund, the lack of consistent government resolves in implementing STI policies emerged as a recurrent theme. Participants emphasized that policies often remain ineffective due to poor execution, insufficient monitoring, and the absence of infrastructural support for long-term innovation.

Overall, the findings of this study reveal that STI policies in Pakistan have had a limited and fragmented impact on the creation of innovation and technologies with commercial potential. The study highlights the urgent need for institutional reforms, updated curricula, dedicated innovation forums, and strategic policy implementation to align Pakistan's STI framework with the goals of a knowledge-based economy.

Recommendations

To improve the effectiveness of STI policies and their contribution to economic growth, the MoST and the government must strengthen legislation, monitoring, and infrastructure. Pakistan's political instability, weak economy, high inflation, unsupportive tax policies, and unstable input costs have exerted immense pressure on the industrial sector, demanding urgent and coordinated action.

- **Align Academia with Industry Needs:** Update university curricula with industry input to focus on research addressing industrial challenges and fostering innovation.
- **Revise Reward Systems:** Modify HEC policies to prioritize innovation and patent filings, and industry collaboration over publication counts.
- **Strengthen Institutional and Regulatory Support:** Develop robust frameworks to promote university-industry partnerships and effective STI policy implementation.
- **Enhance Funding and Resources:** Provide adequate funding and resources for applied research and technology development, and collaborative university–industry innovation projects.
- **Upgrade Facilities:** Ensure access to state-of-the-art lab facilities near industrial hubs to support innovation and prototyping.
- **Incentivize R&D:** Implement policies offering incentives for industry-focused R&D and support seed and venture capital growth.
- **Establish a National Innovation Policy**: Create a National Innovation Policy that aligns STI objectives with economic growth and develops National Innovation Systems (NIS) to integrate and support innovation efforts across sectors (Fagerberg & Srholec 2008).
- **Promote Cohesion:** Establish a coordinated system linking academia, industry, and policymakers to drive effective STI policy implementation, fostering innovation, and knowledge exchange.
- **Foster a Stable Economic Environment:** Establish stable, long-term economic policies and address inflation, fuel prices, and tax burdens to create a more investment-friendly climate and to attract and retain investors.
- **Rebuild Trust in Academia**: Improve research quality and transparency to restore industry trust and encourage collaborative problem-solving.

Limitations and Future Direction

The non-probability sampling method limits the generalizability of the results and may have introduced interviewer bias. Future research should use probability sampling and multiple interviewers or standardized protocols to reduce bias. Additionally, this study's scope should be expanded beyond Punjab to include other provinces of Pakistan.

Conclusion

This study identifies gaps stemming from insufficient institutional support, ineffective regulatory frameworks, and weak government commitment to implementing STI policy. The findings emphasize the need for strategies that promote university-industry collaboration and allocate resources to support innovation, enhancing the knowledge economy. By highlighting THM stakeholders' perceptions, the study aims to provide insights for improving STI policies to better support innovation and technology creation, contributing to sustainable economic growth and competitiveness.

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Appendix

Abbreviation

HEC: Higher Education Commission
HEIs: Higher Education Institutes
ICT: Information and Communication Technology
MoST: Ministry of Science and Technology
NIS: National Innovation Systems
PSF: Pakistan Science Foundation
R&D: Research and Development
STI: Science, Technology & Innovation
THM: Triple Helix Model