Chapter 25

KNOWLEDGE AND TECHNOLOGY-BASED DEVELOPMENT

The knowledge and technology-based economy will provide a platform to sustain a rapid rate of THE economic growth and enhance international competitiveness so as to achieve the objectives of the Vision 2025. It will also strengthen Pakistan's capability to innovate, adapt and create indigenous technology and design, develop and market new products; thereby providing the foundation for local growth. In addition, the knowledge and technology-based economy will complement and accelerate the change from an input-driven to a productivity-driven growth strategy, which is a major policy thrust initiated under the Plan. This transition is dependent on the performance of the higher education and science and technology sectors. Institutions of the higher learning will play a leadership role through the production of skilled, innovative and enterprising knowledge workers. Research organisationswill also come up with solution based and innovative research in collaboration with the industry and academia for fruitful results.

Situational analysis

The changes in science, technology, innovation and higher education are creating a multidisciplinary area in which institutions of many countries act together to achieve desired economic outcomes. All these sectors will contribute, which will lead towards the desired economic growth.

Unlike developed and many developing countries, the importance of knowledge-based economic development was not a priority in Pakistan. However, since the start of the 21st century, focus and investment have been given to the higher education sector for production of scientists and technologists, who will lead to an eventual technological development.

The birth of the Higher Education Commission (HEC) in 2001-02 and investment in the infrastructure development of the universities as well as production of the PhDs helped in injecting fresh blood to the ailing academic, and Research and Development (R&D) institutions. The HEC came up with a Medium-Term Development Framework known as MTDF HE-1 (2005-10). The HE-1 identified quality, access, and relevance as the key challenges facing the sector at that time. Programmes were launched to support original research at universities, align the academic programme structure to three-tier bachelor, master and doctoral programme structure implemented in the rest of the world, and ensure adherence to the internationally benchmarked quality standards and processes. The investment in the sector provided means for improving overall infrastructure and faculty. In the MTDF HE-II (2011-15), the HEC focus has been on sustaining gains in faculty development, quality improvement, and maximising opportunities for acquisition of the quality higher education.

Despite remarkable improvement compared to the past, Pakistan still needs to improve access to tertiary education, quality of university education and its relevance to national needs. The number of Pakistani universities in top 500 is still merely in a single figure, while the availability of the PhD faculty in universities and R&D organisations is still much less than the global standards, that is, still less than 30 per cent of the total faculty, which will reach 40-50 per cent

by the end of the Plan period. The HEC has persuaded the universities to establish the Quality Enhancement Cells (QECs), which are bound to submit quality report periodically to the Quality Assurance Division ofthe HEC. Some universities still need to accomplish this task, but all universities will have the QECs before 2018. One of the good steps taken for quality enhancement was the introduction of a search committee for appointment of vice chancellors, which has helped in minimising political influence.

It is estimated that less than seven per cent youth, aged between 17-23 years, have access to higher education, which is next only to the sub-Saharan countries. Pakistan will improve this to 10-12 per cent during the Plan period. Of course, this needs provision of access through setting up new universities, establishing sub-campuses of the universities and enhancing enrolment capacity of the existing universities. Keeping in view this policy, many new universities have been established in far-flung areas as well as metropolises, while establishing women universities to address gender imbalance in the tertiary education and introduction of disciplines more relevant to women, like social sciences, media, fine arts, textile designing, home economics, etc. The role of distance learning universities cannot be ignored for the higher education. Two distance learning universities, the Allama Iqbal Open and Virtual, are expanding their reach and need to do so more during the Plan period.

The next important aspect is relevance of research to the national needs. This covers sub-areas, like revamping and standardisation of the curricula, commercialisation of research, innovation, promotion of entrepreneurship and establishing centres of excellence in priority areas of research. In the last five years, many universities have established the Office of Research, Innovation and Commercialisation (ORIC) and by the end of the Plan, every university will have this office. Standardisation of the curricula for various disciplines is being done by the HEC in collaboration with other stakeholders, and will be a continuous phenomenon during the coming years. Some universities have also set up business or technology incubators. However, there is no science park in the country, which will be a major area of focus in the Plan. Centres of excellence in many disciplines of engineering and sciences have already been established and some more will be set up during the Plan period.

Universities and R&D organisations will develop strong linkages with the industry and produce meaningful research. This has been a weak link as the R&D organisations have done research mostly in isolation. The R&D organisations associated with or working under the Ministry of Science and Technology (and those outside) have some linkages to the local industry and they provide testing, pilot scale product development and other facilities. However, there is a large room for improvement. Enhancing the linkage of academia, R&D, government and industry will remain the central area of the Plan.

Despite facing many challenges like energy shortage, deteriorating law and order situation, security concerns, natural disasters and price hike of essential commodities,Pakistan has managed to remain afloat as a dynamically pluralistic society comprising various ethnicities. The economic growth has been steady and improvement of the security situation, enabling environment, and committed and facilitating leadership can drive the country towards new horizons of development.

Pakistan is ranked 146th out of 186 countries in terms of the Human Development Index. Likewise, the Technology Index of Pakistan has been reported to be 83, Growth Competitiveness Index 97, Public Institutions Index 115, production of Scientists and

Technologists Index 60 and 124th position for higher education and training *(Human Development Report 2013)*.

At the international level, the Global Competitiveness Index (GCI) is used as a matrix to measure a nation's competitive edge, economic development with respect to innovation and state of tertiary education. The GCI integrates the macroeconomic environment, public institutions, technology and innovation, which define the current sustainable level of economic activity, and where wealth is actually created. Pakistan is ranked 129th on the GCI in 2014-15, which was lower compared to several other developed and developing countries (Table-1). It is also important to note that Pakistan was ranked 133rd in 2013-14, so the ranking has improved to some extent; however, compared to 2012-13 it is still lower. Regional security situations, internal political instability, energy crisis, impact of terrorism and low rate of the economic growth have been the major contributors for change in overall unstable ranking. Pakistan needs to and will work on war footings to be competitive at the regional and global levels. Pakistan has been investing heavily in the higher education sector for over a decade, and the results of this investment have started to materialise. There is a considerable improvement in its capacity to innovate, availability of scientists and engineers and quality of scientific research institutions as compared to the previous rankings.

Table 1: Comparing parameters of the CGI 2014-15

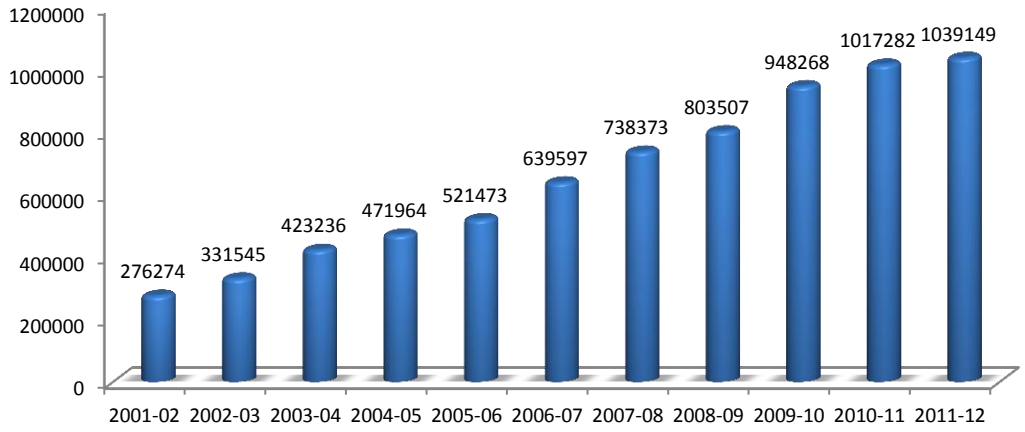
Parameters	GCI 2014-15 Score (Scale of 1-7, 1=very poor, 7=very good)							
	Pakistan	China	India	Korea	Malaysia	Turkey	USA	UK
Technological readiness	2.8	3.5	2.8	5.4	4.2	4.3	5.8	6.3
Capacity for innovation	4.0	4.2	4	4.7	5.2	3.7	5.9	5.3
Higher education and training	2.8	4.4	3.9	5.4	4.8	4.7	5.8	5.5
Availability of scientists and engineers	4.3	4.4	4.4	4.4	5.2	4.2	5.3	5.2
University and industry collaboration in R&D	3.2	4.4	3.9	4.6	5.3	3.7	5.8	5.7
Company spending on R&D	2.9	4.3	3.8	4.5	4.9	2.9	5.5	4.8
Quality of scientific research institutions	3.4	4.3	4	5	5.2	3.9	6.1	6.3
Overall ranking	129	28	71	26	20	45	3	9

Source: *Global Competitiveness Index Report 2014-15*

Growth in the number of public and private universities and degree awarding institutions over the previous few years was significant. This increase in the number of institutions was also accompanied by a significant increase in the number of campuses of the public sector universities. Total enrolment in the higher education in 2014 stood at almost 1.206 million students (514,450 in public and private universities, about 324,800 in distance education, and 367,200 in affiliated colleges) representing about five per cent of the age cohort of 17-23-year-old in the country. While this shows significant increase of over 2.6 per cent in 2002, it compares dismally to more than 10 per cent of 17-23-year-old having access to the higher education in India and more than 20 per cent having access in Malaysia. Student enrolment is projected to grow at 15 per cent, private university student enrolment at 18 per cent, while

distance education is expected to grow at 12 per cent. The rapid increase in enrolment in the higher education sector, during 2002-2012, is reflected in the graph (Figure1).

Figure 1: Enrolment in the higher education sector during 2002-2012



Issues and challenges

The pattern of science and technology and higher education sectors development in Pakistan has been inconsistent over the years. The major issues and challenges hindering the technological development are:

- Low enrolment in higher education (6-7 per cent) compared to the region
- Poor state of the infrastructure
- More focus on assembling and import instead of transfer of technology
- Lack of applied and solution-based R&D for local problems of various sectors
- No or minimal career guidance to the students at various levels of education
- Weak information support system for technological forecasting and assessment
- Poor quality and marketability of the higher education
- Inadequacy of research and its relationship to the technology development, innovation, enterprise and management
- Poor appreciation and involvement of the private sector in the R&D
- Weak linkages among universities, research institutions, industry and government
- Low investment in research and development by public as well as private sectors
- Inadequate system of commercialisation of technologies
- Poor or no protection of intellectual property rights and patents
- Low fund generation and user charge recovery by universities
- Less focus on social sciences and humanities
- Inadequate testing and lab facilities to meet demands of the market

- Gender imbalance in the tertiary education and subsequent employability
- Shortage of the PhD faculty
- Minimal national and international collaboration and linkages of universities and R&D organisations
- Lack of recognised testing and quality assurance, standards of labs and institutes as well as internal quality assurance cells in universities and R&D organisations

Objectives

The objectives to be achieved during the Plan period are:

Access and equity

- Raise enrolment in the higher education of the 17-23 year age group from the present about seven per cent to 10 per cent by the end of the Plan period
- Significantly enhance quality of education
- Ensure equitable access to the higher education
- Promote provision of quality of distance education
- Promote the private sector for provision of quality higher education

University linkages

- Promotion of university – society links
- Promotion of university – industry and R&D linkages through research capacity buildings of universities
- Make higher education system more competitive globally, while reforming and restructuring universities in Pakistan through international linkages
- Significantly enhance funds being given to universities through philanthropy, industry-sponsored research and other non-government sources
- Support research projects of universities related to alternative energy, national management, security, water, poverty reduction, infrastructure building, etc.

Quality

- Enhance quality of education, research and university management procedures to meet international standards
- Increase PhD faculty of universities
- Increase the number of globally ranked Pakistani institutions
- Build a 'culture of evidence' in the higher education linking objective assessment and performance of institutions of the higher learning
- Ensure development of support services at universities to achieve excellence in teaching and research

Economic development

- Promotion of harmony between university and social goals through constant dialogue
- Promotion of research and development activities in universities with special emphasis on areas of economic relevance to the country
- Active involvement of the university faculty in enhancing export competitiveness of industry, especially in the sectors of engineering, IT and software, chemicals and pharmaceuticals
- Promotion of linkages between university and technical and vocational institutions, especially for faculty development in subjects pursued at the Technical Education and Vocational Training Authorities (TEVTAs)
- Establishment of the business incubators in selected public universities
- Encouragement of research and innovation in areas of relevance for the economy and society, particularly by promoting close and productive interaction between private and public institutions in science and technology, while special importance be given to key leverage technologies, such as biotechnology, material sciences, electronics, space sciences, oceanography, and others
- Engage scientific and technological experts in the decision-making of the development initiatives and budgets to
    - involve vigorously the private sector in research and development
    - promote lifelong learning in the higher education institutions by allowing faculty to upgrade their skills at regular intervals for responding to diverse demands
    - effectively leverage Information and Communication Technologies (ICT) to deliver high quality teaching and research support in the higher education both on-campus and using distance education
    - share expertise and facilities among universities though national and international partnerships for supporting socio-economic regeneration and growth, and
    - reorganise, strengthen and establish new industrial development corporations to encourage applied R&D, innovation and technology development

Strategy

In order to realise these broad objectives, it is essential to spell out an implementation strategy, which will enable classification of specific plans and programmes with clearly defined tasks, approximation of necessary resources and time bound targets.

Access to higher education

The enrolment in the tertiary education has increased from 0.276 million in 2001-02 to 0.738 million in 2007-08 and in excess to a million since 2010-11. This enrolment has come with a significant increase of female students. The gender-wise studies show that the gap between male and female students has lessened from 63:37 in 2001-02 to 54:46 in 2010-11.

Enhancing equitable access to the higher education will remain a key objective of the higher education strategy. Specific emphasis will be given to equity in access to the higher education for ensuring that students, from under-represented areas and groups, are able to acquire higher education. Additional strategic options for enhancing equity to be pursued are:

- Opening of universities and sub-campuses in the disadvantaged regions
- Provision of full need-based scholarships
- Promotion of quality distance learning
- Financial aid for needy students, and student loans

The student enrolment projections of the HEC have been given in the following table.

Table 2: Enrolment projections for the Plan period

(Thousands)

Institutions	Per cent increase	Projected enrolment					
		2013	2014	2015	2016	2017	2018
Public universities	15	408	469	540	621	714	821
Private universities	18	106	125	148	174	206	243
Distance learning	12	325	364	407	456	511	572
Colleges	8	367	396	428	462	500	540
Total		**1,206**	**1,355**	**1,523**	**1,714**	**1,930**	**2,176**

Academic reforms

These reforms will focus on:

- Improve quality of the higher education through the modernisation of syllabi, increased research, networking of universities and departments and increased allocation of funds
- Promoting innovations in teaching and for pursuing high quality research
- Providing opportunities and means to the universities and institutes to interact across geographical boundaries of institutions, integration of teaching, research and evaluation, and mutual collaboration and cooperation for optimum utilisation of available resources
- Making university accreditation process more transparent, time-bound and be progressively freed of government regulations and control leading to a situation when the whole procedure will be based on a system of the public appraisal and acceptance
- Encouraging universities to revisit the fee structures and gradually decrease the subsidy in the tertiary education. However, this will not compromise right of poor students for quality higher education. Universities will also be encourages for income generation by other means like by involving alumni, donations, endowment funds, international cooperation, etc.

Faculty development

The major objective of the faculty development is to increase number and percentage of faculty members with terminal degree, attracting talented faculty by initiatives, like Tenure Track System, providing PhD training facilities to talented youth and faculty, rewarding excellence in all modes, and incentivise faculty development. This is envisaged to be done by taking the following steps.

- Human resource development through indigenous and foreign scholarship programmes
- Initiating split PhD programmes in collaboration with the developed countries
- Merit-cum-need-based scholarships
- Special scholarships programmes for less developed areas, like FATA and Balochistan
- Special scholarships for weaker and new universities
- Post-doctor fellowships for the existing faculty and researchers
- Short trainings of six months to one year for students and faculty
- Hiring of foreign and expatriate Pakistani faculty for medium (six months) and short(up to one month) periods to meet immediate faculty needs
- Continuing with the Tenure Track System for attracting faculty
- Incentivising establishment of the Continuous Professional Development Centres (CPDC)
- Supporting universities to launch joint degree programmes in collaboration with the foreign premier universities

Quality assurance

The main aim of quality assurance is to place a mechanism for assessing quality of the product, programmes, the institutions and infrastructure. Most of the universities already have in place the QECs. The HEC also has its own Quality Assurance Division. In order to sustain the quality, the following steps have been proposed.

- All the universities should have QECs during the Plan period.
- The Quality Assurance Division at the HEC should make sure that all universities submit periodic quality assurance reports and the same are also physically verified. The outcomes should also be published for information of the public.
- Develop proper mechanism for assessing quality of higher education institutions
- Implementation and evaluation of the Institutional Performance Evaluation Standards
- Liaison with the international QA bodies for sharing the best practices and experience in the areas of mutual interest
- Improving accreditation and regulatory system for various disciplines at the universities

Professional development

While academic faculty represents the most important entity of any university, the provision of university services requires efficient support staff and systems for carrying out the myriad of

tasks in a modern higher education institution. Our public institutions will have to be provided necessary IT hardware, software for campus management, HR management, financial management, procurement, etc., as well as training for personnel to change current systems and introduce modern techniques. The establishment of these key offices in every university, provision of necessary equipment and software as well as training of personnel will be vigorously pursued during the Plan period.

Leadership, governance and management

Improvement in the quality of education and research imparted in universities requires the availability of professional management, well-versed with modern university governance and management principles. Universities are expected to be community leaders. The evolution of our institutions of higher learning into such community leaders will require training of the university leadership (vice chancellors, deans, department chairs and heads of support service programmes) as well as the availability of the governance structures in these institutions facilitating this transformation. Modern universities today operate with the paradigm of the shared governance, and it is necessary for the Pakistani university leadership to embrace this paradigm and practice it as well. Universities can no longer afford to operate in isolation of their community and society.

Indigenous technology development and Triple Helix System

Collaboration among government, academia and R&D institutions and industry brings each stakeholder to the table talent, resources and differentiated perspectives that together create a robust whole in addressing the problems. The academia and R&D-industry-government linkage is also being known as the Triple Helix relations. The challenge lies in aligning the institutions of the higher learning, S&T research institutes and industrial players to work synergistically towards enhancing competitiveness of the goods and services industry and addressing all challenges that will arise in this endeavour. The steps are:

- Improving laboratories and equipment facilities of the R&D organisations and universities
- Ensuring availability of the locally trained manpower as per needs of the industry
- Develop Triple Helix Centres in the science and technology policy research institutes and centres to additionally work on this aspect of technology development
- Ensuring a public procurement policy that gives preference to indigenous products
- Steps for enhancing share of the cottage industry in the economy
- Motivating big industrial units to establish R&D cells and increase spending on the R&D and support universities and S&T organisations
- Technical support for the SMEs from academia and S&T organisations for enhancing quality of their products.
- Prioritising industries to be focused for economic development and their support and help in establishing linkages with the R&D and academia

Promoting research, innovation and tech entrepreneurship

Efforts will be directed to produce a research sector, which is dynamic as well as responsive to the changing research environment and market needs. On the other hand, innovation and

promotion of entrepreneurship are keys for sustainable economic growth. The following steps need to be taken for promoting these aspects.

- Ensuring that the academic programmes offered in engineering, science, humanities, and arts are relevant to the industrial and societal needs.
- Continuous development of the physical infrastructure and facilities at universities and R&D organisations
- Research grants for faculty, especially newly-appointed PhD faculty
- Equal importance to research in humanities, arts and social sciences as to science and engineering
- Establish Offices of Research, Innovation and Commercialization (ORICs) in all universities
- Establish business and tech incubators at universities, and science and technology parks in major cities
- Establishing academic think tanks and policy institutes
- Incentivising private sector and industry for spending on the R&D
- Innovation fund
- Venture capital and equity funds

Role of the private sector universities and institutions

The government has a limited pool of resources and cannot shoulder the burden of providing higher education all by itself. The private sector must rise for provision of quality higher education to the masses. However, it is quite alarming that only a few private sector institutions have been maintaining quality standards. It is necessary to bring private institutions to the centre stage in order to contribute significantly to the higher education.

Thrust areas

The following thrust areas have been identified for their development to help economic growth.

Metrology, Standards, Testing and Quality

Pakistan has set up a nascent MSTQ system with three organisations, namely Pakistan Standards and Quality Control Authority (PSQCA), National Physical and Standards Laboratory (NPSL) and Pakistan National Accreditation Council (PNAC), as its components. However, these have not been able to perform as expected due to various reasons. The following is being proposed to strengthen the MSTQ system.

- Strengthening of the existing MSTQ organisations
- Clearly redefine functions of each organisation so as to remove conflicts on jurisdiction
- Capacity-building of the staff of these organisations
- Making sure international accreditation and recognition of these organisations as well for acceptance of their certificates

- Increasing the number of mandatory standards and their enforcement on imported goods lest the local market gets flooded with sub-standard foreign goods
- Harmonising the federal and provincial laws on standards
- Increasing the number of ISOs and IEC accredited laboratories and certification bodies

Energy education

Keeping in view the current energy crisis, there is a need to use technological solutions in resolving the crisis and enhancing efficiencies of the existing processes. The focus will be on:

- introduction of the energy-related academic and training programmes at universities,
- incentivising the private sector for manufacturing the renewable energy products, components and systems, and
- development of the pilot projects and their large-scale dissemination based on the existing technologies, such as solar water heaters, biogas plants, photovoltaic, etc.

Food technology

Food technology is the application of food science to the selection, preservation, processing, packaging, distribution, and use of safe, nutritious, and wholesome food. At present, Pakistan is not well-equipped to respond to the existing and emerging food safety and quality standards due to lack of technical infrastructure. Investment will be made to resolve the food technology issues for providing safe and high quality food to the domestic and international markets.

Leather technology

The leather industry, being the second largest export-earning sector of Pakistan after textile, includes leather garments, gloves and footwear. It is contributing about $800 million a year, but has the potential to multiply volume of exports with the improvement of quality and diversification in different range of products, especially garments and footwear. Universities and R&D institutes need to work in collaboration of the private sector to identify gaps of trained manpower, solution-based R&D, development of new processes and adopting global standards.

Space science

Space technology is one of the most important technologies of the future. Over the years, its applications have increased in many fields like communication, meteorology, telecommunications, defence, resource exploration, environmental protection, land management, infrastructure development, R&D in exploitation of telemedicine, distance education, disaster monitoring and many other fields. The steps are:

- Promote R&D efforts by all relevant R&D and higher education institutions to develop indigenously built satellites, double stage solid fuelled propelled Satellite Launch Vehicles, robust Intermediate Range Ballistic Missile (IRBMs)
- Facilities for the Satellite Environmental Validation and Testing (EVT), Satellite Dynamic System Testing and Satellite Assembly Integration and Test (SAINT) to be developed to keep pace with other countries
- Produce trained manpower in space, and science and technology

- Promoting use of remote sensing and other satellite data for important aspects, like communication, mapping, survey, land disputes and other such important aspects

Material sciences and nano-technology

Material sciences play a pivotal role in determining and improving economic performance and quality of life. Progress in the technologies critically depends on the development of new and tailor-made materials with improved and novel properties, like new biocompatible materials for medical applications, and opto-electronic materials for computers and communication devices. Unfortunately, Pakistan lags behind in this area and nothing promising has so far been achieved in this regard. The steps will be:

- Focused research for material sciences to develop materials of the future
- Setting up centres for research on material sciences at universities
- Involving strategic S&T organisations for defence-related new materials
- PhD level training of the manpower in material sciences
- Exploiting technology transfer option for this important field
- Establishment of a National Material Science Research Institute

Nanotechnology is the ability to fabricate devices at nano-scale (one billionth of a metre) for practical applications. Nanotechnology has been labelled as enabling technology creating new applications in medicine, energy, industry, foods and consumer goods. Pakistan is lagging behind despite having a good infrastructure. Certain pockets of expertise exist because of the earlier funding by the HEC and Ministry of Science and Technology, but these are scattered. A National Commission on Nano-Science and Technology (NCNST), constituted in 2003, is now defunct.

- Revitalise NCNST with a task to develop the National Nanotechnology Initiative, and bring all the stakeholders of the public and private sectors on board to develop a roadmap
- Exploiting applications of the nano-technology in energy, environment, agriculture, health and other sectors
- Developing institutes of nanotechnology at selected universities and equip them with the state-of-the-art equipment and requisite manpower
- Asking the private sector to contribute in the research funding of the projects directly or indirectly related to industry (on the lines of the ICT R&D Fund)

Marine resources

Pakistan has a coastline of 990 kilometres, extending from the Indian border in the East to the Iranian border in the West. The Exclusive Economic Zone (EEZ) of Pakistan is about 250,000 square kilometres. Under the 'Commission on the limits of the Continental Shelf', Pakistan stands to annex an additional area of about 60,000 square kilometres. As such, this maritime zone of Pakistan will be over 30 per cent of the land area. The area is characterised by distinctive oceanic phenomena and features, which are capable of producing rich fisheries, mineral, oil and gas resources. Extensive survey, data collection and research are required to understand the processes and features having a direct bearing on locating the living and non-living marine resources and their sustainable development and conservation. The marine

resources have so far remained unexploited and concerted oceanographic research will be undertaken.

Electronics

Electronics is considered to be one of the world's fastest growing industries with global revenue worth trillions of dollars per annum. Unfortunately in Pakistan, the electronics sector is still in infancy and never became a major revenue-generating industry. The electronic industry in Pakistan mostly revolves around consumer electronics, with activities confined to assembling of the conventional TV sets, radios, and other allied consumer electronic products from Complete Knocked Down (CKD) or Semi Knocked Down (SKD) kits imported mostly from China, Malaysia, Korea, and other countries.

It is, thus, imperative that a coherent strategy is put in place to develop this sector with a view to increase the country's growth potential as well as achieving self-sufficiency by reducing dependence on foreign sources of products, materials, components and equipment. Pakistan will encourage local manufacturing and curb import of the finished electronic goods, facilitate import of the Printed Circuit Board (PCB) manufacturing plants, automated component stuffing, focusing on micro-electronics, robotics and soldering equipment.

Automotive engineering

The automobile industry has been an active and growing field in Pakistan for a long time but it is not as much established to figure in the prominent list of the top automotive industries of the world. The total contribution of the auto industry to the GDP in 2008-09 was 2.8 per cent, which has increased to about 4.5 to 5 per cent in 2013-14. There are 500 auto-parts manufacturers in the country, which supply parts to original equipment manufacturers.

A strategy, that would greatly help in strengthening the automotive industry, is building gainful partnerships with the leading players in the global auto industry (like Germany, Japan, etc.) to enable and facilitate the technology transfer to assemble plants setup in Pakistan. There is also a need to develop compatibility to shift the auto industry to use alternate fuel technologies, like Ethanol, as Brazil is using.

Information Technology

The inherent strength of Information Technology as an agent of change, transformation and growth of economies around the world, has made it a corner stone of the futuristic vision of countries to become dynamic, knowledge-based and highly developed competitive nations. The IT includes computer technology, communication technology and robotics. The IT industry is probably one of the most exciting and dynamic sectors in the country today with nearly all major global IT companies of the world have a presence in Pakistan. The need of the hour is to have quality IT faculty in universities to produce quality IT manpower, encourage development of the IT incubators and build world-class companies through mergers, acquisitions, joint ventures with foreign software houses, etc. The Internet City and Knowledge Village will be established to achieve critical mass of high technology companies.

Biotechnology

As agriculture is the vanguard of our economy, so it is required that this is developed as the core-competency, and for this, biotechnology can play the role of a catalyst. It can be used in the following areas:

- Medicine, food production and fertilizers
- Plants, animal health, vaccine production, bio-diagnostics, and pharmacogenomics
- Strengthening of the existing institutes working on biotechnology and introducing this programme in selected universities
- Developing biotechnology-based products, their testing at pilot scale and subsequent commercialisation

Engineering and manufacturing

The engineering products and services are the most tangible objects of development activity. The products are also the ones where the role of knowledge and technology is the most obvious. The existing industrial infrastructure has enormous potential of export earning, but is marred by multifarious problems of management, innovation, energy supplies, unfavourable local and international regulations, high interest rates, etc.

The engineering sector is an ensemble of various other sectors, which benefit from it, include agriculture, textiles, leather industries, materials, chemical process industry, engineering goods, electronics, energy, telecommunications, Information Technology, construction and housing, and transport. Hence, these will be the focus of research and education of engineering as well as the sector itself.

The government is committed to transform the manufacturing sector to support high-value innovative and export-led economy. The sector is heavily dependent on imported technologies, as largely based on imported raw materials and spares with insufficient operational practices and lack of quality control and R&D. Pakistan needs to invest in new technologies, and R&D, and also improve exports of this field. The manufacturing-related programmes will be introduced as subjects at university level.

Action plan

The objectives and strategy will be implemented by the HEC and universities.

Strategy	Action and programmes	Financial Impact
Access to higher education	• Universities in far-flung areas and sub-campuses in small cities are being established. • Women universities at Lahore, Rawalpindi, Peshawar, and sub campuses at Jhang and other districts • AIOU and Virtual University will enhance their reach to cover almost the whole country through distance learning.	Rs36.5 billion will be spent on ongoing and new universities, sub-campuses, enhancing distance learning and financial support to needy students.

Faculty development	• Indigenous and overseas scholarships programmes, Second phase of the Pak-US need-cum-merit based scholarships, US Fulbright scholarships, MS leading to PhD scholarships • Short training programmes to continue • Post-docs fellowships programme to continue • Hiring of faculty on regular contracts as well as for short-term and Tenure Track System to continue	Rs 42 billion have been allocated for the Plan period to cater for faculty development and HRD-related initiatives.
Research enhancement	• Chairs in foreign universities and local universities • Collaboration with universities in developed countries, SAARC and other regions • Student, faculty and scientists exchanges • Establishing 25 incubation centres and three S&T Parks • Revamping of curricula at all levels • Establishing QECs in all universities • Thematic research grants	More than Rs12 billion will be spent during the Plan period on such initiatives.
Focusing on thrust areas	• Establishing centres of excellence in relevant fields • Focusing on important initiatives, like launch of Pakistan Remote Sensing Satellite (PRSS), Establishment of National Electronic Complex (NECOP), centres of excellence in Energy, Food Security and water, Cluster Councils for local industries, Institutes of Nano-Technology, Wind/solar based research, S&T projects for MSTQ, etc. • Research grants to the faculty and students • Trainings in relevant fields • Enhancement of R&D output, like research papers, patents, pilot scale product development, commercialisation, and collaboration with industry • Revamping IPO, patent registration and other relevant areas • Establishing and strengthening of existing quality control labs, testing labs, standard organisations and accreditation bodies • Strengthening of regulatory framework in higher education, and science & technology	Rs35 billion will be spent in the Plan period on the relevant initiatives.

Institutional arraignments

The Planning Commission will coordinate and facilitate the implementation of knowledge economy. Its multi-sectoral membership, which includes representatives from other line departments, business and industry, and the academia, enable it to oversee the implementation of the Plan. The HEC, Ministry of Science & Technology, universities, R&D Organisations, private sector and Industry will be the other important players, which will directly or indirectly play an important role. The Planning Commission will forge partnerships and networking among different players through the creation of technical working groups to steer and oversee particular knowledge economy programmes and projects. It will act as the think tank and resource bank for the government, with forecasting through policy research units, which will be strengthened and augmented. Indicators will be prepared for monitoring implementation and progress of projects and facilitation mechanisms.

Parameters for measuring knowledge and technology-based development

Development indicators
• Rankings in the Global Competitiveness Index (GCI)
• Rankings in the Technological Index (TI)
• Percentage of total education and R&D expenditures to the GDP
• Value-added in high technology exports
• Technology's balance of payments
• Investment in high technology areas
• Number of science and technology parks and incubators
• Number of international accredited laboratories
• Number of R&D personnel per million population
• Number of PhD in science and engineering per million population
• Share of private sector in R&D expenditure
• Number of publications in the international science citations

Capital outlay

The total investment for the knowledge and technology-based development has been proposed as Rs136.6 billion (that is, Rs114.2 billion for the higher education and Rs22.5 billion for science and technology sectors). Major areas for investment are the higher education, HRD and R&D in cutting-edge technologies for promoting knowledge and technology-led development to provide the path of fast track economic growth. The programmes in these sectors will have to be prioritised, and the targets and goals of the Plan will be difficult to achieve with this level of investment. Detail allocations of the higher education, and science and technology sectors are given at Annexure-I.

The government will continue to intensify efforts towards innovation, R&D in key areas and knowledge-based development to meet the requirements of a knowledge-based economy. The

private sector will need to keep pace with the technology advancements in the global world, and expand their capacity in the R&D to complement the efforts of the government.

The challenges lie in developing a competitive edge at the global level. This will be determined by our ability to create, acquire and use knowledge and technology-based development for socio-economic development. The HEC and Ministry of Science & Technology have to play a very important role in the transition towards a knowledge driven development. The acquisition of high technology and its use as a strategic tool as well as the immense transformative power of technology and innovation and the need of appropriate policy and plans for harnessing this power, which can improve all different aspects of the lives of people, and help Pakistan attain its development potential.

Annexure-I

Knowledge and technology-based development (Plan 2013-18)
(Financial outlay)

(Rs billion)

S. No.	Area/ Sector	Total allocation
A.	**Higher and professional education**	
	Human Resources Development	34.2
	Teaching and learning	11.4
	Research enhancement	10.2
	Infrastructure	29.7
	Access to information/equipment	17.6
	Office equipment and others	11.1
	Sub-Total (A)	**114.2**
B.	**Science & Technology**	
	Science and Technology Policy Research	0.5
	Science Talent Farming	0.7
	Technology Innovative Development Fund	2.4
	Academia-Industry-Government linkage	1.4
	Technology assessment & development organisation	1.0
	Biotechnology	1.4
	Food technology	1.0
	Leather goods	0.7
	Space sciences	1.2
	Material science and nano-technology	1.4
	Marine and water Research	1.4
	Electronics	1.4
	Automotive engineering	1.0
	Information Technology	1.0
	Energy and renewable Energy	4.8
	Engineering and Manufacturing	1.0
	Sub-total (B)	**22.5**
	Total	**136.6**