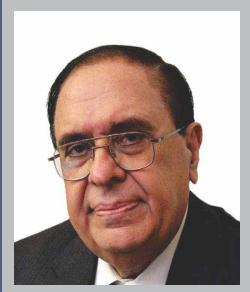


technology graduation
human college commerce balance idea wealth marketing market
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book learning investment
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symbol development science reading information
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KNOWLEDGE ECONOMY IN PAKISTAN

ABSTRACT



Dr Atta-ur-Rahman

Countries that are investing in education, science and technology, innovation and entrepreneurship are succeeding in developing strong Knowledge Economies, leading to inclusive and sustainable socio-economic development of the Nation. Pakistan does not need to work in isolation on the concept, and many projects could be undertaken in close partnership with China and linked to the CPEC Belt and Road program and thereby benefit from the vast human and material resources of China. Pakistan can also benefit from its demographic advantage of having some 100 million young men and women below the age of 20, whereas many other nations suffer from an ageing population and a lack of youthful manpower. To implement a Knowledge Economy in Pakistan will require visionary leadership and dynamic interaction between the universities and private enterprises capable of taking appropriate research and development concepts into commercially viable products. The focus of the article is to seek investment in quality education, improve the science and technology infra-structure, launch viable projects which utilize such emerging areas as artificial intelligence, next generation IT and biotechnology. The outcome of a sustained effort in development of Knowledge Economy would be the manufacture and export of high technology products and a reduction in the import of manufactured goods into Pakistan.

Keywords: Knowledge Economies, Socio-Economic Development, Quality Education, Leadership, Science and Technology Infra-Structure, High Technology Products, Artificial Intelligence, IT and Biotechnology



The advanced countries have 2500-3000 scientists/engineers per million population and they form the backbone of their development process

Science Parks should be developed with interdisciplinary ethos where the best of scientists and technologists from all disciplines are attracted

In order to build a strong knowledge economy, Pakistan needs to rid itself of the constraints of a natural resource driven approach to socio-economic development and focus on strengthening the “triple helix” of the knowledge economy. Its three necessary key pillars are:

- Government policies directed at strengthening the knowledge and research base, enhancing manufacturing and exports of high technology products.
- Establishment of world class universities and centres of excellence in key fields.
- Promotion of private sector so that strong linkages can be established between industry and agriculture with national research institutions.

Government may promote R & D within private sector institutions through incentives. This will enhance high technology manufacturing exports from Pakistan. There are lessons to be learned from other countries. Singapore has virtually no natural resources but have focused on research and manufacturing of high technology products. The result: Singapore has astonishing high exports of over \$ 450 billion annually compared to only \$ 30 billion from Pakistan, a country with a population about 40 times that of Singapore.

Human Resource Development

School and college level education requires major reforms. Universities and Research Centers need to be strengthened by the induction of high quality Ph.D. level faculty (1 Ph.D. level faculty member for every 15 students in each university) in order to provide the quality manpower needed for development of our educational institutions, services and production industry.

The advanced countries have 2500-3000 scientists/engineers per million population and they form the backbone of their development process. Pakistan only has about 120 scientists and engineers per million population and needs to develop at least 500,000 high quality scientists/engineers over the next ten years in carefully selected fields.

We need to develop a competitive edge in the changing global scenario. World-class Centres of Excellences should therefore be created in selected priority fields so that Pakistan becomes internationally competitive. These centres should be tasked to nurture high quality talent in various fields of science and engineering and to establish linkages with industry, agriculture and health, and to tackle major national problems. Centres of Excellence should also be established in technology development and technology commercialization.

Science, Innovation and Entrepreneurship

Special emphasis should be given on the translation of new knowledge into new technological products ensuring the development of small, medium and large-sized industries in the country. Mechanisms should be introduced so that the benefits of technological growth reach the vast masses with the aim of impacting and improving the quality of life of every citizen of the country. In this context, Science Parks should be developed with interdisciplinary ethos where the best of scientists and technologists from all disciplines are attracted. “Technology foresight” exercises should be regularly carried out to assess the present and future needs of technology, the niche opportunities for Pakistan and the projected impact of such technologies on social, economic, health and environmental aspects.





R&D institutions should therefore set up strong commercial units which can develop effective liaison with industry

It is important to develop appropriate steps to encourage innovation and entrepreneurship. This would involve a close cooperation between government departments, universities, Ministry of Science & Technology, Higher Education Commission and the private sector. While it is important to encourage basic research and new product and process development, in the short and medium term high priority should be given to acquire foreign technology and to initiate programmes of reverse engineering in order to understand and absorb such technologies, leading thereafter to adaptive research as well as domestic research and development in basic sciences.

The national defence organizations are a repository of considerable skills in instrumentation, control and advanced material handling

Promotion of Commercial Research

There is a need to develop corporate culture for scientific institutions so that their output can be utilized. R&D institutions should therefore set up strong commercial units which can develop effective liaison with industry. These units should be properly funded, managed by suitable senior level marketing personnel and given appropriate funding so that they can invest in areas of importance for commercialization and strong marketing initiatives undertaken by the institutions.

Promotion of High Technology

The proportion of hi-tech products is increasing in world trade. Pakistan's share of total exports in hi-tech products is insignificant. We have achieved competence in several state-of-the-art technologies including aerodynamics, thermal imaging, precision manufacturing, computational fluid dynamics, electric magnetic compatibility design and testing and encryption etc. These technologies need to be commercialized through public/private partnership. The national defence organizations are a repository of considerable skills

in instrumentation, control and advanced material handling. Extending or converting these skills to civil use could broaden our industrial skill base considerably and would help us develop hi-tech industries.

Quality Assurance

Quality assurance is a vital aspect for industrial growth but has remained largely neglected. Rigid quality standards for testing and accreditation need to be established for each industrial sector in order to meet the challenges imposed by WTO. An internationally recognized accreditation system should be incorporated in all major laboratories in the country, so that exports of our products can be certified to meet the minimum quality criteria laid down by international buyers.

▪ **Science, Technology, Innovative and Production (STIP)**

- Use Science, Technology, Innovation and Production (STIP) to achieve a science and technology driven Knowledge Economy – an integral element of the vision, strategy and action plan leading to a coordinated, equitable and sustained socio-economic development of Pakistan.
- For these far-reaching recommendations to be implemented, it is necessary for the Prime Minister to lead the national effort aimed at instilling ethos for STIP so that Pakistan is able to migrate from its underdeveloped economy to a technology driven Knowledge



Inauguration of first locally produced ventilators facility



Selected key areas should be given a high national priority in order for Pakistan to make best use of its demographic advantage

The educational systems in schools, colleges and universities should be modified to develop problem solving skills, critical thinking and innovation among students at all levels

Economy. The mandate for implementing STIP should be directed under the close supervision of the Prime Minister to ensure the successful strategic implementation of the policy.

- The national STIP policy must be approved by the Government following close consultations with all stakeholders. These stakeholders would include nominated experts from the private sector and also the opposition parties creating a national consensus.
- To ensure that the policy recommendations are action orientated, they should be strictly time bound, and include all relevant Government Ministries/institutions responsible for science, technology, innovation and production.
- All STIP action plans should be developed through regular Foresight Exercises, aligned to the Sustained Development Goals of Pakistan (SDGP) and must be integrated across all the relevant Government Ministries. An organization must be established for Technology Assessment and Forecasting Performance (TAFP). An existing organization such as the Pakistan Council for Science & Technology should provide training of personnel in the Planning Ministry on the methodology and techniques required for Foresight Exercises, according to well-established international norms.
- The STIP indicators must be monitored on a six monthly basis and correlated with the progress in the SDGP.
- World-class STIP Policy Research Institutes should be established for carrying out evidence-based policy research and science advisory functions in the area of technology and innovation policy.
- Selected key areas should be given a high national priority in order for Pakistan to make best use of its demographic advantage. These include Information Technology, Artificial Intelligence, Machine Learning, Robotics, Big Data and Internet of Things. All these topics are based on software development which is relatively low-cost to

implement and can take advantage of Pakistan's large population base. Priority should be given to Technical education, high-value agriculture methodology and utilization of energy resources.

▪ Education/Training for Science, Technology, Innovation & Production (STIP)

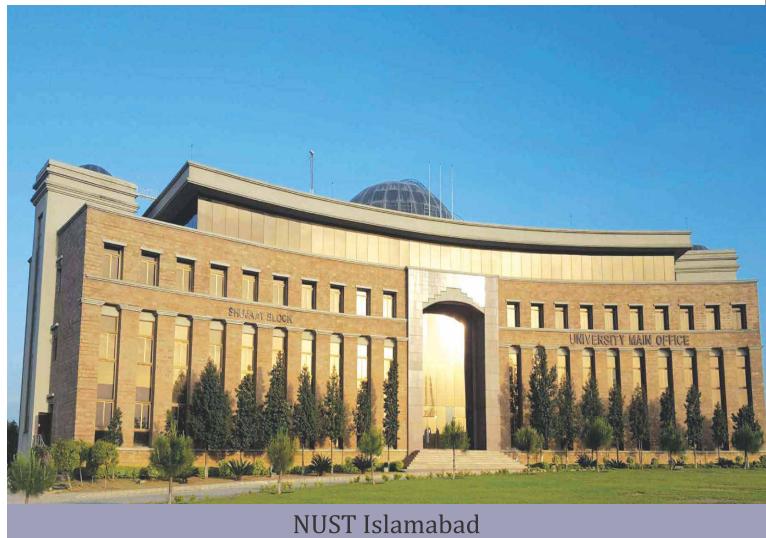
- Restructuring of Technological and Scientific Education and Training
 - ◆ The educational systems in schools, colleges and universities should be modified to develop problem solving skills, critical thinking and innovation among students at all levels
 - ◆ Minimum quality benchmarks should be set for College, Technical and Higher Education with a focus on adequate faculty qualifications and the linking of long term faculty appointments with regular performance evaluation.
 - ◆ Educational reforms should be introduced to ensure high quality and uniformity at all levels in the educational system.
 - ◆ To attain internationally accredited academic/research standards, use should be made of new technologies like, linkages and networks across the world, a profusion of Open Online Courses, peer-evaluation of research quality, institutional restructuring to create research facilities, revision of curricula and promotion of research. Open education should be encouraged by utilizing open knowledge sharing systems. The objective is to foster cross-sector collaboration based on simple mechanisms for interaction between the private sector and government funded university or national research institutions.
 - ◆ The access to technical and higher education should be progressively raised to 40% of the 18+ age group in the population to facilitate the migration of



the whole nation to a Knowledge Economy.

- The incentives and investments enabling high quality technical and vocational training must be enhanced; the physical infrastructure such as laboratory equipment and ICT tools must be improved. A legislative framework needs to be formulated to ensure an integrated high quality system of school education across Pakistan. The quality of curriculum in teaching and research establishments must be raised to international standards in order to support the anticipated growth and expansion of the technological industry created by the Knowledge Economy.
- A sustained effort is needed to raise the number of high quality professional scientists, engineers and technically trained manpower to a ratio of 3,000 professionals involved in R & D per million of the population. To achieve this target at least 10,000 young men and women should be sent for training abroad annually for Ph.D. degrees, post-doctoral positions and industry-related technical training. It is vitally important to ensure that on their return they are absorbed in universities, research organizations and industry. Posts must be created in universities, research centers and industry for freshly trained returnees to Pakistan
- The initiative to establish Foreign Engineering Universities that offer their degrees to Pakistani students and have a dynamic Science & Technology Park should be revived
- The universities and research organizations should be restructured so that the brightest scientists and engineers are employed on a contract basis with attractive market-based salaries, clear achievement targets, complete autonomy at work, but with full accountability and regular performance assessment.

In parallel with technological institutions, world-class business schools should be established to train managers and develop entrepreneurial skills



NUST Islamabad

- The Tenure Track contractual system of appointments of faculty with regular international assessment should be made mandatory for all new appointments in universities. The threefold difference between the Tenure Track system and the BPS system, that has eroded with time, must be revived and maintained.
- In parallel with technological institutions, World-class business schools should be established to train managers and develop entrepreneurial skills.
- **The Diaspora of Pakistani Scientists and Technologists Across the Globe**
 - A major program should be launched to attract the diaspora of Pakistanis across the world into returning to Pakistan. They should help to establish high-quality universities and research centers in Pakistan and to support industry in Pakistan and, where possible, return to Pakistan permanently. This resource would be invaluable towards establishing a strong Knowledge Economy leading eventually to the manufacture of high technology products within Pakistan, thus eliminating imports. Eventually, Pakistan will be able to export high technology goods with the help of the Pakistanis working and living abroad.
 - Networks covering different high technology fields should be established among the diaspora abroad to come to a consensus on the best way to help



Research and development activity in the private sector should be extensively promoted by the Government through assistance with technology upgrading and manpower training

To facilitate the development of high technology manufacturing and export, the government should underwrite risk taking by private industry through introducing special insurance schemes

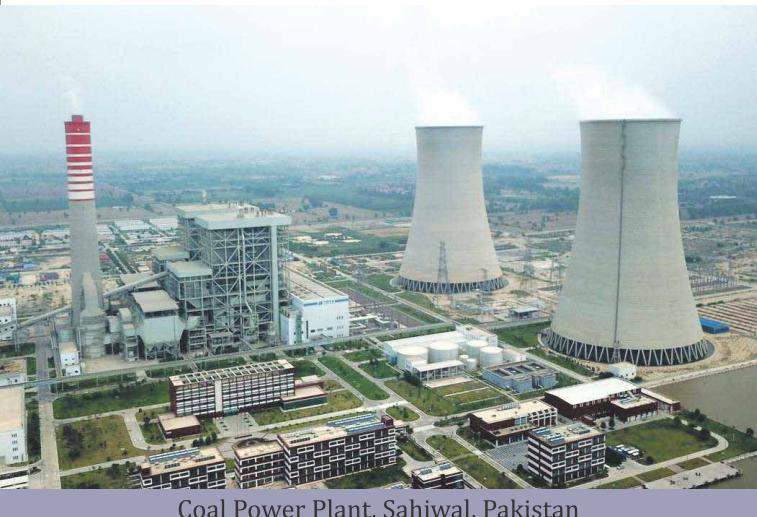
Pakistan and subsequently guide Pakistan's Knowledge Economy for the promotion of high technology entrepreneurship, and for the transfer of key technologies to Pakistan for the production and export of high technology products.

- **Technology Transfer and Industrial Development**

- The implementation of STIP policies could be greatly facilitated by providing access to Venture Capital funds and by establishing innovation hubs. In parallel, legal and financial services including assistance with preparing professional business plans should be offered to encourage the formation of more start-up companies.
- Research and development activity in the private sector should be extensively promoted by the Government through assistance with technology upgrading and manpower training.
- The absorptive capacity of Pakistan's government and private institutions to productively use external and internal

knowledge, and advanced technologies can be increased rapidly by hiring skilled personnel, such as management consultants. A key area for Pakistan is the encouragement of reverse engineering of products while building facilities for experimentation and R&D.

- The Government must increase investment in the production capabilities of private sector institutions by facilitating the process of adaptive engineering, productivity improvements, employment regeneration and export orientation of manufacturers within Pakistan.
- CPEC should focus on the manufacturing and export of medium and high technology products, preferably in collaboration with private sector industry in China. The aim would be to progressively enhance our export to \$ 300 billion/annum over the next ten years. To facilitate this process, technical and vocational training institutions should be set up near each of the specialized industrial hubs, ensuring the availability of highly skilled technical manpower for CPEC as well as other demand-driven and collaborative operations in the industrial clusters along the corridor.
- Businesses that are geared to the manufacture and export of high technology goods and those that explicitly address the three pillars of the SDGs should be rewarded through tax incentives, matching grants and public procurement policies.
- The duties and tax structures should be revised so that there are no taxes on parts needed for manufacture of medium and high technology goods, and significant taxes on import of finished products, to encourage basic manufacture.
- A revolving National Innovation Fund of at least Rs. 5 billion should be established to support indigenous technology development. Its purpose would be to facilitate the adoption, adaptation and rapid absorption of key technologies in both public and private sector institutions.



Coal Power Plant, Sahiwal, Pakistan



Defense establishments should outsource a major portion of their requirements to universities and research centers so that manufacture and export of defense related products within Pakistan could be promoted

- To facilitate the development of high technology manufacturing and export, the government should underwrite risk taking by private industry through introducing special insurance schemes.
- Appropriate mechanisms should be established, such as the revival of the earlier approved initiative of the Ministry of Science & Technology, "Science and Technology for Economic Development", (STED) to promote research collaborations and strategic alliances among national laboratories, and between public laboratories and industry.
- To improve the quality of manufactured products from Pakistan, attempting to gain access to global markets, Pakistan should establish high-quality infrastructure for Metrology, Standards, Testing and Quality (MSTQ). Pakistan standards must mimic international standards and seek international recognition. It is essential to establish a sound quality assessment system, and to ensure the prevention of manufacturing defects in goods from Pakistan. It is also important to ensure term cost savings, the reduction of waste and increased productivity. This should be accompanied with government support for larger companies for branding of our products in international markets, to enhance exports.
- Measures should be taken to strengthen industrial research, and technology development including pilot plant level studies.
- Industrial clusters should be established, including Small to Medium Enterprise (SME) clusters, to promote innovation and growth.
- Existing links between industry, R&D institutions and universities must be strengthened and individual industrial companies must be encouraged to engage with industrial clusters for information exchange and knowledge sharing.
- New research institutions should be established in carefully selected fields bearing in mind the fourth industrial

revolution that is creating disruptive technologies in many spheres of industry and education.

- Specialized institutions be set up to regulate the information flow between industry and research institutions. At the same time legal institutions related to corporate law and intellectual property should be established.
- Knowledge clusters should be set up to generate positive impacts from co-location/proximity, pooling/sharing of mutually useful knowledge, reduction in transaction costs and synergies from collaborative work throughout industry.
- Venture capital providers, business angels and micro-finance infrastructure should be created and financial institutions and markets reformed in order to encourage entrepreneurship.
- "Pioneering" status should be granted to high tech industries with the benefit of long term tax free status, thus promoting manufacturing in high-tech fields.
- Foreign Direct Investment (FDI) should be linked to knowledge transfer to Pakistan in all development projects to address the issue of global competitiveness of Pakistan's industry, now and in the future.
- Government purchases of software/ hardware should be from local manufacturers. If technology is not locally available, then local companies may partner with foreign companies, provided substantial technology transfer is incorporated.
- All development projects submitted for approval by the Planning Division should have a mandatory element of technology development, equivalent to at least 5% of the project cost, in order to ensure national self-





The Science & Technology and Higher Education sectors have to play a critically important role in the transition towards a "Knowledge Economy"

reliance and to enhance Pakistan's export capabilities. This should be reviewed and approved by an experts committee, prior to project processing.

- A "Digitised Pakistan" should be created with Smart Cities. All Federal and Provincial government offices should be fully digitized. High-quality and affordable access to the ICT infrastructure should be ensured through the rapid expansion of broad band services in Pakistan. Pakistan must urgently acquire the best quality 5G services and it must be competitive in the region.
- NADRA should be digitally linked to FBR and other key national organisations in order to widen the tax net and raise national tax revenue.
- Measures should be taken to facilitate the entrepreneurial process from discovery to the marketplace. Courses on entrepreneurship and business plan development should be taught in colleges and universities. Topics such as risk-sharing, negotiation expertise, legal protection and institutional infrastructure must be included in the curriculum.
- Defense establishments should outsource a major portion of their requirements to universities and research centers so that manufacture and export of defense related products within Pakistan could be promoted.
- In order to enhance the capability of local companies, public funds should be used as a powerful tool to outsource projects to the private sector in areas such as E Governance, E Commerce, Artificial Intelligence and others.

Budget

- Initially at least 4% of Pakistan's GDP should be allocated to education and progressively increased to 6%. At least 30% of this allocation should be directed towards the higher education sector. Initially at least 2% of the GDP, progressively increasing to 4% of GDP, should be set aside for the STIP programs.
- A National Research Fund amounting to 1% of GDP should be created to promote research related to technology development.

Conclusion

The challenge for Pakistan is to develop a competitive edge at the global level for sustainable development. This will be determined by the ability of our nation to create, acquire and use knowledge for socio-economic development. The Science & Technology and Higher Education sectors have to play a critically important role in the transition towards a "Knowledge Economy". It is only if we are armed with the right knowledge and skills, we can improve our living standards and provide a decent future to our children.

The "Technology Based Industrial Vision and Strategy for Socio-economic Development" is a 320 page document, prepared by leading national experts. It was approved by the Cabinet in August 2007 and provides a comprehensive plan of action for social and economic development. It contains details of projects to be undertaken and specific recommendations that need to be implemented with a sense of urgency.

Dr Atta-ur-Rehman has served as the chairman of the Higher Education Commission of Pakistan (2002 – 2008) and the Minister for Science and Technology (2000 – 2002). Presently he is the Co-Chair of the UN Committee on Science, Technology and Innovation for UNESCAP

Shaheer Niazi, 17-year-old, has garnered praise for his visualisation of a phenomenon, known to physicists for decades, which can help engineers develop technology for printing, heating or biomedicine