Revitalising Science, Technology and Innovation in Iraq

A Roadmap

Preface

This Roadmap is an update of an earlier version circulated and discussed at a meeting organised by the UNESCO Iraq Office, in Beirut during 12th - 14th December, 2011. The principal aim of this meeting was to arrive at an overall plan constituting basis for revitalising science, technology and innovation capabilities in the country, through a variety of initiatives, including establishment of specific institutional entities, reform of current legislative frameworks and promotion of greater cooperation and networking among principal actors both at home and abroad. The meeting was attended by Iraqi decision and policy makers, national experts, a group of prominent expatriate Iraqi scientists in addition to UNESCO staff.

Comments put forward before, during and following this meeting were used in producing the present version. In particular some changes were made regarding the Roadmap's timeline and several paragraphs were added in explanation of its implementation modalities.

The present version of Roadmap is made up of four closely related parts. Following a brief introduction, the first part presents a set of issues in need of priority attention in Iraq's scientific research system.

The second part is based on the notion that in order to rehabilitate scientific research in a given country, there is need to revitalise the entire science, technology and innovation system, strengthen demand for services provided by that system as well as build capabilities for effectively employing research outcomes in sustainable socioeconomic development, as well as job creation and poverty reduction. The latter requirement is of particular relevance to widening the base for entry into the educational system, in general, and higher education and research activity, in particular. In other words, this part takes the view that adopting a holistic view in tackling both the supply and demand sides of the "science and technology for development" equation is an essential precondition for rehabilitation of scientific research AND higher education. With such issues in mind this part addresses the need to rebuild the country's entire science, technology and innovation system, as well as revitalise its business and innovation climates through creating or redesigning relevant institutional entities and strategies.

The third part of the present Roadmap is dedicated to a concise review of proposed implementation modalities, including a proposed sequence of activities as well as possible modalities for their implementation. Naturally, all suggestions made in this part would need to be carefully reviewed and synchronised taking into account predominant national needs and priorities.

The fourth part of the Roadmap presents a short resume of strategies designed by the ministries of higher education and scientific research, both in Baghdad and the Kurdistan Region, with the intention of improving scientific research capabilities. This part allows a closer look at the above ministries' top priorities in relation to the range of tasks required for building a viable science, technology and innovation system. Both strategies are included here since they are, firstly, still under implementation, and, secondly, since they provide good examples of initiatives with which the present Roadmap would need to dovetail, targeting overall national objectives as well as specific priority issues.

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List of abbreviations

ATF	Auxiliary taskforce
b.	billion
CoEs	centres of excellence
CTF	core taskforce
CTF/ISTIC	core taskforce's ISTIC report
CTF/ISTIP	core taskforce's ISTIP report
CTRE	centres of teaching and research excellence
EIS	enterprise incubation schemes
FDI	foreign direct investment
GDP	gross domestic product
ICT	information and communications technology
ID	Iraqi Dinar
ISTIC	Science, Technology and Innovation Commission
ISTIP	Science, Technology and Innovation Policy
IVSL	Iraq's Virtual Science Library
KRG	Kurdistan Regional Government
m.	million
MoHESR	Ministry of Higher Education and Scientific Research
MoHESR/Baghdad	Ministry of Higher Education and Scientific Research in Baghdad
MoHESR/Kurdistan	Ministry of Higher Education and Scientific Research in Kurdistan
MoWR	Iraqi Ministry of Water Resources
NEPA	enterprise promotion agency
NISA	Network of Iraqi Scientists Abroad
NSA	National Science Academy
P&P	programmes and projects
PC	planning cycle
PRMU	policy research and monitoring unit
PS&D	priority sectors and disciplines
R&D	Research and development
RTP	research and technology parks
SMEs	small and medium enterprises
SRC	Scientific Research Council
STIF	Science, Technology and Innovation Foundation
STI	science, technology and innovation
SWOT	strengths, weaknesses, opportunities and threats
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNESCO/Iraq	UNESCO Iraq Office in Amman
US$	United States Dollars

Executive Summary

This Roadmap is intended as basis for carrying out a series of activities aimed at revitalising science, technology and innovation (STI) in Iraq with the aim of placing Iraq's society and economy en route to becoming STI-based by the year 2020.

Activities to be implemented in seeking the above objective include formulation of a comprehensive STI policy, restructuring national STI governance, institution building and reform, overhaul of related legislative and regulatory arrangements as well as implementation of a variety of national and sectoral initiatives. At all times, emphasis is placed on STI capacity building in sectors and disciplines with priority status for the country's sustainable socioeconomic development.

Based on an analysis of the status of scientific research undertaken by the UNESCO Iraq Office in Amman (UNESCO/Iraq) during the months of July-August 2011, and using input from an earlier study outlining various aspects of STI activity -also conducted by UNESCO/Iraq- this Roadmap takes into account:

- weaknesses and points of strength that characterise higher education and scientific research systems in Iraq;
- evident threats and possible challenges that may be expected to emerge during the years ahead;
- current initiative and priorities with which future initiatives would need to mesh.

This Roadmap is essentially designed with:

- due cognisance of current thinking with regard to national science, technology and innovation systems. It takes into account recent experience and success stories in both developed and developing countries in the region and overseas.
- accent on coordination and cooperation among concerned institutions, with inherent possibilities for extensive networking and feedback at various levels throughout implementation;
- emphasis on well-defined deliverables and timelines for the various components of the Roadmap and on subjecting all outcomes to appropriate quality assurance measures.

The following paragraphs present a summary of this final version of the Roadmap; with its main directives organised under headings reflecting areas of activity to be tackled in its implementation.

Implementing the Roadmap

Following its approval by concerned authorities, it is recommended that the Roadmap be launched at a national conference dedicated to the purpose. This conference should be held as soon as the Roadmap is approved, hopefully during the first quarter of 2012. At this conference, the Roadmap's objectives and implementation modalities would be presented and a division of labour discussed with suitable timelines and benchmarks agreed upon.

The Roadmap's central taskforce

Following the Roadmap's approval and based on the Conference's outcomes, a central taskforce (CTF) should be established by major ministries in charge of science, technology and innovation in order to initiate streamlined implementation of the Roadmap.

This central taskforce should comprise a team of high-level officials and experts concerned with STI-related duties in Iraq and should be charged with preparations for establishing Iraq's Science, Technology and Innovation Commission (ISTIC), which is to play the leading role in all activities aimed at revitalising Iraq's STI capabilities in the years ahead. Once ISTIC becomes operational, the central taskforce may be disbanded, and its members assigned specific duties within the ISTIC organisational structure.

It would also be advisable that the same central taskforce be charged with undertaking setting the scene for the formulation of Iraq's Science, Technology and Innovation Policy (ISTIP), including preliminary contacts, formation of institutional and sectoral teams by concerned parties, organisation of preliminary delivery schedules and timelines concerned with various ISTIP aspects, in accordance with overall timelines already established within the final approved version of the Roadmap. These activities would later be reviewed by ISTIC with view to arriving at final ISTIP formulation schedules and delivery dates.

The Roadmap's taskforce would naturally hand its duties over to ISTIC as soon as the latter is established. Additional specialised taskforces and teams would need to be set up with specific mandates based on the Roadmap's objectives by ISTIC as soon as is established.

The Iraq Science, Technology and Innovation Commission

ISTIC should be invested with the means to design and oversee:

- ISTIP formulation and design of implementation strategies, work plans and related initiatives;
- the launch of several waves of STI institutional reform as well as complementing Iraq's STI institutional set up through establishing novel institutional forms, including centres of teaching and research excellence (CTRE), research and technology parks (RTP), and STI-based enterprise incubation schemes (EIS);
- the design and implementation of a host of initiatives, with ambitious objectives and delivery dates, aimed at creating improved responses to Iraq's STI-based socioeconomic development with particular attention to:
    - restructuring and upgrading performance of STI institutions;
    - creation of missing institutional components within the national STI system;
    - introduction of quality criteria to various aspects of national STI activity;
    - harmonisation of approaches adopted in various regions.

In order to discharge the above tasks, ISTIC would need to enjoy support by an advisory body an efficient secretariat as well as number of sub units, shown in figure (1). Additionally, ISTIC would need to be granted powers enabling it to set up taskforces with specific mandates directly related to the Roadmap's implementation.

The Iraq Science, Technology and Innovation Policy

One of the first activities to be carried out on the basis of the approved Roadmap and the national conference's deliberations is the formulation of Iraq's comprehensive national science, technology and innovation policy.

Drafting ISTIP, its implementation strategies and action plans must be based upon rigorous and in-depth SWOT exercises designed to explore possible futures of selected priority sectors and

sub-sectors in production and services, with due reference to their particularities, short- and long-term needs, as well as possible futures of selected priority disciplines in science and technology.

ISTIP directives would need to lay down implementation guidelines; paving the way to the design of a series of special initiatives with constituent programmes and projects; allowing implementation of several waves of rapid-results projects aimed at "quick wins" as well as longer-term reforms, incorporating challenging deadlines and targeting well-defined and readily measurable outcomes.

Once approved, ISTIP should be adopted as an integral part of national development plans approved by central and regional authorities and implemented through well-defined strategies. It is recommended that another national conference be held upon ISTIP finalisation with view to highlighting its objectives and garnering support for implementation of its directives.

Following, ISTIP formulating a series of workshops would need to be organised with the intention of ensuring thorough discussion of ISTIP articles, directives and implementation modalities within specialist circles involved in, or impacted by, its outcomes. It is proposed that these workshops be held under the auspices of ISTIC in collaboration with various government ministries, and, whenever possible, public and private enterprise institutions and other stakeholders.

Implementation strategies, work plans and initiatives

Implementing Iraq's STI policy has to proceed through well defined implementation strategies, work plans as well as associated national and sectoral initiatives targeting a variety of objectives, including, among others, institutional and legislative reform, institution building, partnerships, coordination and networking.

ISTIP implementation strategies, work plans and initiatives must to be subjected to extensive debate in special workshops held under the auspices of ISTIC in partnership with concerned national institutions.

In formulating ISTIP implementation strategies and work plans care should be taken to:

- consider experiences in STI capacity building from around the world;
- engage STI stakeholders and end-users in incisive discussions eliciting support and commitment on overall objectives as well as goals of special interest to each;
- avoid top-down approaches and enhance participation by as many levels of decision making as possible;
- allow for adequate flexibility and trajectory changes in subsequent stages.

STI institution building

Further actions to be taken following the adoption of the Roadmap should include:

- finalising measures aimed at establishing the proposed **Scientific Research Council (SRC)**.
- re-inventing the **Iraqi Science Academy** (ISA) and investing it with resources and support, so that it may fulfil its intended functions;
- creating a national **STI Foundation** (STIF) with a sufficiently wide mandate aimed at supporting future activities aimed at national STI capacity building, emphasising its role as coordination and funding agency with power and resources enabling it to

establish national and international STI initiatives in line with national development plans;
- re-creating Iraq's **National Scientific Academy** with a mandate that is more in line with present-day requirements, advisedly exceeding linguistic and historical studies to encompass an increasingly wider range of studies in the physical and social sciences as well as humanities;
- establishing, throughout Iraq, a host of bridging institutions, including research and technology parks, with view to linking universities and other STI institutions to business enterprises;
- launching STI-based business incubation schemes within selected research centres and universities with inherent capabilities for growing such schemes into full-fledged centres for the incubation of STI-based enterprises;
- catalysing the creation of innovative business clusters in close cooperation with universities and major research centres as well as concerned ministries.

Simultaneously, avenues should be explored for the establishment of other entities, essential for enhancing STI capabilities and promoting STI- and knowledge-based development. Several such entities are listed in Section I.4, below.

While not methodologically preferable, considering the need for rapid results as well as evident poverty of the STI institutional scene in Iraq, it would also be advisable to launch exploratory and preparatory efforts leading to the establishment of certain entities as soon as possible following the Roadmap's adoption.

Clearly, the establishment of the above institutional entities would take considerable time and effort. However, it is hoped that the present national climate, which is clearly in favour of accelerated institutional reform and institution building, would be conducive to fast-track developments, provided high-level awareness and matching commitment are generated and maintained during initial months of the Roadmap's implementation.

STI institutional reform

Reform of existing STI institutions is to focus on restructuring institutions of higher education and scientific research. Details of this restructuring fall beyond the scope of this document. Suffice it to indicate, here, that a good deal may be gained through greater emphasis on tangible market needs and greater adherence to national priorities.

Additionally, intensive efforts must be directed towards transforming selected university and research institutions into centres of teaching and research excellence.

Other restructuring tasks of STI institutions in Iraq should address the need for units to perform STI planning and coordination activities within key ministries. This will be especially important for ministries whose operations demand constant STI input and intensive links to university research departments and research and development (R&D) centres as well as proposed research and technology parks.

On another level, there is also need to restructure research facilities in selected social sciences departments and research units so as to establish research units specialising in STI policy and futures' research. Both types of research units must be equipped with suitable networking capabilities, with national hubs for coordination/harmonisation purposes.

It is to be noted that at least some of the above recommendations could be implemented in harmony with efforts aimed at networking and cooperation with Iraq's expatriate STI professionals. On the other hand, some of the above recommendations could open avenues for the creation of specialised STI-based enterprises as well as public-private partnerships.

ISTIC taskforces

Led by key staff from the Ministries of Higher Education and Scientific Research in Baghdad and the Kurdistan Region, as well as the Ministry of Science and Technology **and** in full cooperation/coordination with STI stakeholders and end-users, STI taskforces will be created and charged with preparing for and implementing specific tasks including:

- formulation of Iraq's science, technology and innovation policy;
- initiate programmes aimed at upgrading capabilities of researchers in various fields of endeavour throughout the country;
- organise schemes of sabbatical leaves and tours of study at prominent research facilities abroad, with view to attaining comprehensive and integrated research capabilities in selected priority areas;
- evaluate various modalities with evident benefit in internalising expertise for continual upgrading STI human power, including research staff in priority domains;
- enhance training (and improve conditions) of auxiliary and support staff at research institutions, including administrators and technicians;
- address deficiencies in national vocational training and education institutions, and ensure that their performance remains abreast with advances made in the country's STI system.

Formulating Iraq's STI policy

The ultimate ISTIP objective will be to place Iraqi society and its economy on a firm footing with viable STI inputs at a variety of levels and directions, promote STI-based development and lead to creation of a knowledge-based society and economy in Iraq by the year 2020.

Principal issues to be addressed by ISTIP include enhancing standards at Iraq's STI institutions and improving quality of their output and its relevance to comprehensive socioeconomic development in general.

In order to achieve viable outcomes, ISTIP would need to be formulated on the basis of through and in-depth analysis of science, technology and innovation in Iraq. Both supply and demand sides should be examined in sufficient depth. ISTIP would, furthermore, need to embody guidelines for launching reforms and capacity building schemes targeting STI supply and demand in a variety of priority domains that will need to be identified through national and regional workshops and in reference to adopted national development policy directives.

Overhauling Iraq's system of education and vocational training

Under the auspices of the proposed Iraq Science, Technology and Innovation Commission a series of initiatives aimed at radical overhaul of the country's entire system of education and vocational training with focus on:

- quality;
- equal opportunities;
- relevance of skills imparted to market requirements and priority development needs;

- innovativeness and creativity as prime attributes at all levels;
- openness towards end-user sectors;.

Examples of concrete objectives to be targeted by such initiatives could include attaining international recognition for degrees awarded in selected specialisations by certain universities within a set period of time, say by 2015 followed by recognition of all degrees awarded by Iraqi universities in a wide range of specialities by the year 2020. In the case of this example, it would clearly be up to individual, and groups of, universities to play a crucial role aided by the Ministry of Higher Education and Scientific Research, in Baghdad and the Kurdistan Region.

Objectives related to revamping the country's educational system would need to be implemented in a manner that couples human resource development with efforts aimed at networking with expatriate STI professionals as well as the creation of specialised STI enterprises, within research and innovation parks incubation schemes.

Reform and restructuring of Iraq's research institutions

Improved performance of Iraq's research institutions is an essential prerequisite for the country's future development. There is need to reinforce, design and implement initiatives including specialised training programmes aimed at enhancing researchers' capacity to undertake complex STI tasks in:

- selected priority areas;
- modern scientific research and technology development;
- transfer of research results into application areas.

Authorised by the national policy, ISTIC should act to reform and complement existing STI infrastructure. Urgent attention should be accorded to:

- upgrading ICT infrastructures, emphasising ICT facilities and services;
- improving researchers' access to a variety of Web resources;
- acquiring state-of-the-art equipment and laboratory facilities in a variety of priority areas, including agriculture, water resources, industry, energy sources and the environment;
- establish national and regional schemes for sharing expensive equipment items with commensurate training facilities;
- building endogenous capacity for training researchers in areas of general interest, e.g. research project design and management.

Ensuring adequate flow of researchers and innovators

In relation to preparing future generations of researchers and innovators, special national initiatives must be implemented:

- targeting specific priority sectors;
- including ambitious objectives;
- within specified but very short cut-off dates.

Examples of objectives that might be targeted by the above initiatives would include graduating fully trained teams with international-class credentials to advance research, technology development and innovative enterprise in selected:

- medical biotechnologies and related medical diagnostics within the next 3 years
- solar energy technologies and related industries;

- basic petrochemicals and downstream derivatives in support of a priority application sector, e.g. housing, water treatment equipment, arid land agriculture, etc..

Upgrading research outcomes

National initiatives must be designed with particular regard to improving research outcomes. With this in mind there is need to:

- monitor publications by Iraqi STI professionals and reward quality output with special reference to impact national priorities.
- establish more refereed journals at home with stringent measures aimed at quality assurance;
- assist patenting activity by STI professionals in accordance to international intellectual property regulations and criteria and instituting measures that facilitate patent commercialisation in Iraq and abroad.

ISTIC is to take charge of implementing related ISTIP directives. Among others, special initiatives might be launched by ISTIC with the purpose of ridding research centres of the need to perform routine technical services that drain their technical resources and do not always produce positive impact in terms of quality output. Examples provided by countries that turned units specialising in such services into autonomous or semi-autonomous entities, sometimes even into small and medium enterprises (SMEs), might be looked into and adopted as goals for restructuring and reform initiatives.

Legislative and regulatory reform at the national level

A host of institutional reform measures are needed in order to promote STI capacity building in Iraq. Thus, reforms would need to address inadequacies relating to the status of researchers as a particular category of civil servants and private sector institutions.

Additionally, there is need to consider scientific research as an essential function in public and private sector institutions, entailing special handling of relating expenditures and accounting practices.

Legislative reform should also address enhancing contributions by public and private sector institutions to research funding. Thus a certain percentage of annual profits by both public and private institutions would need to be dedicated to STI capacity building, including the creation of novel institutional forms and incubation schemes.

At the institutional level, ISTIC should champion adoption of regulation placing scientific research on an equal footing with teaching as essential duties for academic staff in the country's universities.

Funding STI in Iraq's

ISTIC, empowered by specific articles in the national policy would oversee enhanced levels of government spending on research scientific research, technology development and innovation. It is proposed that the level of national STI spending be increased to 2 percent by the year 2020.

However, enhanced STI funding would need to be coupled to enforcing regulations that guarantee transparency and accountability while maintaining adequate flexibility. In particular, it would be essential to disburse increasing proportions of research funds on competitive bases.

ISTIC will also need to forge and introduce revised STI funding strategies with view to promoting:

- stronger STI links between university institutions and research centres, and both private and public enterprises;
- specific innovations in the manufacturing and services industries as well as other national priority areas, including water, environment and agricultural production.

There will also be need to identify other sources of funding for STI activities throughout Iraq, including promotion of "conventional" sources, such as waqf, zakat and wills (wasiyah) in support of special research areas.

Creation of a wider range of institutions to foster technology development and innovation,[1] would initially have to be provided for through government funding. However, revised institutional strategies and business plans should see to it that increasing resource levels are made available through public-private sector partnerships. Innovations in the manufacturing and services industries in national priority areas, including water, environmental protection and agricultural production should constitute sensible bases for a wide scope of such partnerships.

The above partnerships should be the target of initiatives especially designed by a specialist ISTIC taskforce. Emulating steps taken in neighbouring countries in which both public and private enterprises contribute set percentages out of their annual profits should provide a good starting point for such initiatives.

Cooperation and coordination modalities

ISTIP directives and ISTIC initiatives would need to tackle issues relating to cooperation and coordination among STI institutions with emphasis on priority socioeconomic issues.

More specifically there is need to launch special incentives designed to:

- nourish research cooperation and coordination both among institutions within Iraq as well as with renowned institutions and prominent scientists and technologists abroad.
- measures used in funding research projects should reinforce cooperation and coordination among institutions at home and with counterparts abroad.
- joint publications in international refereed journals must be especially rewarded.

Additionally, specialised networks will have to be established, and provided with continual support, with Iraqi STI expatriates around the world, replicating successful experiences and lessons learned from other countries. In particular, rules and regulations governing operations of established networks should be amended to enable Iraqi STI expatriates to return home to work on temporary basis as well as mentor junior STI professionals from Iraq.

Creating and nurturing an STI-friendly culture

An STI-friendly environment is the product of a variety of factors. Prime among which are legislation and regulations governing:

- STI human resource formation and employment conditions;
- research, development and innovation activity;

[1] Including centres of teaching and research excellence (CTRE) in specific domains, research and technology parks, technology-based business incubators, networks in specialised fields of research.

- acquisition, utilisation and dissemination of new knowledge embodied in new products and processes;
- dissemination of STI knowledge among the population at large.

A special taskforce should be charged with formulating concrete proposals with regard to the above issues, with emphasis on amending existing legislation as well as crafting novel legislative and regulatory arrangements, as needed.

In relation to creating and nurturing an STI-friendly culture at the popular level, cross-cutting initiatives targeting educational institutions, particularly at the intermediate, secondary and tertiary levels must be launched. Media campaigns should be organised for the purpose with a dedicated ISTIC unit assuming a coordinating role. National initiatives aimed at promoting an SIT-friendly environment should be designed targeting the general public as well as youth and children. Such programmes would need to be implemented by a wide variety of educational and research institutions. Examples might include organisation of:

- fairs and exhibitions involving schools and universities, to encourage STI-based competition within and among regions as well as schools;
- a national "science week" with presentations, public and specialised debates on selected topics of current interest, as well as concurrent exhibitions and contests.

Establishing a business-friendly STI environment

Establishing a business-friendly environment requires extensive changes in existing legislation and the design of legislative and regulatory instruments that are more conducive to STI-based foreign direct investment (FDI) and STI-based SMEs. Stronger linkages between STI supply and demand sides should also be sought in order to promote innovation-based business ventures, in particular.

Additionally, steps will need to be taken, particularly in partnership with trade and industry associations, to enhance the business sector's capacity to adopt and absorb novel STI inputs as embodied within new product and process and new business models and value chains.

With both the above two issues in mind it is recommended that a national SME enterprise promotion agency (NEPA) be created with mandate to implement initiatives aimed at forging stronger links between institutions of higher education, vocational training and business institutions at large. NEPA could also be charged with coordination duties in the creation of research and technology parks and business incubation schemes.

Examples of quick-win projects that might be championed by NEPA would include the establishment of information and communications technology (ICT) business incubators with emphasis on start-ups specialising in the development, adaptation, Arabisation of e-learning packages. Another example could be to establish a series of Smart Community Centres in rural and impoverished urban localities. Special NEPA programmes could also be launched with view to:

- launching incentive schemes aimed at promoting STI-based business promotion in priority areas such as agriculture, industry, water resources, health, energy;
- creation of special investment funds and venture capital schemes targeting STI-based business enterprises.

Timeline for implementation

Part III of this document presents in some detail salient features of the timeline. Additionally, appendix VI presents a proposed timeline/scheme for implementing key Roadmap activities. Given the protracted nature of the Roadmap and its numerous initiatives, this table should be merely considered as a starting point in the process of planning the Roadmap's implementation. Nevertheless, it is worth noting that recommendations, following discussions of this timeline at the UNESCO meeting during 12-14 December 2011, included a specific request directed by participants at concerned authorities, to the effect that they adhere as far as possible to the proposed timeline.

The proposed timeline allows for a period of around six months, from the start of the implementation process, for the establishment and staffing of ISTIC, and around ten months before ISTIP is finally formulated. Following attainment of these milestones ISTIC would launch a series of planning cycles and waves of institution building and reform initiatives as well as a sequence of programmes and projects targeting STI capacity building in an expanding set of sectors and disciplines with priority concern for sustainable socioeconomic development.

Durations of around six months are allowed for each planning cycle with the actual initiatives lasting for periods of around one year. As shown in appendix VI. The timeline is punctuated by frequent monitoring and evaluation exercises. Bursts of incubation schemes are included at six-monthly intervals with the main objective of promoting STI-based enterprises throughout the country.

Proposed planning cycles and waves of initiatives are expected to continue with increasingly ambitious goals in accordance with overall objectives et by the national STI policy, achieving an overwhelmingly STI and knowledge-based Iraqi society and economy by the year 2020.

Part I
Revamping Iraq's Science Technology and Innovation System

I.1. Introduction

Many of the challenges that face Iraq, including stalled socioeconomic development, inadequate infrastructures, rampant unemployment, water scarcity, climate change, energy and food security, may be tackled through approaches based on scientific research as well as knowledge that embodies innovative technology inputs. Once adapted to local needs, the dissemination of such inputs should:

- promote overall sustainable socioeconomic development;
- enhance productivity and growth in priority economic sectors;
- harmonize output from the education system with job market needs;
- afford new employment opportunities for the country's massive and growing youthful populations.

However, along with many of the country's institutions, universities and scientific research centres in Iraq suffered enormous damage, in terms of both human resources and physical assets. Additionally, a great deal of damage was sustained by cooperation and coordination efforts among Iraqi STI institutions as well as linkages to their counterparts across around the earth.

The present Roadmap is intended as basis for promoting Iraq's scientific research and associated technology development and innovation capabilities as well as utilising scientific, technological and innovative inputs in shaping Iraq's future in both the economic and social spheres. In seeking to address its objectives, this Roadmap is cognisant of the fact that scientific research may not be considered in isolation from other crucial activities such as technology acquisition and development as well as innovation. Establishing the strongest possible links between scientific research on the one hand, and technology acquisition and dissemination as well as innovation in manufacturing and service activities, on the other hand, is essential if overall development objectives are to be attained and effectively sustained.

The Roadmap is intended for implementation through a number of stages starting with an assessment of key policies, initiatives, programmes and institutional settings; both conducive to and inhibiting the implementation of scientific research and innovation policies at various levels, emphasising selected high potential sectors and development priorities. Detailed examination of these programmes with accent on both their positive and negative contributions to development is to be attempted at the outset.

Sectors and disciplines with potential for optimal reception and effective contributions in terms of new knowledge and innovative technology inputs should constitute prime loci of attention. Future efforts would assess sectors and sub-sectors with comparative advantages and potential and to identify means that facilitate their development.[2]

In particular, future efforts based on the present Roadmap should attempt (a) closer inspection of the needs and potential contributions of target sectors; (b) the implementation of specific action oriented modalities aimed at enhancing research capacity and infusion of new knowledge into the

[2] Tentatively, it may be stated here that ICT, petrochemicals, agricultural production and tourism might qualify as focus for future attention.

selected sectors; (c) sharing tasks aimed at capacity building among constituents of a national network of institutions, equipped with effective operational modalities; (d) identifying institutions that constitute essential components of a national network that would eventually assume ownership of scientific research and innovation initiatives and advance the entire STI-based development process.

The Roadmap is proposed by the UNESCO Iraq Office in Amman for fine-tuning and ultimate adoption by concerned ministries at an important juncture in Iraq's, and indeed the entire region's, socioeconomic development. Once launched, it should help accelerate moves towards rational sustainable development, greater economic competitiveness, social cohesion and capacity for job creation, through the adoption of scientific research, innovation and technology programmes as bases for future transformations targeting selected high potential sectors, in particular.

A close review of documents targeting strategies designed to enhance Iraq's scientific research capabilities produced over the past few years would reveal the following characteristics, grouped within categories pertaining to overall policy issues, institutional settings, human, funding and infrastructure considerations as well as cooperation and coordination and research output. Reference is frequently made to issues relating to higher education on account of its special links to scientific research. Relevant recommendations are embedded within the following sections.

I. 2. National Science, Technology and Innovation Policy; essential basis for Iraq's future development and prosperity

While a variety of policy documents may have been authored, particularly with regard to various aspects of the education sector, a comprehensive policy linking all of these activities to innovative economic activity is yet to be formulated. See frame (1).

Since the nineteen eighties and throughout the world, this goal has been approached through the formulation of comprehensive national science, technology and innovation (STI) policies. It is only through such policies that bridges may be created between the science and technology supply side; essentially universities and research centres, on the one hand, and the demand side; represented by end-user sectors and the general population, on the other. Indeed, it would be difficult to imagine how synergy between all actors concerned with scientific and technological knowledge-based development could be generated and maintained without the benefit of a national STI policy.

Principal outcomes sought from an integrated science, technology and innovation system include not only the creation of new scientific and technological knowledge, but also the profitable adaptation, utilization and dissemination of existing knowledge in the widest variety of settings, with objectives including competitive private enterprises, efficient public sector institutions, and a safe environment for all, together with a wide range of job opportunities.[3]

Iraq's STI policy would need to address a small number of numerical goals established in accordance with international practice, e.g. overall spending on R&D as percentage of gross

[3] There is need to impress upon politicians, specialists as well as the general public that innovation may be defined as "the application of new ideas, technologies, or processes to productive activities, in a given context." Thus, the creation of absolutely new S&T knowledge or technology may not necessarily be involved. However, it is often that R&D efforts are needed to adapt whatever kind of knowledge being utilized for optimal results within a target sector or market segment.

domestic product (GDP), total number of researchers in relation to total population, etc.. Apart from that, its main contribution to the country's STI-based development should materialise in guidelines and frameworks for future action targeting the transformation of the country from overwhelming reliance on its mineral resources to one that is increasingly reliant on science, technology and innovation as sources of future equitable and sustainable development.

On the other hand, derivative implementation strategies will need to set several quantifiable goals with milestones and, as far as possible, numerical benchmarks relating to various aspects of national and institutional performance. In setting numerical goals and benchmarks it would be advisable to keep in step with internationally accepted indicators. However, overdue emphasis on certain indicators, e.g. number of publications in refereed journals, might need to be tempered; to be replaced with greater accent on tangible benefits in socioeconomic terms.

Frame (1); Existing policy/strategy strands may be adapted and embedded into a comprehensive ISTIP document and subsequent reform processes

Calls for a national STI policy in Iraq may NOT be understood as demanding that existing policy inputs designed to move ahead in specific sectors would need to be scrapped. For all intents and purposes such policy inputs must be assumed as having been formulated on the basis of tangible and still valid needs. However, through considering policy inputs relevant to various STI players, end-users and other stakeholders, it would be possible to further polish individual policy strands, revise priorities and ensure steady flow of resources with optimal benefits for all.

As indicated in Part IV of the present document, both the Ministries of Higher Education and Scientific Research in Baghdad and the Kurdistan Regional Government have taken steps to tackle selected elements in higher education and scientific research strategies. What is urgently required, however, is the establishment of organic links between research activities addressed by both strategies to application sectors, thereby promoting economic activity. Such issues may only be dealt with through a national innovation policy with support by agencies capable of dedicating resources, establishing novel institutional forms and amending relevant legislative tools and regulatory arrangements.

On the other hand, while policies developed to cater for individual sectors, e.g. in agriculture and manufacturing may tackle requisite science, technology and innovative inputs, it is only through a comprehensive national STI policy that all such strands may be interwoven in a holistic whole with cumulative contributions to sustainable development by the various government ministries, public and private sector concerns as well as trade and labour federations and professional associations.

Evidence provided by policy initiatives undertaken, not only by small developed countries, such as Finland and Singapore, but also much larger developing countries, such as Malaysia, India, South Africa and Brazil indicates that involving private sector concerns, is a sure recipe for much needed improvements in productivity, growth and job creation.

Once finalised, Iraq's proposed STI policy should be adopted, and approved at the highest level, as an integral part of the country's national development plan, with science, technology and innovation as its main pillars. This should further empower the national STI policy, allowing its strategies, plans and programmes a wider national scope as well as greater rallying power.

In short there is urgent need to formulate a comprehensive national STI policy outlining Iraq's commitment to creating a science, technology and innovation society; including commensurate dedication to the creation of an environment supportive of science, technology and innovation and including institutional reform and new institution building, revision of outdated and contradictory legislation and regulatory arrangements, highlighting priority areas, ensuring reduced centralisation, greater transparency, and enhancing cooperation and coordination of STI activities both inside Iraq and with regional and international abroad. The resulting policy document, including numerical goals related to internationally accepted benchmarks, should be

adopted as part of a national development plan approved by central and regional authorities and implemented through well defined strategies.[4]

Based on the above considerations, this Roadmap requires that the following tasks be undertaken:

1. Undertake formulation of a science, technology and innovation policy (STIP) for Iraq, with relevant tasks undertaken by concerned Government Ministries, and non-governmental institutions, e.g. industry and trade federations as an issue of top priority. Once finalized, the STIP principles, guidelines and implementation requirements should be taken up by national development plans and derived strategies aimed at promoting national development in general, and innovation and entrepreneurship, in particular.

2. Drafting Iraq's national STIP document, subsequent implementation strategies and action plans should be based upon rigorous SWOT and foresight exercises targeting selected priority sectors and sub-sectors, in production and services, with due regard to their particularities as well as short- and long-term needs.[5]

3. Iraq's STIP document should include detailed implementation guidelines; designed as a series of plans and programmes,[6] allowing for several waves of rapid-results projects aimed at "quick wins" as well as longer-term reforms, incorporating challenging deadlines, well-defined achievements and measurable outcomes. Indicators and methods of evaluation should be instituted allowing policy makers and stakeholders to monitor progress and alter trajectories as and when required.

4. When charting implementation plans for Iraq's science, technology and innovation policy care should be taken to: (a) consider experiences from around the world, (b) engage all possible stakeholders in pointed discussions with well defined outcomes, eliciting their support and commitment on overall as well as specific issues, (c) avoid top-down approaches and (d) allow for maximum flexibility and trajectory changes in subsequent stages.

I. 3. Reforming higher education and vocational training; key to improving Iraq's scientific research capabilities

Iraq's government has traditionally been the key player in all aspects of education and skills development. While success may be claimed in providing educational services to wide segments of the country's population and the creation of essential research facilities, an appraisal of the country's resulting education and research systems reveals inadequate measures for performance evaluation, with grave consequences for quality. Additionally, vocational training has limited

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[4] Five-year plans would then need to spell out specific STI programmes and projects, including institution building and STI-based national development programmes/projects, e.g. addressing environmental, healthcare, national productivity issues.

[5] Sectors that appear to have reasonable chances of inclusion as priority areas include: light industry, pharmaceuticals, agricultural production and agro-food processing, tourism, the media industry and the information technology industry, emphasizing software development. In all cases looked at, both the home as well as the regional and international markets should be considered as outlets.

[6] By opting to formulate their own plans for higher education and scientific research, Ministries of Higher Education and Scientific Research in both Baghdad and the Kurdistan Region would in fact be taking a leading role in the STI policy formulation process. However, involvement by other concerned Governmental and non-governmental bodies should be sought as early as possible.

relevance to modern manufacturing and service industries and is in need of a much wider range of specializations, better trained instructors and radical improvements in available facilities.

Numerous private educational institutions have been established since 2003.[7] A significant number of private universities have recently been licensed to operate, presumably under supervision by the Ministries of Higher Education and Scientific Research, in both Baghdad and Kurdistan. It is generally felt that their performance leaves something to be desired. Other indications point to their contributions to widening the range of available skills on offer.

Nevertheless, the traditional higher education system in Iraq has repeatedly demonstrated its ability to produce high-calibre academics and researchers, provided adequate funding, dedicated management and a certain measure of autonomy were available. Thus, numerous specialists who graduated from science, engineering and medical faculties at the universities of Baghdad and Mosul, for example, are known to have embarked on renowned careers in teaching and research in various developed countries.

Experience from developing countries around the world indicates that reliance upon international cooperation to salvage educational systems in these countries never proved fruitful in the absence of home-grown strategies targeting constant improvements. On the other hand, each time such strategies are put in action immense benefits may be reaped. This is not a case of opting for one approach instead of another. Rather, it would be essential to adopt a balanced approach in which both approaches may contribute to enriching national human resources with requisite skills in a variety of domains, including scientific research, technology development and innovation.

Led by the Ministries of Higher Education and Scientific Research in Baghdad and the Kurdistan Region, as well as the Ministry of Science and Technology, steps must be taken to:

5. Implement radical overhaul of the country's entire system of education and vocational training with focus on quality, equal opportunities for all, relevance of skills imparted to market requirements and with innovativeness and creativity as a prime attribute of graduates at all levels.

6. Revise attempts at isolated improvements in the country's STI system in Iraq with view to launching initiatives with wider scope, more stringent quality criteria, ambitious delivery dates as well as optimal harmonisation of approaches adopted in various regions. Examples of such initiatives might include acquiring international recognition for degrees awarded in selected specialisations by certain universities within a set period of time, say by 2015, and almost universal recognition of all degrees awarded by Iraqi universities by the year 2020.

Additionally, based on a review of available strategies for enhancing performance of Iraq's educational system, this Roadmap recommends that:

7. Specific initiatives designed and launched with focus on graduating future generations of researchers and innovators, targeting specific priority sectors and including ambitious objectives and very short cut-off dates; e.g. graduating fully trained teams with international-class credentials to advance research, technology development and innovative enterprises in

[7] It would be desirable to produce an in-depth assessment of Iraq's experience with regard to private education in general and that concerning higher educational institutions, in particular. The Kurdistan region has probably had the longest and most prolific experience with private education. Hence, it would be essential to attempt a detailed evaluation of the Kurdistan experience as a first step.

solar energy technologies and related industries, or in medical biotechnologies and related medical diagnostics, within the next 3 years.

I. 4. Institutional environment

Attention during the past few decades appears to have been directed mostly at the reform of, and capacity building in, traditional higher education, particularly at the country's universities, while research centres and STI support facilities seem to have received only scant attention. Even less emphasis seems to have been placed on creating novel institutional forms; such as research and technology parks, innovative business clusters. Such novel forms would help link scientific research and technology development to end-user sectors in the public and private domains. While such institutions are sometimes mentioned in some documents, little is mentioned regarding when and how they would be established, with what resources and by whom.

Also missing on the institutional scene are policy research and monitoring units, normally established to provide decision makers with reliable information on various aspects of the national STI scene, emerging patterns of demand on STI institutions' services as well as help monitor progress along paths set by established currently being implemented. See Frame (2).

Frame (2); Policy research and monitoring unit (PRMU)

To start with, the policy research and monitoring unit (PRMU) might undertake a diagnosis of research and innovation systems in a variety of developed and developing countries with an eye to the following issues:

- Identifying research and innovation priorities within selected priority sectors, e.g. industrial production activities linked to upstream as well as downstream petrochemicals, agriculture, water resources and the environment.
- Exploring funding modalities, e.g. weighing the advantages of direct versus competitive funding and systems of financial incentives to promote research and innovation would provide effective input to policy implementation.
- Selection of optimal benchmarks and monitoring modalities firstly to accurately evaluate the status of research and innovation activities and then to follow up on progress in implementing relevant strategic plans.

Other issues that PRMU could attend to as it amasses experience and reaches higher levels of maturity might include drafting proposals for amendments to policy articles and strategic plans. Thus, based on input gathered from the field PRU would be able to propose amendments to implementation strategies, and less frequently changes to be introduced into certain policy articles.

Arguments may also be made for undertaking prospective activities intended to explore the future of various science and technology disciplines and the evolution of demand by priority sectors for science and technology inputs. Equally convincing arguments may be made for the creation of a network of "technology futures research" units and specialists concerned with prospective studies. Naturally, such a network would have to be invested with means to coordinate activities, harmonise prospective research approaches and disseminate results to concerned decision and policy makers.

Other institutional deficiencies are evident at the level of policy coordination and oversight. Thus, while the need for a Scientific Research Council (SRC) has been spelled out by the Ministry of Higher Education and Scientific Research, with recent news indicating rapid progress towards its creation, there is need to create yet another central agency to oversee the building of science,

technology and innovation capabilities throughout the country. Many other countries, some in the region, have opted for establishing STI Commissions directly linked to the Prime Minister. In some cases this Commission is headed by the Prime Minister with a ministry of state or the ministry for science and technology providing a general secretariat for the STI Commission. This Commission is often charged with thrashing out topmost policy issues and acting as primary locus for high-level debate and policy making with regard to various STI issues.

Several countries around the world have also established national STI foundations with mandates including coordination and provision of funding for research and innovation in areas of national interest. It would be advisable for Iraq to establish such a foundation. The proposed foundation would have to be granted sufficient powers as well as adequate human and budgetary resources enabling it to establish, as well as take part in, national and international STI initiatives in line with national development plans.

At another level altogether, there is need to revive the Iraqi Academy of Science investing it with a fresh mandate that allows it to act as the foremost national body in fostering science AND technology with its membership extended to prominent national and expatriate scientists and technologists. As shown in many other countries around the world, if properly funded and vested with sufficient authority a science academy could act as beacon and powerhouse in the drive towards excellence in science, technology and innovation.

To summarise, based on background research and reviews undertaken in preparation of the present Roadmap, and in order to reap optimal benefits out of efforts aimed at promoting scientific research, technology development and innovation in Iraq, there is need to establish the institutional entities listed below. In cases where steps have already been taken to set up such entities, it would be advisable to accelerate the process, enabling it to launch fully equipped into its STI revitalisation process.

8. Setting up a national Science, Technology and Innovation Commission (ISTIC) attached to the Prime Minister as well as a Scientific Research Council to oversee formulation of a comprehensive national STI policy and related initiatives, providing support towards their implementation and guiding the process of transforming Iraq into an STI-based society by the year 2020. As indicated in figure (1), ISTIC would be established with direct link to the Prime Minister and would undertake STI policy making, coordination, funding allocation and overall supervision duties.

9. Finalising measures aimed at establishing the proposed Scientific Research Council within the Ministry of Higher Education and Scientific Research, granting its programmes full support, enabling it to revitalise scientific research, with special accent on capacity building in fields of enquiry and disciplines of key importance to Iraq's society and the economy.

10. Establishing a national Science, Technology and Innovation Foundation (STIF) as an autonomous body with mandate and sufficient resources enabling it to play essential roles in the coordination and funding of STI initiatives with nationwide implications alongside other STI institutions in the country.

11. Re-inventing the Iraqi Science Academy and investing it with resources and support, so that it may fulfil its intended functions in promoting enquiry and dissemination of knowledge in various spheres of science, technology and the humanities.

12. Creation of research and technology parks and centres of teaching and research excellence to act as bridges between universities, research laboratories and business sector institutions, thereby promoting STI-based enterprise competitiveness and related job creation.

13. Creation of incubation schemes within selected research centres and universities and granting them the ability to transform into veritable incubation centres with fully equipped facilities in order to contribute to job creation and a reduction of unemployment among qualifies university graduates throughout the country.

14. Establishing innovative business clusters in close cooperation with major trade and industry federations as well as major universities, enabling established clusters to benefit from joint technical services and STI facilities.

15. Setting up research units at major universities equipped with viable STI monitoring components and relevant facilities and with adequate linkages to policy making institutions, in particular ISTIC, with view to undertaking studies and research work on STI policy as well as national STI monitoring exercises in priority disciplines and sectors.[8]

16. Creation of STI prospective and futures' studies and research units equipped with suitable networking capabilities and a hub for coordination/harmonisation purposes at major universities, with adequate linkages to policy making institutions, particularly ISTIC and its taskforces.

17. Establishing scientific research planning and coordination units within key ministries whose operations demand constant STI input and intensive links to university research departments and research centres, with sufficient scope to analyse their ministries' STI requirements and formulate optimal solutions that may be tackled through targeted research.[9]

18. Establishing a national fund with a board of directors and a supervisory body with mandate to fund research in selected priority areas in accordance with the stipulations of national policies but also targeting uncharted areas with evident promise and assured future benefits for socioeconomic development.

I. 5. Human resource development

Understandably, many documents concerned with enhancing scientific research capabilities in Iraq focus on human resource development. Material on the subject authored by experts and government officials from the Kurdistan Region appears to emphasise modalities in which training of researches is intensively linked to cooperation with established university institutions abroad. However, available documents expounding this line of action do not present analyses of costs and benefits of such options in relation to other possibilities, e.g. setting up joint higher education and scientific research bodies at home in cooperation with renowned foreign partners. This is not intended to promote the latter option against the former. Rather, it is a call for closer evaluation of all available options, including efforts that may be implemented, with assured benefits, at home, leading to the establishment of Iraq's own centres of teaching and research excellence (CTRE).

Documents authored in Iraq on upgrading the capabilities of researchers at universities and research centres in Iraq reflect greater focus on enhancing performance of trainee researchers, while an army of researchers already on board are in fact in need of at least equal attention. One approach for improving the performance of the latter group of researchers is to have them take

[8] It is also recommended that ISTIC establish a policy research unit as well. This may act as a catalyst , coordinator and clearing house for STI policy research and STI futures research throughout the country.
[9] This recommendation may not be allowed to interfere with some ministries' requirement for setting up their own research facilities in order to address specific recurring issues.

sabbaticals at selected universities abroad. This approach may be quite effective, in the short and medium terms. Such training exercises would need to enhance managerial skills in addition to other abilities, more closely linked to specific research practices. In the long run, it would be reasonable to have this approach supported, by a series of training programmes developed and delivered by Iraqi experts and expatriates. Such exercises would most probably be far more cost effective and would furthermore be able to reach out to a larger number of trainees on their home ground. Additionally, opting for the latter approach would ultimately result in internalising underlying expertise.

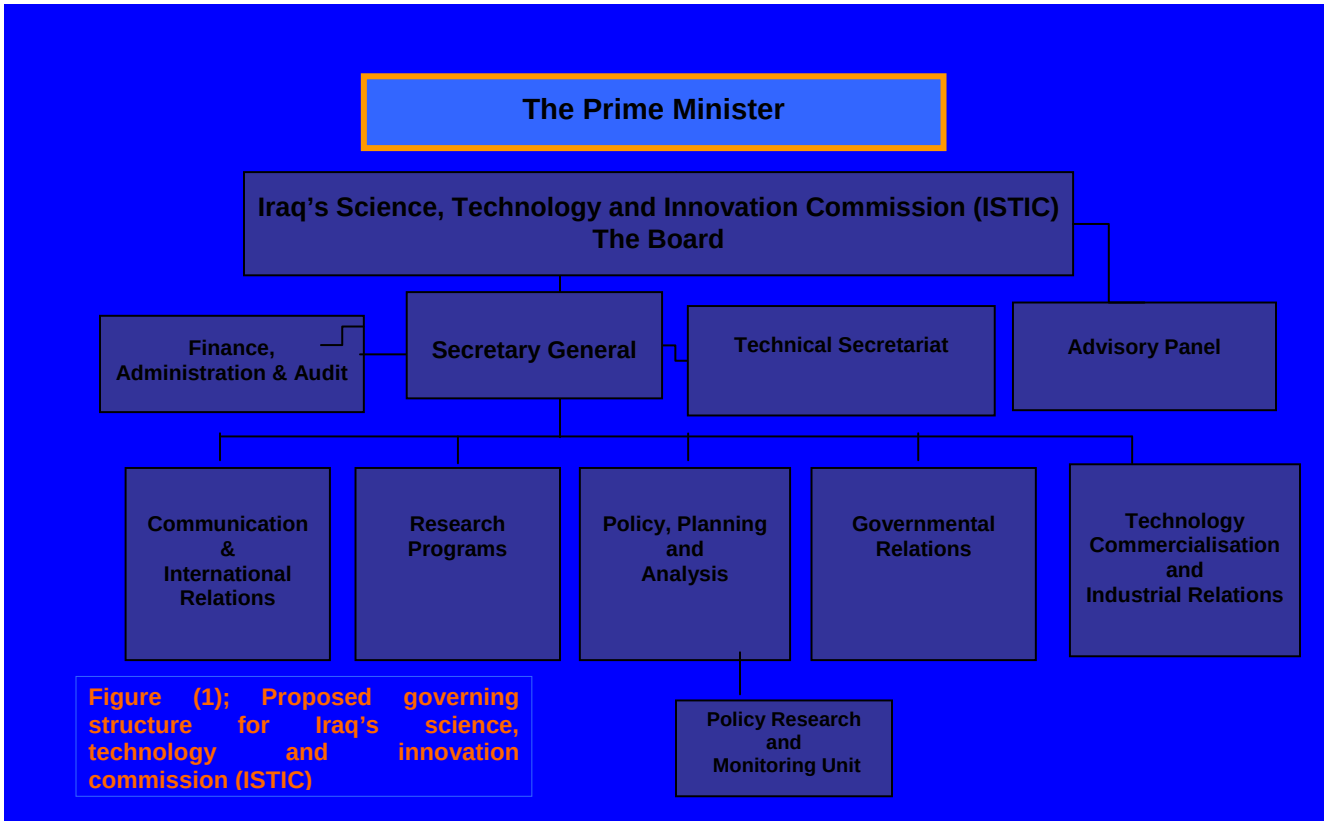

Figure (1); Proposed governing structure for Iraq's science, technology and innovation commission (ISTIC)

Another deficiency; made apparent by recent analyses of scientific research capabilities, concerns the limited amount of attention paid to vocational education and training. This is probably born out of the fact that most documents reviewed in the run up to the present Roadmap were authored by universities and ministry officials unrelated to vocational training and education. Nevertheless, it would be essential for Iraq to undertake a full policy review of its vocational training and education as prelude to a radical overhaul of this sector based on medium and long-range strategies.[10]

To summarise, concerned institutions, led by the Ministries of Higher Education and Scientific Research in Baghdad and the Kurdistan Region, as well as the Ministry of Science and Technology would need to:

[10] The formulation of a comprehensive national STI policy could well serve as an occasion for revising vocational training and education, along with a host of other related, policies in Iraq.

19. ***Initiate programmes aimed at upgrading capabilities of researchers in various fields of endeavour throughout the country, including organisation of sabbatical leaves and tours of study at prominent research facilities abroad, as well as evaluate other modalities with evident benefits in internalising relevant expertise and enabling continual upgrading of researcher skills.***

20. ***Address deficiencies in national vocational training and education institutions in order to keep their performance abreast with advances made in other components of Iraq's STI system and provide enhanced training, working conditions and incentives to auxiliary and support staff at research institutions, including administrators as well as technicians.***

I. 6. Financial resources

The UNESCO survey of research facilities in Iraq, conducted in July-August 2011, clearly indicated inadequate funding of scientific research facilities all over the country. Additionally, very few contractual schemes aimed at specific research results appear to be in place.

Many countries around the world have opted to setting national funds, expressly dedicated to promoting research and development in priority areas. Iraq would do well to establish such a fund which would need to receive benefit from direct government funding as well as other national and international sources, including public and private sector enterprises as well as charitable contributions.

The meeting organised in Beirut during 27-28 September, 2011, recommended that at least 1 percent of the country's GDP be allocated to scientific research throughout the country.[11] This sum is likely to amount to around US$1 billion. In view of the need to address widespread deficiencies throughout Iraq's STI system it would be essential to allocate much higher sums over a number of years. It would appear that a proportion approximating 2 percent of GDP might be a more likely response to actual requirements.

Despite the need to refurbish and improve their facilities, it is unlikely that existing research institutions would be capable of spending the large sums implied by such relatively high allocations. However, should Iraqi authorities opt for establishing new research units as well as lay grounds for novel institutional entities, such as research and technology parks, centres of teaching and research excellence then such sums would hardly be sufficient. Consequently, it would be essential to set higher levels of expenditure, dedicated not merely to scientific research, but to the entire range of activities involved in implementing the entire range of initiatives to be launched by Iraq's full-fledged STI policy.

Apart form the total volume of resources made available for national development of scientific and technological capabilities, there is the issue of funding modalities. This issue would need to be taken up in detailed discussion of the country's future STI policy and subsequent implementation strategies. For the time being, however, it suffices to state that allocation of

[11] Additionally, material presented by the Ministry of Higher Education and Scientific Research during the meeting expressed the need to have private sector firms dedicate 1 percent of their net profits to scientific research.

specific budgets to national science and technology programmes[12] might continue while others on based on competitive grounds would certainly need to be introduced.

Finally, it would be essential to have such goals officially adopted by the above-mentioned national STI policy and then enshrined in legislation, stipulating that these and other similar goals may be revised as needed in view of emerging requirements.

The present Roadmap proposes that concerned institutions, primarily the Ministries of Higher Education and Scientific Research in Baghdad and the Kurdistan Region, as well as the Ministry of Science and Technology seek to:

21. ***Enhance levels of spending on scientific research, technology development and innovation, in a manner commensurate with goals embedded in the STI policy to be formulated during 2012, and in line with regulations that guarantee transparency and accountability as well as continual monitoring of progress and evaluation of results attained.***

22. ***Promote STI funding throughout Iraq using modalities allowing for increasing proportions of research funding to be granted on competitive bases.***

23. ***Enhance spending on creation of a wider range of bridging STI institutions to foster the utilisation of novel STI inputs in enterprise and job creation, including centres of teaching and research excellence in specific domains, research and technology parks and incubation schemes.***

24. ***Implement revised STI funding strategies with view to promoting:***
    a. ***stronger STI links between university institutions and research centres, on the one hand, and both private and public companies, on the other;***
    b. ***innovation in the manufacturing and services industries as well as other national priority areas, including water, environment and agricultural production.***

25. ***Promote and accelerate attempts at getting both public and private sector enterprises to contribute a certain percentage of their annual profits to scientific research, technology development and innovation in priority areas.***

I. 7. Legislative and regulatory arrangements

Documents reviewed in preparing the present Roadmap are replete with calls for revising existing legislative instruments and regulatory arrangements. Attention is drawn by several key contributions in this regard to shortcomings that include inadequate recognition of the status of researchers as a particular category of civil servants, with attendant rights and duties. It is also

[12] The Ministry of Higher Education and Scientific Research in Baghdad has adopted such a modality in funding a number of projects dedicated to medical, environmental and other research activities, as indicated in the presentation by Dr. Mohammed Abid Atiya Al Saraj Director General of Research and Development at the Ministry of Higher Education and Scientific Research, Baghdad, at the meeting of the Core Group of Experts in Beirut, September 27-28, 2011.

often stated the actual activity of carrying out scientific research is also inadequately recognised as an essential function, entailing special items of expenditure and accounting.

Calls for improving the environment for research and innovation should never be reduced to mere salary scale improvements for researchers or regulations allowing researchers improved financial incentives. Rather, the objective should be comprehensive improvement of the environment for scientific research and technological development. On the other hand, whenever incentives are allowed, they ought to be linked to performance and achievement through transparent modalities. In many instances, it is a case of regulations spelling out policy intentions clearly. Thus, should university regulations and relevant administrative articles, declare that doing research is both a right held by academic staff, as well as a duty, to which they are accountable, then this would immediately place conceptual as well as practical issues pertaining to research activity on a higher and more beneficial footing.

It is often noted that a legislative/regulatory environment that is STI-friendly coincides with that required for innovative business practices. In both cases legislative and regulatory arrangements would have to be capable of handling risks and possibilities of failure as well as responsibly dealing with successful as well as inadequate outcomes, inherent in both research and innovative business activity. Legislative and regulatory reforms are, therefore, recommended by this Roadmap with the intention of:

26. Fostering the creation of an STI-friendly legislative/regulatory environment.

27. Establishing regulations that recognise the status of researchers as a special category of civil servants.

28. Placing research on an equal footing with teaching as essential duties for academic staff.

29. Allowing wider bases for STI funding with meaningful and transparent performance-related incentives for STI workers.

I. 8. Infrastructure development

Plans to revitalise scientific research in Iraq would stand minimal chances of success, given present quality and level of dissemination of information and communications technology in Iraq's research institutions, and several of its universities. Refurbishing ICT capabilities constitutes an urgent requirement for future progress, especially with regard to access to science and technology Web resources and with regard to networking and coordination within Iraq and collaboration with partners abroad.

Another aspect of STI infrastructure relates to access to expensive equipment items. Several developed countries run common services where expensive research equipment may be shared by national institutions. Establishing similar facilities in Iraq would certainly enhance research capabilities and allow Iraqi institutions to dedicate future efforts aimed at cooperation with research centres abroad to more substantive endeavours.

Establishing active links to allow Iraq's researchers access to research publications and databases is another infrastructure priority. Iraq's Virtual Science Library (IVSL) constitutes an important step in the right direction with regard to accessing books and periodicals. Several years have

elapsed since IVSL was establishment, however. It would, hence, be appropriate to consider lessons learned, assess cost-effectiveness of solutions adopted and chart future avenues for further IVSL development.[13]

Similar considerations apply to sharing of expertise and training facilities directed towards generic topics of common interest in fields such as:

- design, planning and management of research projects;
- transition from research results to actual end-user applications;
- authoring scientific papers;
- research funding and fund administration;
- application for patents, intellectual property rights;
- start-up of innovative and technology-intensive enterprises.

A good start would be to set up teams of experts in such topics which would then provide advice and conduct workshops for researchers on the above issues. Ultimately, steps would need to be taken to design special courses of regular training at all universities actively engaged in research.

Considering the above issues, it is recommended that revitalising Iraq's STI capabilities would require:

30. ***Intensive development and upgrading of research infrastructures, emphasising ICT equipment, associated services and human resource capabilities as well as researchers' access to Web resources.***

31. ***Establishment of national and regional schemes and associated facilities for sharing expensive equipment items.***

32. ***Building endogenous capacity for training researchers in areas of common interests, e.g. research management, authorship skills, translating research results into viable applications, among other objectives aimed at producing well-rounded STI workers.***

I. 9. Cooperation and coordination

Even in the most advanced countries, few institutions engaged in scientific, technological and innovation activity may now afford to work in isolation. Cooperation and coordination of all manner of STI activity is presently the norm rather than the exception. This is more of a necessity in view of Iraq's STI capabilities; still suffering the effects of neglect as well as conflict and strife of the past decades.

Promoting cooperation and coordination both among STI institutions in Iraq and with outside partners must be taken up as a major objective of the proposed STI policy and related strategic plans, with information and communication technologies providing means for extending

[13] IVSL is an online collection of millions of scientific and engineering journals, freely available to all Iraqi universities. IVSL was reported as having had 6,000 registered users. In 2011, a presentation made by Dr. Mohammed Abid Atiya Al Saraj Director General of Research and Development at the Ministry of Higher Education and Scientific Research, Baghdad, quoted the number of users as 17,000. In the same presentation the Ministry was reported as having set a goal for increasing this number to encompass 80% of university staff and students throughout the country.

networking and cooperation between STI institutions and their cadres. Both formal and informal networking and cooperation possibilities will need to be established and continually promoted and encouraged through special funding and evaluation schemes.

A sizeable expatriate community of Iraqi scientists, technologists and innovators is now well-established around the globe,[14] with many scientists, engineers, physicians, technologists and innovative entrepreneurs occupying prominent positions in their newly adopted countries. At least one attempt has been made to establish a network of Iraqi scientists and technologists.[15] Linking up to Iraq's expatriate STI community, along lines adopted with considerable success by many other developing countries around the world would, therefore, constitute an effective means of accelerating moves aimed at revitalising STI capabilities.

In view of the above, the Roadmap recommends that:

33. ***Special incentives be designed to promote and nourish research cooperation and coordination both among institutions and STI manpower within Iraq as well as with renowned institutions and prominent scientists and technologists abroad. Incentives should be embedded into project selection procedures for funding. Joint publications in international refereed journals must also be rewarded.***

34. ***Active networking is established with Iraqi STI expatriates around the world, replicating successful experiences and lessons learned from other countries.*** [16] ***Rules and regulations governing operations of established networks should hence be amended and seed funding allocated in order to allow Iraqi STI expatriates to return home on temporary basis to fulfil specific tasks as well as mentor junior STI professionals from Iraq.***

I. 10. Research output

The number of publications produced by a country or an institution is admittedly an important indicator of standards reached relative to other institutions and countries around the world. On this basis alone, it would be wise to retain this indicator and use it in reporting progress in the rehabilitation of scientific research in Iraq. On the other hand, it would also be essential to assign comparable emphasis to tangible benefits attained by key end-users. While it is true that such benefits may not be amenable to quantitative benchmarking in the short term, numerous methodologies may be available for their measurement. Indeed, some such benchmarks might even be developed for the express purposes of specific STI end-user sectors in Iraq.

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[14] No exact figures are available as to the size of Iraq's first generation of expatriate scientists and technologists abroad. However, it is likely that they may number a few million expatriates. Out of these it is possible that at least a few tens of thousands, if not a few hundred thousands, are involved in scientific research, technology development and innovative entrepreneurial activities.

[15] This is the Network of Iraqi Scientists Abroad (NISA) established in collaboration with the UNESCO Iraq Office in Amman. NISA members are frequent contributors to science and technology related conferences in Iraq and neighbouring countries.

[16] In this respect, it would be essential to consider the experiences of other countries, such as Ireland, Chile, Taiwan and China.

The present Roadmap, therefore, requires that:

35. ***Publication activity by Iraqi STI professionals be monitored, documented and periodically reported with special reference to impact on national priorities.***

36. ***Further refereed journals are established in Iraq and the transformation of non-refereed periodicals currently published in Iraq into refereed ones is promoted with strict measures aimed at quality assurance.***

37. ***Patenting activity within Iraq be subjected to international criteria with measures implemented to facilitate suitable commercialisation of patents produced in Iraq.***

I. 11. Enhancing popular STI awareness

Several countries around the world, both developing and developed, have put in place national programmes designed to enhance awareness of the importance of science, technology and innovation for development. The main objectives of such programmes include creation of an overall environment that is friendlier towards science, technology and innovation.

Programmes of this nature are generally directed at two sets of recipient populations, the general public on the one hand, and the country's youth, on the other. Programmes directed at the former category often target a variety of objectives; including promotion of particular national projects, in ICT, energy, water, the environment. While programmes targeting youth are aimed inducing larger numbers of students to opt for studies, and future careers, in science, engineering, medicine and related disciplines..

Programmes undertaken with the above objectives in mind include the organisation of fairs and exhibitions, often at the regional level involving a number of schools whose students, mainly at the intermediate, secondary and university levels, contribute products and processes they were able to develop on the basis their own research and development activities, with prizes and other incentives presented to winning entries, and with schools and regions amassing scores in competition for top placement at the national level. Several countries also organise a "science week" during which debates and presentations are made on selected topics of current interest, sometimes with concurrent exhibitions and contests.

These and other modalities may well be included within future Iraqi strategies aimed at enhancing awareness of the importance of science, technology and innovation and creating interest in related professions among the country's youth.

It is also often that efforts intended to popularise science, technology and innovation take the form of national media campaigns that include diffusion of science-oriented programmes, distribution of relevant publications as well as the design and dissemination of computer games that promote interest in science and engineering.

The Roadmap recommends that:

38. ***National and regional media- and school-based programmes should be launched in Iraq with view to enhancing public awareness of science, technology and innovation as inputs for development and sources of enterprise and employment opportunities. The main objectives of such programmes would be to create an STI friendly environment***

all over the country, thereby facilitating reception of future STI initiatives to be implemented in coming months and years.

I. 12. Concluding remarks

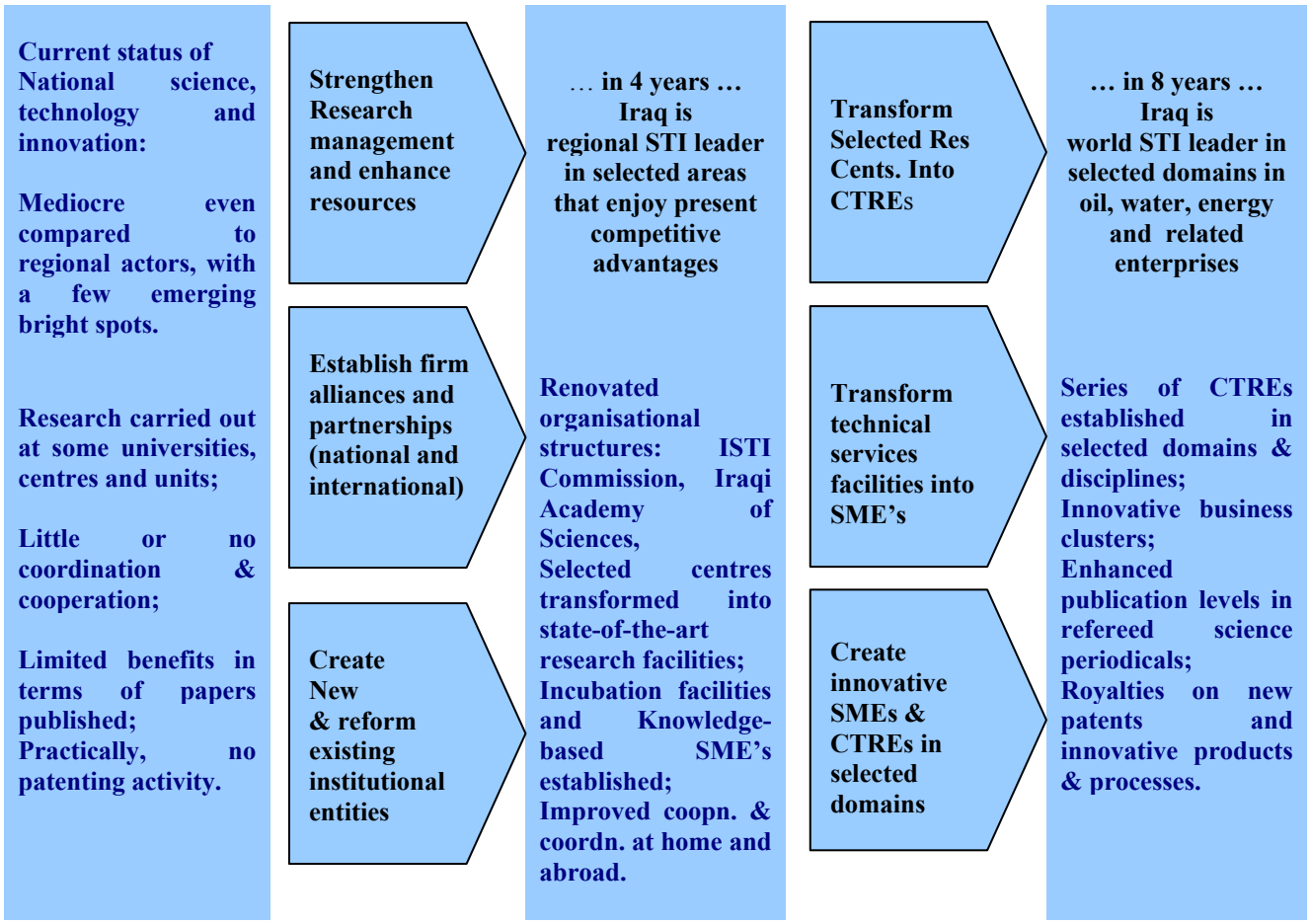
A variety of new institutions and a host of reform and restructuring activities would be needed in order to firmly place scientific research, technology development and innovation high on Iraq's development agenda. While some tasks might seem too protracted and in need of considerable resources at a time when Iraq still faces other serious challenges on several fronts, it should be remembered that establishing a functional national STI system holds effective solutions to many of Iraq's current challenges. This, has been the lesson learnt from a variety of other instances in which countries forged national STI capacity to overcome myriad difficulties.

Furthermore, as has often been the case in such examples, if properly initiated and managed, with adequate political commitment, the process of creating a national STI system will create its own momentum in accordance with extant supply and demand dynamics, launching knowledge-based development on a benign cycle, in which valuable outcomes will lead to STI system upgrades and further positive contributions to the country's stability and prosperity.

Figure (2) presents a concise summary of possible paths for the evolution of Iraq's STI system over the next eight years, and up to the year 2020. Examples of some of the transformations that are required in order to create a vibrant STI system in Iraq are to be viewed in light of material presented above as well as comments made in succeeding parts of the Roadmap.

Figure (2)

Evolution of Iraq's STI System



Part II
STI system, enterprise and employment creation in Iraq

II. 1. Introduction

As products and production processes become more complex and technology-intensive they increasingly demand an ever more skilled workforce. Thus, no country can move up the development ladder without investing in quality higher education and vocational training as well as creating scientific research and innovation systems to support public and private sector requirements, for improved productivity, rational use of scarce resources as well as employment creation.

Frame (3); technological readiness vs. technology acquisition

The notion of technological readiness is distinct from the related concept of technology acquisition. In essence, technological readiness embodies the ability to adapt and even improve on adopted technologies, albeit to a more or less limited extent, in order to enhance competitiveness and market share. Whereas success in mere acquisition of new technologies may readily contribute to productivity gains in specific production processes and service activities, innovative capabilities attained through improved technological readiness will help expands technology applications in a wider range of production and service activities. National productivity enhancements, particularly in production and service operations away from state-of-the-art technologies, may well be attained through acquisition of exogenous technology inputs. However, the scope of such a strategy is inherently threatened by developed, even developing countries, as they move to capture markets based on products and processes embodying even newer technologies as bases for more efficient production and service activities. Hence, it would be advisable for Iraq to acquire technological readiness rather than simply, the capacity for technology adoption.

Efforts that went into the design of scientific research and technology development policies in the nineteen sixties and seventies tended to focus on responses to demand for specific science and technology inputs by the private and public sectors with little emphasis on creation of an overall environment that is conducive to innovations based on new technologies, with all what such an environment would require in terms of legislative and regulatory arrangements, e.g. in terms of protecting intellectual property rights, ensuring public safety and environmental protection.

During the nineteen eighties and nineties, competition intensified and barriers to trade were progressively dismantled across the Globe. This necessitated organic links connecting science and technology development to application sectors.

Gains in competitiveness based on science and technology prompted many developed nations as well as large firms to dedicate increasing resources to innovative products and processes, rendering policy and legislative environments that are inherently friendly to innovation ever more important. Several developing nations followed suite, some achieving outstanding global status in less than one decade.

Bringing the benefits of novel technologies to operating enterprises is an issue in need of special attention in Iraq. While seemingly a simple matter, such initiatives require a range of technical, legislative and regulatory changes. Once accomplished, such changes are said to afford a country or an institution with technological readiness. The concept of technological readiness extends beyond mere transfer and adoption of innovative technologies. In effect, technological readiness reflects a country's ability to adopt the latest technologies as well as adapt and use them to

increase domestic productivity.[17] Thus, a great deal may be realized, in terms of productivity gains, economic growth, employment creation and social stability, simply by making good use of technologies that have been developed elsewhere. Attaining improved technological readiness is a task that is to be squarely faced by national educational systems and associated infrastructures.

In addition to productivity enhancement, improved technological readiness provides direct opportunities for job creation, admittedly in skill-intensive occupations such as ICT-related outsourcing services. This, in turn, requires readjustments in education and vocational training.

Issues to be tackled in order to create a friendly environment for research and innovative business enterprise include a climate that readily supports healthy competition to drive business efficiency, and to enable market entry by new innovative businesses of various sizes. An efficient and equitable labour market has also been found essential in ensuring that talent is put to best use in the national economy.

Thus, a flexible labour market supported by meritocratic incentive structures devoid of discrimination based on ethnic and religious considerations, is best placed to contribute to competitiveness. Balancing business needs for highly flexible legislative and regulatory environments and the need to maintain government controls, e.g. to enforce labour and consumers protection as well as safeguard the environment have always been a source of intense debate. Nevertheless, examples abound of countries where enforcement of such measures did little to hamper innovative ventures and productivity gains. A key factor, repeatedly demonstrated in all such examples, is success in harmonising inputs by the main components of their STI systems; that is higher education, scientific research and innovative capacity.

II. 2. Linking the supply and demand sides in Iraq's STI system

A good deal of what has been said and written about the status and future prospects of higher education and scientific research in many developing countries, including Iraq, is the result of brainstorming among academics and, less often, active researchers, with minimal participation by decision makers from STI end-user institutions, in industry, agriculture and service activities. This has invariably led to emphasis of supply, as opposed to demand considerations in strategies and development plans intended to reform both areas of activity.

Additionally, despite the occasional contributions by applied research centres to attempts at drafting strategies for the future of higher education and scientific research, the fact that many such centres have been functioning practically in isolation meant that their contributions lacked attention to the actual needs of end-users, whether operating in the public or private domains.

In short, available documents aimed at tackling challenges facing Iraq's higher education and scientific research fall short of expectations in relation to issues such as technology acquisition, development and innovation.[18] Based on evidence from a variety of other countries, both developing and developed, little may be achieved through emphasis on supply aspects, to the

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18 Innovations allowing production and services sectors higher productivity and wider market shares may not necessarily be always based on scientific and technological inputs. Thus, innovations, in management, marketing, stocktaking etc., may boost productivity and help open up wider markets with attendant socioeconomic benefits. The role played by information and communications technology in attaining such innovations is paramount.

neglect of critical demand considerations. Even less may be attained if attention remains focused on producing Masters and PhD holders, as well as publishing scientific articles, albeit in international refereed journals, if the tacit knowledge held by researchers and embedded in the articles they produce, bears little or no tangible benefits for Iraq's socioeconomic development.

Further elaboration of the present Roadmap as well as drafting strategies and programmes for its implementation, ought to recognise the fact that research is but one component in a complex system that ensures knowledge generation and implementation. This system does not include only national universities and research institutes. Since, in addition to these essential parts of a national STI system, other components, including production and service firms, small and medium enterprises, extension services, trade federations as well as labour and farmers' unions, etc., also perform important roles. Additionally, the evolution of markets and consumer demand plays a crucial role in shaping national STI systems. This emphasises the necessity of creating a research and innovation friendly environment. In turn, this would also underline the need for extending research efforts towards the social sciences and humanities in addition to hard science and technology-based research.

To take a simple example from agriculture, a new virus-resistant wheat variety may have great potential for boosting yields and producing additional farmer incomes. However, should seed storage and distribution policies and related extension services in place be inadequate for getting this innovative input to farmers, there is very little chance that it would make significant contributions to national food production or farmers' welfare. Therefore, to strengthen national agricultural innovation systems there is need to fund not only agricultural research but also related higher education institutions, extension services and farmer's cooperatives. While these might appear onerous tasks, it ought to be remembered than novel technologies provide excellent means for their realisation. Thus, information and communications technologies may further the reach of both farmers, extension services as well as concerned government departments in ways that could not even be imagined a few years back.

Therefore, it is essential to enable a national STI system to function and deliver as such, i.e. as an integrated and interlinked system, with its various components working in harmony to produce better and more effective responses to both present and future challenges. This is no mean undertaking for Iraq's. However, it is also one that may well be achieved given sufficiently determined leadership, adequate resources and sound strategies.

Facing the challenge of building an integrated STI system for Iraq would, at least in part, entail that, in addition to bolstering their own research infrastructure, national and regional governments take responsibility for:

- devising legislative instruments and regulatory arrangements;
- enhancing their physical as well as ICT based infrastructures;
- enabling the creation of novel institutional settings.

In short what is needed is nurturing a healthy environment involving both supply and demand sides in the creation, evaluation and adoption of new knowledge inputs, on the one hand, and the adaptation and implementation of tested technologies, on the other, rather than leave it to research departments to decide what national development needs and how best such needs might be addressed.

II. 3. Improving the attractiveness of the business environment is key to STI development

Along with its neighbouring countries, Iraq has had a long history as a hub for entrepreneurship and innovation. In consequence of economic policies adopted during the past few decades, obstacles posed to doing business by inflexible legislative/regulatory frameworks have continually mounted.

Foreign direct investment (FDI) in sophisticated, high-tech enterprises, in both manufacturing and service industries is generally considered beneficial in terms of creating an environment that is conducive to scientific research and innovation. However, it is unlikely that such investment could proceed in the immediate future. Indeed, such investment would be judged risky in a country that still suffers frequent security incidents as well as acute shortages in skilled workers/technicians on top of an inadequate legislative business climate.

Nevertheless, improved infrastructures, e.g. dense broadband coverage, quality higher education and vocational training as well as novel institutional forms that link research to enterprise creation and development would go a considerable way towards attracting FDI in more secure regions.

One way out of constraints posed by longwinded bureaucratic procedures blocking much needed improvements in legislative/regulatory frameworks is to adopt carefully designed fast-track approaches in selected regions/locations to improve the business environment. However, such approaches would need to be subject to stringent measures of transparency and accountability.[19]

The level of sophistication attained by businesses in a given country is a crucial factor in determining its overall socioeconomic health. Thus, advanced capabilities in marketing and distribution, which have come to rely increasingly on ICT, enhance productivity by augmenting the value of products and services as well as through opening new markets, thereby reducing production costs, improving overall returns and creating a wider range of job opportunities.

In general, the level of sophistication possessed by a given enterprise is dependent upon how effective it is able to take up and utilise innovative inputs. Since, through innovation it is generally possible to expand technology adaptation and applications involving new products and processes as well as possibilities for their dissemination. This usually holds considerable benefits for the workforce, in terms of higher wages and improved work conditions. In deed, businesses in the developed countries would not be able to sustain their high wage levels were it not for incessant moves to expand technology frontiers. In other words, the constant drive to develop cutting-edge products, services and manufacturing processes is a necessity, without which living standards and socioeconomic stability would surely suffer.

Historically, innovations adopted in Iraq's businesses have so far been almost entirely based on technologies originating abroad with limited if any endogenous involvement aimed at unpacking technology bundles, enabling future adaptation to future changes, e.g. in raw materials and auxiliary inputs. Utilization of home-grown R&D outcomes may have taken place to a much

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[19] In 2011, Iraq was reported as having ranked 159th among 183 countries in the "Doing Business Survey" conducted by the International Finance Corporation and the World Bank. See the following link http://www.doingbusiness.org/data/exploreeconomies/iraq/ and the related report "Economy Report: Iraq, Doing Business in a more transparent world; 2012." Using the World Bank Doing Business benchmark indicators would provide guidelines for the design of initiatives aimed at improving the country's business environment with particular reference to innovative enterprise creation.

smaller extent, e.g. in agriculture. It may well be argued, on the other hand, that Iraqi enterprises have been even less successful in targeting other types of innovations based upon:

(a) combining sets of technology inputs, both new and mature, to produce novel products and services;

(b) new business models and processes, that may capitalize on new technologies but generate value principally through inventing new ways of doing things.[20]

Research activity would certainly be needed to adapt and hone modern and mature technologies for implementation in specific fields with generally limited resource commitments. At any rate, to build upon, and replicate past successes, as well as initiate action on new grounds, Iraq would need to promote the influx of innovative and novel technology inputs of all types into the business sector. And, to do this effectively there is need to establish specialised institutional entities, including science, technology and innovation parks, technology/business incubators and CTREs.[21]

This Roadmap suggests that:

39. ***Action plans incorporating ambitious goals and record timelines be devised with the aim of radically improving Iraq's attractiveness to innovative business ventures. Such plans would need to be implemented on the basis of consultations among concerned government agencies, private enterprise as well as concerned NGOs.***[22]

40. ***Novel but proven modalities be adopted to ensure rapid and effective responses by institutions of higher education and scientific research to emerging needs in production and service sectors, in terms of human resources as well as technical and advisory services.***

41. ***Steps be taken to enhance the capacity of Iraq's business sector to exploit the following three strands of innovation (a) those solely based on novel S&T inputs, (b) those targeting new product and process on the basis of existing technologies and (c) those embodying new business models and innovative value chains.***[23]

II. 4. Promoting innovative small and medium enterprises

Improved legislative tools and regulatory arrangements are necessary but insufficient conditions for advancing the cause of innovative enterprise. This is especially the case for nascent innovative small and medium enterprises (SMEs). Strategic approaches with focus on enhancing innovative capabilities of Iraq's SMEs should consider the merits and disadvantages of establishing a

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[20] 'Newness' in this respect may not be intrinsic to a product or a process but to novel modes of delivery or customisation.

[21] Such entities would be needed not only in areas of scientific and technological research but also in studies and research aimed at policy, strategic planning/management and related specialties.

[22] Such consultations are imperative due to socioeconomic impact caused by improving Iraq's regional ranking on the business environment.

[23] This would necessitate that the proposed national STI policy pave the way towards incorporating all three strands into strategic interventions aimed at number of domains with high potential for success as well as sizable socioeconomic returns.

powerful agency,[24] entirely devoted to strengthening the position of SME's within the national economy, through:

- improving access by SMEs to a wide range of innovative services and novel technology inputs;
- encouraging and rewarding the adaptation and adoption of novel business process models and practices by new and well established SMEs as well as other state-owned and private enterprises;
- upgrading skills of SME operatives, with emphasis on information and communications technology;
- enhancing the quality of products and services provided by SMEs, for the home and international markets.

Other means of securing innovative inputs and novel skills for SME operatives should also be considered, including sector- and location-specific initiatives.

Promoting innovative SME exports would have to be taken up as an area of special concern by forthcoming national development plans. This is essential since, while the home market is capable of supporting a wide range of SMEs, it is doubtful that nascent Iraqi SMEs could survive the challenges of reduced barriers to imports now widely adopted throughout the region. Thus, as a result of trade agreements intended to create open markets with Iraq's neighbours many Iraqi SMEs stand to loose grounds to manufacturers and service providers in their immediate neighbourhood, such as Turkey, Iran and Syria as well as more distant manufacturers and service providers in countries.

The slow pace of improvement in the quality of local products and services and failure of educational and vocational training institutions in graduating human resources with adequate skills are examples of internal challenges that must also be urgently dealt with. At any rate, creating conditions that encourage exports by Iraqi SMEs across the board should have the effect of pushing them to innovate and enhance the quality of their output, as well as inducing improvements upstream in educational and training institutions.

Relying upon imported novel technology inputs and innovative business practices may be important to kick-start the drive towards an innovative national economy. In the long run, however, increasing proportions of innovative inputs would need to be generated, at least adapted and further developed, by national institutions, university research laboratories, specialized research centres, and in at least some instances, by manufacturing and services firms themselves.

The above issues will require special attention by the proposed Scientific Research Council (SRC). The SRC mandate would need to include support for innovation in priority sectors, not only through the conduct of traditional research activity, but also by providing help in the development of novel products and processes and assistance in bringing them onto the national

[24] Similar agencies have been created as independent bodies under the auspices of the Council of Ministers, often with representatives from chambers of commerce and professional associations on its board. The proposed agency might also be linked through joint membership of its governing council and board of directors to the Scientific Research Council (Committee). This would be particularly advantageous if the latter Commission could eventually extend its mandate to include innovation as a priority concern, in addition to research and development in science and technology. Failing this it would be essential for another body to promote innovation at the national level while extending special care to innovative small and medium enterprises.

and international markets, with adequate attention to competitiveness and environmental quality criteria.

Microenterprises have been acknowledged in many countries around the world as contributors to national development, employment creation, economic growth and innovation. Two additional reasons merit allocation of attention by policy makers and corresponding resources to assist microenterprises in Iraq's urban and rural settings. The first is to do with the fact that most enterprises operating in Iraq may not qualify for the "small enterprise" label and should rather be regarded as microenterprises which would still greatly benefit from innovative and novel technology inputs.[25] The second reason is that, devoid of such support, many national microenterprises may not withstand competitive pressures, with their failure triggering further unemployment and ensuing social and political problems. On the other hand, due to their numbers and proliferation, attempts aimed at introducing even minor innovations into existing and start-up microenterprises should produce considerable returns. One proven modality would be to set up microenterprise networks and clusters, allowing members to function in unison, empowered by now prevalent and highly reliable ICT tools and in accordance with international quality and performance criteria, thereby enhancing their collective output, in terms of volume and quality, and allowing them wider market access.[26] In short, enhancing outreach and funding dedicated to initiatives aimed at promoting micro, small and medium enterprises, to address the needs of microenterprises would go a long way towards improving their resilience and ability to catalyse and utilise innovative inputs.

The present Roadmap requires that:

42. ***Detailed feasibility studies be conducted, based on thorough consultations with concerned stakeholder institutions, with the aim of establishing a national SME enterprise promotion agency (NEPA) with initiatives targeting STI-based enterprises in particular.***

43. ***The results of the above studies be moulded into specific NEPA goals to be achieved as early as possible within forthcoming development plans.***

44. ***NEPA is established as early as possible in the STI policy implementation process with mandates aimed at:***

- ***securing adequate new technology and other innovative inputs, whether through technology transfer, endogenous R&D activity or combinations thereof;***
- ***promotion of higher education and vocational training activities especially suited to innovative SME operations.***

II. 5. Concluding remarks

Iraq's government appears intent upon implementing further reform and liberalization measures. The need to transform the country into a knowledge-based economy is often stressed by senior

[25] Micro enterprises share many of the problems that face small enterprises, particularly in relation to accessing technology and innovative inputs. Clearly, the design of specific initiatives, whether involving financial planning and management, product or service delivery modalities, packaging or processing methodologies should be carried out on the basis of extensive surveys and serious market research.

[26] There are many examples of such networks. Most notable are those that came about in the specialized textile sector in parts of Europe during the last two decades of the twentieth century.

officials, university presidents and the nation's deputies. Clearly, such an objective may not be attained before comprehensive national policies are adopted and wide ranging innovations implemented in the economic and educational spheres with emphasis on a more conducive legislative environment for scientific research and innovation.

As indicated above, the present Roadmap and its recommendations are intended for debate, fine-tuning and ultimate adoption in guiding the country's future socioeconomic development.

An important point to bear in mind in the formulation of the proposed national policy and the design of derivative strategies and action plans is to ensure that benefits are as widely disseminated as possible. As repeatedly shown in many parts of the world, innovation-led development will produce lasting results only when tangible benefits are felt by all. Governance of Iraq's STI system should therefore receive a good deal of attention, particularly during formative years of its revitalization.

Part III
Implementing the Roadmap

III. 1. Introduction

Implementing the Roadmap is an essentially complex and multifaceted undertaking. While only a few institutions may be involved in drawing up plans aimed at revitalising national STI capabilities, and then leading efforts aimed at their implementation, all the country's universities, vocational training centres and research institutions would have to partake in the actual implementation process. Additionally, several STI end-user institutions would be strongly impacted by its projects and programmes. Later stages of the Roadmap's implementation should also see many production and service enterprises, federations as well as nongovernmental organisations taking up specific roles outlined in the country's science, technology and innovation policy.

As indicated in previous sections, implementation of this Roadmap must be supervised and closely monitored by ISTIC, which has to be linked to the Prime Minister with its membership drawn from concerned ministries and institutions. In order to ensure optimal results, ISTIC would have to enjoy the support of an efficient, ably staffed and actively led secretariat at the very outset.

Taskforces to be entrusted with implementing initiatives of the Roadmap would need to have on board representatives of concerned ministries, regions and stakeholders, whose input would be crucial to successful outcomes of the Roadmap's programmes and projects as well as representatives of public and private enterprises whose activities stand to be influenced by such outcomes.

Additionally, an astute mix of centralised and dispersed decision taking and monitoring practices would be needed in accommodating to the Iraq's realities. ISTIC members and members of the taskforces it would be setting up should be able to meet frequently and regularly, especially during the first and second years of the implementation process. They should also have the ability to communicate with their official counterparts and colleagues throughout Iraq and abroad on continual basis, through email, teleconferencing and other means in with and concerned institutions and stakeholders. In particular, as in the case any national endeavour of this nature and magnitude, there will be strong need to have channels of communications constantly open between ISTIC members and concerned ministries, regions, stakeholder and STI end-user institutions.

To ensure proper and timely dialogue with all concerned parties it would be necessary for principal ministries, regional government entities to establish shadow STI units staffed by their own teams of specialists.

III. 2. Formulation, adoption and dissemination of Iraq's STI policy

Several countries in the region have already formulated, and some are actively implementing, more of less comprehensive STI policies. One of the first benefits due to opting for the design and implementation of such policies is that the very exercise of policy formulation often presents invaluable opportunities for coordination and networking among various actors and stakeholders,

highlighting common agreements and differences, and, given the good will and dedication to national goals, paving the way towards harmonious outcomes. In deed, experience shows that policy formulation exercises almost invariably reinforce overall commitment to national goals cement differences that often bedevil implementation and contribute to more rational resource allocations.

The policy formulation process may be carried out in stages, guided by in-depth studies on salient issues including development priorities, optimal modalities for institution building, resource allocation as well as requisite legislative and regulatory reforms. The ISTIP process would need to be punctuated by workshops designed to debate policy components and to ensure that input by all possible stakeholders is debated and taken up in the final version of the national policy document.

The process of policy formulation should be preceded by a series of awareness raising measures, e.g. well-designed media campaigns, official as well as informal announcements. One of the main purposes of such initiatives would be to highlight the importance of innovative practices, alongside scientific research. While not in the least undermining the importance of scientific research, one of the main purposes of such preparatory efforts would be to firmly establish the notion that innovation is not synonymous with research. Rather, innovation is always a complementary prerequisite to sustainable growth and development. Through expounding the need to establish a viable innovation system operating in close harmony with a revived scientific research system, it is hoped that concerned stakeholders would become aware, and supportive of, the role that innovation plays in ensuring productivity gains, employment creation and overall prosperity.

In working towards a national science, technology and innovation policy for Iraq it would be essential to ensure that input is sought from all concerned stakeholders. Formulating Iraq's STI policy may not be carried out as a top-down exercise. Instead, it would need to combine several approaches with input from stakeholders at various levels. In particular, principal government ministries would need to formulate and communicate their own STI policy requirements and possible inputs which would then be harmonised and further elaborated into strategies to be implemented in coordination and cooperation with their partners.[27] Once ISTIP is formulated and ratified it would have to be embedded as a core constituent within national development policy documents.[28] Efforts would be needed to devise downstream implementation strategies, with adequate benchmarks, follow-up and evaluation mechanisms. Discussions leading to its adoption and the roles that various institutions would be undertaking should be widely publicised, with view to enhancing public awareness as well as creating firm commitment by partner institutions.

To improve a country's STI capabilities generally requires tackling a wide range of far-reaching issues.[29] Nevertheless, most STI policies currently being applied, in developed as well as

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[27] Experience in both developed and developing countries indicates that departures form central STI policy may occur, and should in certain cases be well tolerated, provided they are made on reasonable grounds. As such departures become more frequent and equally well-reasoned, it would be appropriate to revise STI policy precepts and introduce requisite modifications.

[28] Information is needed here on what and when the forthcoming national development policy would be formulated. Information such as this would be important in order to dovetail future plans on both scores.

[29] In handling global STI issues, while leaving details to be tackled by derivative strategies, legislative and regulatory adjustments, national STI policies should allow for optimal flexibility and the need to institute changes and variations on main policy themes. Nevertheless, room must still be left for changes to bring the STI policy up to date as changes take place at various levels.

developing countries around the world, are concerned with articulating a limited set of basic and cross-cutting principles, leaving detailed considerations to be handled through implementation strategies and derivative programmes. Nevertheless, grey areas are not uncommon. Thus, both the policy document and implementation strategies would need to address, albeit at different levels of depth and detail, issues such as:

- directions for institutional restructuring and development;
- relationships between STI institutions and socioeconomic surroundings;
- raising public awareness and galvanising support by stakeholders;
- priority sectors and disciplines;
- funding and source allocation;
- criteria to be used in dealing with various components of national STI components, e.g. which universities might be classified as a teaching and research university, what constitutes a national rather than a regional or an institutional research programme.

The following sections provide further commentary on the above issues.

III. 3. Institutional restructuring and development

Plans for institutional restructuring and development are generally produced following ratification of the national policy, including its priority sectors and resource margins. They might be subjected to several rounds of refinement before finalisation together with relevant timelines, benchmarks and progress reporting modalities.

III. 4. Promoting networking and collaboration among key institutions

Successful systems of research and innovation must rely upon networks of stakeholders whose individual and collective actions result in the dissemination of new technologies and knowledge regarding their optimal application. Institutions commonly concerned with promoting research and innovation include:

- Government ministries and departments, playing key roles in laying down broad policy directives, initiating strategic exercises and evaluating progress towards set goals;
- Private sector institutions active in production and services, increasingly reliant upon new technology-based service activities;
- A variety of intermediary institutions bridging innovative service and production activities within the country and with international actors;
- Universities and research institutions providing key knowledge, imparting novel skills, and securing partnerships within an international STI arena;
- Organizations dedicated to ensuring adherence to quality standards and intellectual property rights.

For all of these actors to perform in unison an overall framework is needed to ensure common guidelines and benchmarks as well as effective legislation and regulatory arrangements. Once this framework is provided in the form of a comprehensive national STI policy joint commitments would be required by a range of concerned institutions. Experiences gleaned from countries around the world indicate that networking and collaboration efforts are often galvanised through partnership in national initiatives with well-defined objectives. The design of national STI initiatives and programmes aimed at conducting specific STI activities with objectives linked to

national priorities should, therefore, be taken up by national taskforces with suitable mandates and matching responsibilities. Special taskforces, with representatives of concerned stakeholders, must be formed to implement such initiatives.

III. 5. Enhancing public awareness and stakeholder commitment

As indicated in part II of this Roadmap, raising public awareness of the importance of science, technology and innovation is essentially a task for government institutions. However, it is also a task in which a variety of concerned stakeholders should take part. By taking part in raising public awareness stakeholders would in effect be reaffirming their roles and contributions to the entire process. Thus, commercial enterprises, the media and even selected non-governmental organisations, including trade and industry federations and professional associations, could profitably take part programmes aimed at raising public awareness. It should in fact be possible to initiate public-private partnerships targeting the publication and dissemination, of a variety of publications, including periodicals, children's magazines, electronic games as well as actual science-based toys and tool kits for children.

Programmes aimed at raising public awareness and clinching commitment by stakeholders could emulate those adopted in other parts of the world including measures such as the launch of:

- annual school exhibitions and competitions for essays on topics in science and technology as well as projects aimed at the design and development of model products and processes by youth at the country's schools and universities;
- a national "science week" during which events on a variety of topics, of general as well a special interest, are addressed through presentations, parallel exhibitions and contests, promoted by media campaigns and supported by business enterprises;
- educational TV channels and websites offering youth, and even certain classes of professionals, up-to-date information on selected topics in science and technology;
- SMEs established with view to producing electronic games, science-based toys and kits for children;
- open-days at university laboratories and research centres.

Clearly, all of the above measures would need to be implemented with set numerical goals and benchmarks

III. 6. STI programmes in selected priority areas

There is ample evidence to suggest that efforts aimed at capacity building in science, technology and innovation are amply rewarded whenever they are confined to specific priority domains with well-defined objectives and effective coordination/outreach modalities. Success stories abound from surrounding countries involving, for example, self-sufficiency in agricultural production, carving international niches in petrochemicals, pharmaceuticals and specialty textiles, with the same message throughout: *implementing consistent policies in acquiring knowledge and innovative inputs while attaining endogenous capacity to further develop such inputs is a recipe with high chances of success.*

Remarkable successes have been achieved by firms in Jordan, Lebanon and Syria, in the pharmaceuticals sector for example, often allowing them to compete internationally on the basis of innovative technology inputs and novel business models. By capitalizing on carefully selected

local manpower, committing their own resources in support of study tours and further learning, and establishing better links to universities and partnered with reliable raw materials suppliers and technology providers, these firms could claim sizeable market shares and excellent returns on initial investment. While several such examples may be considered as purely private sector initiatives, many enjoyed considerable government support, one way or another. Indeed, in the case of Syria some early successes could be claimed by public firms working in the pharmaceuticals sector.

Nevertheless, there is no doubt as to the intrinsic value of STI initiatives in selected sectors where the interests of both the public and private sectors coincide, thereby providing wider scope for cultivating home grown STI expertise.

None of the above should be foreign to Iraq. In fact, the practice of patronising research projects of benefit for the country at large has already been adopted by the Ministries of Higher Education and Scientific Research in both Baghdad and the Kurdistan Region. Thus, both ministries presently support research projects with expected impact on public health, the environment and water resources.

Such projects would produce even more valuable outcomes if turned into national STI initiatives. As such they would help establish and refine cooperation and coordination modalities among universities and between public and private sector partners, both at home and abroad. The idea is that while they may initially be conceived simply as limited research endeavours, once turned into full-fledged national initiatives with wide scope for implementation of their outcomes, they would necessitate considerable adaptation and fine-tuning for actual benefits are finally attained. These latter phases of adaptation and refinement provide crucial training for researchers as well as open up avenues for further collaboration between a range of institutions, helping all parties accumulate STI expertise which is incorporated at the institutional and national levels and may eventually be utilised in the same or other adjacent fields.

Upon ratification of Iraq's STI policy, a long list of research initiatives would need to be debated at special workshops with the aim of perfecting their design and responses to priority sectors and disciplines. On the basis of these workshops an optimal set of initiatives should be adopted, based on agreed criteria and detailed analysis of expected contributions to STI capacity building and future benefits for overall socioeconomic development. This would naturally require extensive preparatory studies taking into account requirements as well as prospective impact of the adoption of these projects as well as chances of implementing their outcomes. Clearly, projects responding to national priorities would be granted more support, allowing parent institutions wider scope for involving more partners at home and abroad.

The following paragraphs address a number of domains which appear to be the subject of attention by the Ministries of Higher Education and Scientific Research in both Baghdad and the Kurdistan Region. Guided by experiences of a variety of countries, both developed and developing, such initiatives will only produce worthwhile outcomes when ambitious goals are set for them. For example, it would not be worth the effort to undertake radical overhaul of the agricultural research system simply in order to have more papers published in refereed journals. On the other hand, attaining a leading regional, even international, position in terms of publications as well as tangible impact in terms of yields, export and business opportunities related to a given agricultural crop would certainly be worthy of such efforts. This philosophy is behind the kind of goals presented in figure (2) and appendix IV. It may be further stated that ambitiousness of policy and strategic goals should also extend to the speed with which they are to be implemented. Despite certain shortcomings, great benefits may in fact be attained through

adoption of rapid-results methodologies applied in a variety of development spheres, particularly by developed countries and corporations.

In summary, little progress may be achieved in any of the domains listed below without guidance by sector/discipline specific strategies catering for patent weaknesses and capitalising on points of strength. Additionally, it would be well to build on persistent successes achieved by Iraq's educational and research systems. These points of strength include engineering[30] in which some Iraqi universities could claim valuable achievements.[31]

Sectoral STI strategies should be based on detailed fact-finding, analytical as well as prospective studies with the purpose of identifying likely contributions of the sector at hand to the national economy. Published results on contributions by main sectors to Iraq's GDP indicate that services are likely to make greatly enhanced contributions to Iraq's economic activities, while contributions by the agricultural sector seem to be making diminishing inputs. See table (1). Appendix I presents a fuller picture of the variation in contributions to GDP by main sectors of Iraq's economy.

III. 6. 1. Agriculture

Figures on water availability, agricultural land, and value-added by the agriculture sector indicate that, of the fourteen countries for which data is available, only Iraq, Lebanon, and Morocco have water resources above or near 1000 cubic meters per capita.[32]

Table (1); Origin of GDP (% real change)

Sector	2010a	2011b	2012b
Agriculture	5.0	4.0	3.2
Industry	4.8	11.2	7.1
Services	7.1	8.1	22.6

a Economist Intelligence Unit estimates. b Economist Intelligence Unit forecasts. c Actual.

Source: IMF, *International Financial Statistics*. As quoted by the Economist Intelligence unit's Country Report, dated May 2011.

It is in these countries as well as others with significant freshwater sources, albeit at lower per capita levels, such as Egypt and Syria, that agricultural production and the related agribusiness sector possess greater potential.

Agricultural research in Iraq was well-established in the early twentieth century. Currently, however, current coordination between universities and related government bodies appears to be somewhat limited, leading to inadequate funding, outdated equipment, mediocre personnel training and data collection modalities of inadequate quality.

A national strategy for agricultural research and technology transfer appears to have been drafted in the early nineteen nineties with food self-sufficiency, sustainable management of land and water, and the "elevation of the agricultural sector" as its primary goals. However, it does not seem that sufficient resources were allocated for achieving these goals.[33]

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30 According to the Status Report, UNESCO (Iraq Office), March 2011, around 70 universities offer engineering courses in a variety of specialisations.

31 Some universities, such as the University of Baghdad and the University of Technology have a good track record in graduating prominent engineers who went on to establish highly successful businesses in the country and abroad.

32 Data for the years 2007 and 2008. Last years for which data is currently available. See the Arab World's Competitiveness Report, 2011-2012.

33 The National Agricultural Research Systems of Iraq, (1991) WANA NARS Study, Iraq. This reference is quoted by the Iraq Status Report, produced by the UNESCO Iraq Office in March 2011.

Special STI initiatives targeting agriculture would greatly benefit from fresh strategic perspectives. However, it is most likely that crop improvements, livestock productivity and more efficient use of land and water resources should be assigned high orders of priority.

III. 6. 2. Water

Water resources and their management are exceedingly important for many countries in the region including Iraq. Effective and sustainable management of water resources in the country is essential for all manner of socioeconomic development projects. Forecasts by the Iraqi Ministry of Water Resources (MoWR) suggest, that, based on current practices, the country could face an annual shortage of up to 33 billion cubic meters between 2015 and 2020.[34]

Available information on the status of this sector would require considerable updating, with focus on its priority needs, leading to formulation of a national policy and derivative strategies for the country's water resources and their management.[35] Nevertheless, it is highly likely that special STI initiatives targeting this sector would have to address issues such as:

- maintenance of water and sanitation systems;[36]
- introduction of new technologies in demand management;
- water recycling and desalination;
- reduction of water waste, and improved water harvesting methodologies.

III. 6. 3. Renewable energy resources

The International Energy Agency foresees a global increase of up to 33 percent in the use of renewable resources for electricity generation by 2035. It is estimated that related investments could exceed US$400billion by that year, especially if conducive policies are adopted in the developed countries as well as China and India.

Several countries around Iraq have already launched energy and STI strategies with components dedicated to promoting renewable energy resources. Thus, while, hydrocarbons would still represent a great asset for several years to come, Iraq, as well as other neighbouring countries in the Middle East and North Africa, possess enormous potential for renewable energies, particularly electricity generation from solar sources.[37] Additionally, there are possibilities for utilising Iraq's water resources for hydropower generation.

Nevertheless, a national plan put forward for the electricity sector in Iraq for 2006-2015 does not appear to have addressed renewable energy for electric power production. In sectors such as

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[34] UNESCO (2010) *UNESCO Country programme document for the Republic of IRAQ 2010 - 2014*. UNESCO. Quoted by the Iraq Status Report, produced by the UNESCO Iraq Office in March 2011.

[35] No such policy currently exists according to the Iraq Status Report, produced by the UNESCO Iraq Office in March 2011.

[36] Frankish, H. (2003) Health of the Iraqi people hangs in the balance. *The Lancet*, 361(9358), 623-625; as quoted by the Iraq Status Report, produced by the UNESCO Iraq Office in March 2011.

UNESCO, 2010. Quoted by the Iraq Status Report, produced by the UNESCO Iraq Office in March 2011.

[37] In 2008, less than 3 percent of the region's electricity came from renewable sources. Some countries did exceed this average, however. Thus, Egypt, Syria and Morocco were able to obtain 12, 7, 6 percent of their energy requirements from renewable sources.

power generation little may be achieved without extensive coordination with concerned government bodies playing a leading role in establishing a viable division of labour.

Thus, here too, the starting point for the launch of special STI initiatives targeting utilisation of renewable resources would be to draw up fresh policy/strategic perspectives with solar energy technologies assuming greater attention as basis for national STI initiatives throughout Iraq, and, with wind energy initiatives possibly having greater potential for the Kurdistan Region.

III. 6. 4. Information and communication technologies

Dissemination of information and communication technologies in Iraq is reported as having shown initial successes and a good deal of promise as far back as the early seventies. However, modern developments would certainly require further development of ICT infrastructures, ensuring ready access to broadband services by schools, businesses and community centres as well as the population at large. Available sources point to the need for:

- enhanced fibre infrastructure across the country linked to international facilities;
- reform and capacity building within government policy making bodies and regulatory institutions;
- promoting ICT research and graduate studies in related science and engineering topics with focus on capacity building and development of applications for utilisation in academia, schools, the business sectors, government and marginalised communities.

Astute strategies would be required to guide future progress on all of the above issues. In some respects, it would be well to emulate steps taken by one of Iraq's close neighbours, namely Jordan as well as measures adopted by Egypt in promoting continued development of their ICT capabilities and cheap access for all citizens to ICT services.

Based on the above strategies, ICT initiatives should ideally tackle evident weaknesses in government policy and regulations, infrastructure as well as the need for special content development and capacity building within various types of institutions.[38]

III. 6. 5. New technologies

Some universities in Iraq have already made moves to establish capabilities in a host of new technologies such as remote sensing at the universities of Baghdad and Mosul and laser engineering at the Al Nahrain University and the University of Technology.[39] The UNESCO survey of research institutions conducted in July-August 2011, has also shown that a few research centres have also been recently established in nanotechnology and biotechnology and genetics.

In designing national STI initiatives in these and other novel technology domains, it would be necessary to address issues that reflect actual needs in addition to capacity building, which is a worthy objective, in itself, considering the novelty of such technologies worldwide, and on the Iraqi STI scene, in particular.

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[38] The Status Report; UNESCO Iraq Office, March 2011.

[39] UNESCO. 2004. Iraq Education in Transition: Needs and Challenges. United Nations Educational, Scientific and Cultural Organisation, Paris.

III. 7. Implementing the Roadmap

Implementation procedures must be put in place to allow rapid progress along often difficult paths of restructuring, legislative and regulatory reforms, institution and capacity building, with proper checks and balances as well as measures ensuring transparency and accountability.

III. 7. 1. Overview of the STI revitalisation process

As indicated in tables presented in appendix III, the present Roadmap is designed for implementation in three principal phases. The first is essentially a preparatory one, with its main activities aimed at:

- in-depth analysis of STI status and desired/possible futures
- initiating Iraq's STIP process and design of implementation process;
- ISTIC design and staffing.

The table titled: "Examples of strategic objectives, actions, initiatives and outcomes," in appendix IV presents examples of objectives and likely outcomes that may be sought by Iraq's STI institutions. Objectives listed in this table are essentially ambitious. Achieving them would certainly require a great deal of dedication and coordination among concerned parties. See section III. 7. 5.

Appendix VI provides in tabular form a proposed timeline and scheme for implementing the Roadmap. Detail is sacrificed in order to provide a summary view of main activities and benchmarks on a single sheet of paper.[40]

Further reference is made below to segments derived from the timeline table presented in appendix VI. For the time being, it is important to stress that while this timeline may appear exceptionally charged, resorting to time-honoured and long-winded routines never succeeded in the past and is not likely to succeed in future. To institute the radical changes needed for a better future, one that is firmly founded on novel knowledge and STI inputs, it is essential to embrace ambitious goals and even more ambitious strategies for their attainment.

At any rate, given the complex and multifaceted nature of the Roadmap, this table, along with other proposed aspects relating to modalities and timelines, would need to be closely considered in view of realities on the ground. Thus, there will be need to model implementation processes with reference to detailed consideration of current policy-making and decision-taking procedures in Iraq. Modifications will have to be introduced into at least some of these processes in order to accommodate special requirements and take changing conditions into account. In other words implementation processes should enjoy some flexibility without which only limited benefits may be realised. For example, it may be useful for certain government departments to forego a measure of authority to ensure effective inter-institutional collaboration. On the other hand, it would be essential to grant greater freedom of movement to certain other institutions, particularly universities and their research centres, so that they might by-pass ancient routines and move quickly along often difficult paths of reform and rehabilitation, while complying with new systems of transparency and accountability.

The STI policy formulation process will naturally be a major preoccupation for ISTIC during its first few months. However, while this process is being launched and gradually fulfilled, it would

[40] Colour codes are used to identify various types of activities and symbols are inserted to indicate starting and delivery dates and milestones.

be essential for ISTIC to undertake a variety of preparatory activities aimed at securing optimal outcomes on other fronts, including, for example, the design of planning cycles, setting up monitoring and evaluation criteria and creating taskforces to carry out special STI initiatives and programmes aimed at selected priority sectors and disciplines.

The second phase is dedicated to launching ISTIC and the formulation of the national science, technology and innovation policy. During the third phase, waves of national and sectoral initiatives would be launched, including activities aimed at restructuring existing institutions, establishing novel institutional entities together with relevant partnerships and networking schemes, amending, as well as introducing new, legislative and regulatory arrangements.

III. 7. 2. Implementation taskforces

Iraq's STI revitalisation process is to be initiated on the basis of preparatory activities targeting detailed fact-finding and analysis of assets and requirements, costs and benefits in specific research disciplines and application domains as well as urgently needed legislative and regulatory changes so as to invest the ISTIP process with as much dynamism and clout as possible. In devising implementation strategies, it would be advisable to adopt a "scenario approach;" with several possible alternative paths towards achieving each scenario. Specific objectives with well-defined improvements at thematic, sectoral and disciplinary levels will need to be outlined in characterising each scenario.

Implementing this Roadmap, and for that matter, Iraq's entire STIP process, may not be left solely to individual institutions whose priorities and workloads may, for one reason or another, delay implementation efforts or divert trajectories from their original objectives altogether. Experience in this as well as other fields, where similar transformations involving a multitude of institutions were attempted, points to taskforces made up of specialists and practitioners from a variety of concerned stakeholder institutions as optimal tools for charting and implementing desired change. Inter-institutional taskforces are generally established to formulate, plan and oversee the implementation of strategies whose implementation necessitates crossing institutional boundaries, often involving cooperation with national and international experts, overseas institutions.

It is customary to have a single organisational entity take the lead in setting up and overseeing the work of implementation taskforces. In the case of the present Roadmap it would make a great deal of sense to assign ISTIC as the principal custodian and guardian of the entire process with the MoHESR/ Baghdad, its counterpart in Kurdistan Region the Federal Ministry of Science and Technology as well as the Ministry of Planning providing essential backstopping and support as and when needed. The fact that all three ministries as well as other concerned ministries and stakeholders are represented on the ISTIC Board should guarantee optimal coordination.

Table (2) presents a proposed timeline for setting up and launching implementation taskforces, including the central task force to be charged with preparatory activities.

In view of the fact that ISTIC would not come into being before certain steps have been taken on several tracks, it would be essential to establish a central taskforce (CTF), to take care of all preparatory steps aimed at establishing ISTIC and starting off the entire STI process. Staffing CTF is an especially important task. CTF would need to report to key ministries led by MoHESR in both Baghdad and the Kurdistan Region, and through these ministries to other key partners, including the Ministry of Science and Technology as well as the Ministry of Planning.

Table (2) Proposed timeline for setting up implementation taskforces; months (1-6)									
	App. V	Months from go-ahead date	1	2	3	4	5	6
1	1	Roadmap approved		●				
2	2	Launch STIP process			▶			
3	3	Establish Central taskforce and Auxiliary taskforces		■				
4	3	Identify taskforces, their mandates, benchmarks, etc.			■			
5	3	Set up additional taskforces			■	■		
6	3	Conduct training for taskforce members			■	■		
7	3	Examine reports by CTF & other taskforces as necessary					■	
8	3	Transform TFs & absorb selected members into ISTIC					■	

CTF should be able to take on board a team of high-level officials representing the above ministries in addition to other ministries[41] and stakeholders with extensive need for STI input and with contributions to building Iraq's technology infrastructure. It would also be advisable to have a small number of high calibre experts with relevant experience as full-fledged CTF members. In this regard, it would be essential to identify senior Iraqi, and Iraqi expatriates experts with expertise in policy formulation. Additionally, it may be necessary to organise an intensive series of special workshops to orient CTF members.[42]

As indicated above, CTF must be charged with preparations for establishing ISTIC, which is to play the leading role in all activities aimed at revitalising Iraq's STI capabilities in years to come. It is also advisable that CTF be also charged with undertaking preparatory activities for ISTIP formulation, including preliminary contacts, formation of institutional and sectoral teams by concerned parties, organisation of preliminary delivery schedules and timelines concerned with various ISTIP aspects, in accordance with overall timelines already established within the final approved version of the Roadmap. These activities would later be reviewed by ISTIC with view to arriving at final ISTIP formulation schedules and delivery dates.

Additionally, CTF may be required to initiate formation of several additional or auxiliary taskforces (ATFs) to look into a variety of sector- and discipline specific issues with priority status for Iraq's development. ATFs would perform an extremely valuable service through undertaking in-depth analyses of various sectoral needs and how they might be addressed in future. Other issues worth assigning to ATFs at an early stage in the STI revitalisation process might include analysis of strategies and initiatives already launched in order to see how they might be linked or subsumed within ISTIP future strategies and action plans.

One of the principal CTF duties would be to draw up reports as well as essential documentation needed for launching the ISTIP process as well as the creation of ISTIC. These reports are referred to henceforth as the CTF/ISTIP and CTF/ISTIC Reports.

The CTF mandate would effectively end upon creation of ISTIC and its staffing. It is possible, in deed desirable, for at least some CTF members to continue work as core ISTIC staff and as members of the various taskforces that ISTIC would need to establish. It may also be advisable that ATFs established to undertake special preparatory tasks be transformed into new taskforces

[41] These should include the ministries of petroleum, the economy the environment, agriculture as well as information and communications technology as well as the ministry of planning.
[42] It would be advisable to offer CTF and other taskforce members suitable incentives, which may not necessarily be material, in order to secure their commitment and ensure quality input.

operating under ISTIC guidance on issues relating to sectoral and disciplinary strategies. See section III. 7. 6. below.

III. 7. 3. Iraq's STI Commission

Once reviewed, updated and amended on the basis of comments by key ministries, the CTF/ISTIC Report should be presented to the Prime Minister with the intention of having the Cabinet discuss and approve its recommendations. Clearly, one of the main recommendations would be to create ISTIC with a sufficiently wide mandate covering all aspects of the Roadmap, including planning and overseeing the revitalisation of science, technology and innovation throughout Iraq, including rehabilitation of scientific research, revitalising technology acquisition and related innovation activities, with appropriate budgetary allocations.

The ISTIC Board should include senior officials representing MoHESR/Baghdad and MoHESR/Kurdistan as well as other key ministries and stakeholders. See section III. 7. 3. 1, below. However, once staffed and operational, it would be up to ISTIC to modify details relating to the Roadmap's implementation in all manners required; in efforts aimed at overcoming emerging constraints and in response to a variety of factors that may not be immediately apparent at the time of the Roadmap's adoption.

Periods of uncertainty, common to most, if not all, national policy exercises, will have to be tolerated. During such periods, mandates, responsibilities and action domains for ISTIC and its taskforces would still be in the making, while actions may have to be taken on certain issues. In order to minimise future setbacks care must be taken to keep lines of communications fully open between all concerned STI institutions with free flow of information regarding preparations for future action. Establishing ISTIC under the auspices of the Prime Minister and having its Secretary General report directly to him should allow it the benefit of taking the high-speed lane and to adopt paths of least resistance in planning an implementing processes of restructuring, legislative and regulatory change, institution building and launch of specific initiatives. At the same time ISTIC would be well advised to adopt operational rules adhering to transparency and accountability. In other words, associating ISTIC with the Prime Minister should provide it with requisite authority. However, its political clout must always be used with great caution so as to ensure good will on the part of all concerned.

Table (3) presents a proposed sequence of activities leading to the establishment of ISTIC. While this table is derived from the timeline table presented in appendix VI, it also includes a number of additional entries concerning additional related activities. The colour code used in this table is to single out activities that require intensive coordination with other institutional entities within the Iraqi Government.

As indicated above, several activities falling within the ISTIC mandate require high-quality input by an effective Secretariat, in addition to input provided by taskforces on a variety of technical issues. Such is the case with regard to issues in need of expertise on legislative, regulatory and funding issues and related transformations.

Quite early in the STI revitalisation process, ISTIC should be able to create implementation teams and taskforces to look into projects targeting mostly priority sectors with accent on fast track projects and early wins, for example:

- generating high-calibre researchers to cater for prospective downstream petrochemicals industries;

- rehabilitation of scientific research in arid-zone agriculture;
- creating a series of incubation schemes to ensure a constant stream of employment opportunities for Iraqi youth in technology and innovation industries and services;
- safeguarding and ameliorating the environment in various parts of Iraq.

Table (3); Steps leading to ISTIC establishment and its main activities; months (1-14)

	App. V		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1	Roadmap approved		●												
2	4	Author ISTIC mission, mandate & objectives														
3	4	Contacts & meetings to establish ISTIC														
4	4	ISTIC established						■								
5	5	Contacts/meetings to establish ISTIC components														
6	5	ISTIC fully functional							■							
7	6	Evaluate current STI initiatives														
8	8	Identify priority sectors & disciplines (PSD) strategies														
9	8	Oversee formulation of PSD strategies								▲						
10	8	Lead workshops to coordinate PS&D strategies								○						
11	8	Approve and disseminate PS&D strategies														
12	9	Oversee imptn. PS&D programmes & projects (P&P)														
13	10	Coordinate & revise imptn. of priority PSD/P&P										♦				
14	10	Formulate overall PS&D implementation plans														
15	11	Produce, submit allocate 1st biennial budget											♦			
16	12	Oversee formulation, fine-tune, discuss & finalise ISTIP										♦				
17	13	ISTIP approved & disseminated											●			
18	14	Follow up on legislative & regulatory reforms														…
19	29	Conduct periodic review of world STI dvpts.														
20	30	Feedback & trajectory inputs														

III. 7. 3. 1. ISTIC membership

ISTIC membership should include senior Iraqi decision makers. A group of top-notch experts should serve on its advisory board[43] and selected high-calibre professionals would need to man its various organisational entities. The ISTIC Secretary General should enjoy ministerial status with the ability to report directly to the Prime Minister. In addition to having its own advisory board ISTIC should be granted the ability to summon prominent Iraqi, expatriate or foreign for expert group sessions to debate and formulate key decisions. Equally important is the need to commission reports with recommendations on issues in which the Commission may lack expertise.

III. 7. 3. 2. ISTIC operations

Rules and regulations operations carried out or commissioned by ISTIC and associated taskforces would need to be set down at an early stage of the STI revitalisation process, with clear information on mandates and responsibilities, lines of communications and reporting pathways. It

[43] In addition to creating science, technology and innovation commissions, several countries have opted for the creation of an associated advisory body made up of both nationals as well as expatriate members.

would be convenient to have ISTIC operations organised in accordance with annual agenda with corresponding progress reports directly submitted to the Cabinet.

Taskforces created by ISTIC to examine and report on specific sectoral and disciplinary issues would need to report directly to the ISTIC Secretariat, who would then be responsible for submitting such reports for consideration by ISTIC and concerned institutions.

III. 7. 4. Iraq's STI policy

That ISTIP process should be launched as soon as the CTF/ISTIP report is reviewed and approved by the Prime Minister and his Cabinet. As indicated above one of the main attributes of the entire ISTI P should be its ambitiousness. Aiming at excellence, even within an initial set of domains and application areas, may sound rather hollow, given the present climate in Iraq. Nevertheless, it is a claim that may well be realised given careful planning, determined leadership, proper coordination, adequate resources as well as good public relations, to highlight the urgent need for all concerned parties to embrace new modes of thinking and enlightened practices.

Examples of ambitious, yet credible, strategic objectives, actions and likely outcomes including regional and even world leadership in selected areas are listed in tabular form in appendix IV, under the heading "Examples of strategic objectives, actions, initiatives and outcomes." Thus, regional leadership may well be sought by Iraqi STI institutions in selected:

- high value-added petroleum products;
- applications of biotechnology and genetic engineering in agriculture and medicine;
- Arabic ICT applications, emphasising e-commerce, e-government and e-learning;
- environmentally sustainable development;
- technology commercialization.

As indicated in the same appendix, even global leadership may ultimately be realised following advances on the regional front in selected areas of:

- energy technologies
- water technologies

It may be noted that viable foundations for launching ambitious initiatives, in several of the above domains are already in place. Some such foundations may indeed be used to build upon with fresh strategies and better resources coupled to improved management procedures and determined leadership. It is good to remember that several other countries, some without the benefit of Iraq's resources have made progress along similar lines. Adherence to strategies targeting innovative inputs based on in-depth assessment exercises, and benchmarking illuminated by well-established international criteria seem to have been key success factors.

III. 7. 4. 1. The ISTIP formulation process

As indicated in frame (3) , the Ministry of Higher Education and Scientific Research, in Baghdad recently recommended unification of scientific research policies in Iraq as a whole as well as rebuilding Iraq's scientific research capacity in a manner that is consistent with international practices. Both objectives would constitute strong impetus in favour of the formulation of a national science, technology and innovation policy.

Based on reports already produced on the subject by UNESCO as well as findings of the proposed CTF/ISTIP report, a policy formulation project should be launched to analyse STI status in priority disciplines and application areas as well as examine future perspectives in selected STI end-user sectors. Resulting recommendations are need to be discussed at a national conference held towards the end of the ISTIP formulation process, under the auspices of the Prime Minister, with sufficient publicity, so as to raise public and specialist awareness as well as firm up commitments by key partners.

Table (4) is derived from the table with proposed sequence of the Roadmap's implementation presented in appendix VI, showing initial steps leading to the formulation and approval of Iraq's science, technology and innovation policy. This table covers a 12-month period, by the end of which Iraq should be in possession of a comprehensive national policy for science, technology and innovation.

In addition to information presented in appendix VI, table (4) includes proposed timing for conferences and workshops to be held with specific aims in mind, mainly with purposes such as specialised training and awareness raising in mind.

As indicated in reference to the table in appendix VI, the actual starting date for the entire process is left unspecified. However, in order to dovetail with other development plans in the pipeline, it would be advisable to launch the process as early as possible during the first quarter of 2012.

Table (4); Timeline leading to STIP approval; months (1-12)

	App. V		1	2	3	4	5	6	7	8	9	10	11	12
1	1	**Roadmap approved**		●										
2	2	**National ISTIP conference**			○									
3	2	**Launch ISTIP process**			▶									
4	3	**Produce framework & interim plans**												
5	3	**Establish implementation taskforces (TF)**												
6	3	**Implementation workshops for ISTIP TFs**												
7	6	**Evaluate current STI initiatives**												
8	7	**Undertake prospective projections**								▲				
9	7	**Workshops to discuss projections, feedback & impact**								○				
10	8	**Prepare priority sector & discipline (PSD) strategies**								▲				
11	8	**Workshops to coordinate PS&D strategies**								○				
12	8	**Approve and disseminate PS&D**												
13	9	**Prepare for imptn. PS&D programmes & projects (P&P)**												
14	10	**Coordinate & revise imptn. of priority PSD/P&P**										♦		
15	10	**Formulate overall PS&D implementation plans**												
16	11	**Produce and submit 1st biennial budget**											♦	
17	12	**Formulate, fine-tune, discuss and finalise ISTIP**										♦		
	13	**STIP approved & disseminated**											●	

Table (4) refers to strategic programme and project planning activities to be conducted within the space of time allowed for ISTIP formulation. This is intended to encourage iterative approaches as well full engagement by STI supply and demand sides as well as oversight and funding

institutions in the STIP formulation process. Exposing all concerned to actual demands by priority sectors and disciplines through iterative and non-linear modalities is bound to introduce further complications but is offers best chances for success.

III. 7. 5. STI initiatives, programmes and annual agenda

Based on ISTIP directives and implementation strategies crafted by ISTIC and its taskforces, it should be possible to design national and sectroal initiatives and programmes targeting achievement of specific STI goals by set dates. Figure (2) presents examples of such goals with overall timeframes. While some initiatives and programmes may be planned over one or more years, others might well use shorter financing and reporting cycles; e.g. semi-annual durations. A good deal of dynamism would have to be initially adopted and constantly encouraged in implementation and reporting of all activities undertaken within the STI revitalisation process. With this in mind, the present Roadmap has opted for semi-annual financial and technical evaluation and reporting practices.

As indicated above, and in the timeline presented in appendix VI, preparations for initiatives will need to commence in parallel with steps taken to establish ISTIC, i.e. during the first six months of the start of the STI revitalisation process, and even before ISTIP is formulated and finally approved. Preparations at this stage are mostly directed at identifying strategies and work plans aimed at specific responding to priority sectors and disciplines across the country. Table (5), which is based on entries presented in appendix VI, presents activities that would need to take place between months 4 - 11 of the commencement of the STI revitalisation process in order to prepare for launching action targeting STI in priority sectors and disciplines.

Table (5); Timeline leading to implementation of various STI initiatives; months (4-11)

		…	4	5	6	7	8	9	10	11
6	Evaluate current STI initiatives		■	■	■	■				
7	Undertake prospective projections						▲			
8	Prepare priority sector/discipline (PSD) strategies						▲			
9	Prepare implementation priority progs/projs (P&P)							▲		
10	Integrate into overall PSD implementation plans								♦	
11	Produce, submit and allocate 1st biennial budget									♦

Table (6) provides a summary list of the various proposed initiatives that the STI process would need to undertake during implementation of the STI process. This table covers a period of a little less than two years with proposed activities to be launched following ISTIC establishment and ISTIP finalisation. Two planning cycles (PC1 & PC2) are included within this period, covering a seven month. Each cycle will pave the way for launching a wave of initiatives aimed at the design and approval of legislative and regulatory reforms, STI institution restructuring and building, and the launch of specific projects aimed at enhancing the country's STI capacity in priority sectors and disciplines (PSD initiatives). It may be noted that initiatives aimed at institution building and the launch of PSD initiatives are allocated around one year by each planning cycle, while shorter periods are allocated to restructuring exercises.

Similar planning cycles, with further institution building and PSD initiatives would need to be implemented annually following the period covered by table (6). In later stages of the STI

process, once a good deal of institution building has been achieved, greater emphasis should be placed on PSD initiatives.

Table (6); Timeline leading to implementation of various STI initiatives; months (12-32)

	App.V		…	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	…
1	14	Launch legislative & regulatory reforms		▶																					
2	15	Launch 1st planning cycle		▶																					
3	16	Restructure STI instns. (1st wave)			▶																				
4	17	Initiate 1st wave of STI instn. bldng.			▶																				
5	18	Launch 1st batch of PSD initiatives			▶																				
6	19	Evaluate 1st cycle of initiatives																							
7	21	Feedback & fine-tuning																							
8	22	Launch 2nd planning cycle									▶														
9	20	Restructure STI institutions (2nd wave)										▶													
10	23	Initiate 2nd wave of STI institution bldng.										▶													
11	24	Launch 2nd batch of PSD initiatives										▶													
12	25	Evaluate 2nd cycle of initiatives.																							
13	26	Feedback & fine-tuning																							
14	28	Create waves of incubation schemes																							
15	29	Conduct periodic review of world STI																							
16	30	Feedback & trajectory inputs																							

Creation of incubation facilities is granted considerable prominence in all STI programmes reviewed in preparation of the present Roadmap. The timeline presented in appendix VI allows for three six-monthly waves of incubation schemes with intervals of six months between each, to allow for reviewing results and introducing requisite changes in incubator design, management and funding modalities. In line with similar schemes undertaken in the region and worldwide, preference may be allocated to incubation schemes targeting utilisation and dissemination of ICT applications. The educational sector seems to have captured a good deal of attention in neighbouring countries. However, e-commerce, e-health and e-government incubation projects might also be encouraged as far as possible and whenever their viability is firmly established. Other STI-based incubation schemes that might also be considered as priority areas in early incubation schemes could involve:

- provision of selected scientific and technical services to public and private enterprises;
- applications of modern biotechnologies in:
    - selected areas of agriculture, e.g. in cell and tissue culture aimed at crops such as date palms;
    - the development of medical diagnostics.

Financing incubation schemes may well require government contributions in the first place. Nevertheless, plans to institute venture and risk capital schemes should be looked into at early stages of the STI process.

Finally, room must be left for reviewing outcomes and managing feedback generated as a result of implementing various national and sectoral initiatives with view to introducing trajectory changes as and when necessary. This is necessarily a continuous role. However, the proposed timeline demands that reviewing be punctuated by well-defined annual exercises aimed at

reviewing results achieved over the past year with recommendations submitted to ISTIC regarding feedback demanding changes in established trajectories.

In organising implementation programmes priority might be allocated to restructuring and rehabilitation of selected existing facilities while the creation of entirely new facilities is under study. Ultimately, however, all planned initiatives aimed at STI infrastructure building and enhancing STI operational capabilities would need to be addressed by ISTIC in line with implementation strategies formulated towards the start of the STI revitalisation process.

While there is need to adhere as closely as possible to plans and guidelines initially put in place at the very start of the process, it may well be essential and beneficial to depart from such plans as the need arises for a variety of reasons. Nevertheless, each time such departures are made by ISTIC, underlying reasons must be openly discussed and reported.

In summary, care must also be taken to frame all activities within annual agenda, with clearly defined outcomes, well-defined roles for all parties involved, as well as accurate resource estimates, benchmarks and monitoring modalities. Awareness would also have to be raised in the first place, regarding the necessity for implementing certain legislative and regulatory changes.

III. 7. 6. Monitoring and evaluation

As indicated in various sections of the Roadmap, strategies for implementing finalised plans on all fronts; i.e. regarding legislation, restructuring, PSD initiatives, etc., should allow for periodic reviews with the aim of constantly incorporating innovative inputs on the basis of in-depth assessment exercises and well-established performance criteria. In selecting such criteria, emphasis should be placed on tangible benefits that may clearly be seen as leading to overall development, employment creation and poverty eradication. This, however, may not be taken to mean that standard international criteria, such as publications in refereed journals, are to be neglected. On the contrary, implementation taskforces should see to it that a well-balanced set of criteria is adopted and constantly utilised as reference points in charting progress achieved.

Another important consideration to keep in mind with regard to monitoring and evaluation is the need to introduce self-monitoring and evaluation as a key component in all STIP programmes and projects. Experience shows that adoption of well-designed self-monitoring and evaluation modalities is immensely helpful in bridging divergent viewpoints and ensuring common understanding of performance criteria. Both benefits should make for enhanced outcomes at all levels.

III. 7. 7. Raising STI awareness

Once adopted in principle as basis for future STI action, it is proposed that ISTIP be launched at a national conference be held as early as possible, perhaps during the fourth quarter of 2012. The main purpose of this conference would be to raise public awareness of the entire STI revitalisation process; explaining its objectives, outlining its implementation modalities, and expounding its outcomes, as well as prominent aspects of its timeline and benchmarks.

This national conference should mark the beginning of a series of media events as well as specialist workshops regarding specific programmes and initiatives, which should also receive as much media coverage as possible; highlighting tangible benefits, success stories as well as difficulties met and how they were overcome.

III. 8. Concluding remarks

Implementation of the STI revitalisation process is never a task for a single institution or group of institutions. It is first and foremost a national endeavour, albeit one to be led by a selected group of institutions. While this may be a complicating factor, it may also be turned into a source of immense strength, provided adequate cooperation and coordination modalities are agreed, put in place and managed throughout implementation. Ensuring that all partners possess tangible stakes in achieving positive outcomes is key to success. Otherwise, many successes might prove at best temporary.

The role played by well managed and transparent public-private partnerships is often crucial to permanent benefits. Hence, the importance of novel institutional forms, such as research and technology parks, incubation schemes that nurture healthy partnerships of this nature.

Links forged by research facilities to application sectors and governing bodies should be constantly open in order to ensure positive and 'marketable' outcomes.

Finally, while many STI institutions in Iraq appear to be mostly active in science and technology based research, it ought to be remembered that research in the social sciences, particularly, economics, sociology, and even in certain areas of the humanities would complement efforts undertaken on the science and technology front and could even lead to multiplying their benefits.

Part IV
Enhancing Scientific Research in Iraq
Current Initiatives

IV. 1. Introduction

Both Ministries of Higher Education and Scientific Research in Baghdad and the Kurdistan Region are engaged in the design and implementation of a variety of initiatives with the aim of improving the performance of educational and research institutions in their charge. The following is a brief account of efforts currently being undertaken by both Ministries with view to improving scientific research. These and other efforts should be taken into account in charting ISTIP documents as well as mandates for the work of ISTIC taskforces. This should be particularly the case with regard to the strategy formulated by MoHESR/Baghdad with goals indicated in frame (3).

Judging by information made available in preparation of the present Roadmap, it would seem that the Ministries of Higher Education and Scientific Research in Baghdad and the Kurdistan Region have taken divergent approaches to reform. This conclusion is based on a review of documents authored by these two Ministries on their future strategies. The former, a "Scientific Research Strategy" and the latter a "Roadmap to Quality," intended to improve the quality of both higher education and scientific research. It would, therefore, appear that the Ministry in the Kurdistan Region is mostly concerned with increasing the numbers, and performance of Masters and PhD graduates as a first priority, particularly through cooperative programmes conducted in cooperation with partners abroad. On the other hand, the Ministry in Baghdad seems to target a wider range of issues including implementation of a set of special research projects, which would presumably be implemented through cooperation between partners at home and, possibly, abroad.

Despite the above differences, which may only be apparent, and due to incomplete information available at present, both Ministries are aware of the need to enhance the performance of their higher studies graduates and intent upon improving the quality of their research output.

IV. 2. Scientific research strategy by the Scientific Research Directorate (MoHESR, Baghdad)

The Ministry of Higher Education and Scientific Research initiated cooperation with UNESCO aimed at drafting a strategy aimed at enhancing the country's scientific research capabilities.

This strategy includes projects targeting specific goals aimed at improvements within the following categories:

a. research manpower;
b. budgetary allocations;
c. legislative and regulatory arrangements;
d. access to published information;
e. cooperation with research institutions abroad;
f. research output of research papers and patents.

A detailed list of the MoHESR strategy's goals is presented in frame (3). With regard to resources allocated to research activity, the Ministry is quoted as seeking increased allocations through

amending a law that regulates private sector firms' operations so that 1 percent of annual profits is allocated to scientific research.

Frame (4); Strategic goals sought by the Ministry of Higher Education and Scientific Research in Baghdad

At the UNESCO meeting held in Beirut, in September 2011, to review the status of scientific research in Iraq, the Director General of Scientific Research at the Ministry of Higher Education and Scientific Research in Baghdad presented a strategy aimed at enhancing the country's scientific research capabilities, within domains that fall directly within the Ministry's jurisdiction. Principal goals of this strategy include increasing:

- operational and investment funds allocated to scientific research;
- personnel levels at research facilities in the country's universities and research centres from 44 to 70 percent;
- the number of:
    - university students and staff pursuing higher studies abroad, within the "overseas study tours programme;"
    - grants allocated to students pursuing higher studies within Iraq;
    - subscribers in Iraq's Virtual Science Library from around 17,000 to reach 80 percent of all Iraqi students and staff;
- availability of reference material accessible to students and researchers in the form of new scientific books and refereed journals by at least 10 percent per year;
- supervision rate for higher studies from one to four theses per university professor;
- the proportion of time allocated by universities' teaching staff to scientific research;
- the number of research papers published in scientific journals;
- the number of patents submitted for registration by researchers;
- exchange of expertise with international scientific establishments.

Other goals addressed by the strategy include improving the balance between males and females across levels of qualifications and decreasing the number of higher diploma, masters and doctorate research projects undertaken in humanities.

The presentation made by the Director General of Scientific Research, included the following recommendations:

- unification of scientific research policies in Iraq as a whole;
- rebuilding Iraq's scientific research capacity in a manner that is consistent with international practices;
- promulgation of a new law proposed for MoHESR and regulations regarding higher studies, first proposed in 1990;
- marketing the results of Iraq's scientific research both in the country and abroad;
- raising awareness of the importance of scientific research in rebuilding Iraq.

Projects targeting goals of the MoHESR strategy are mostly to be implemented by the Ministry itself through funding allocated for its operations during 2011-2012. A proportion of these projects will require additional funding which would presumably be sought from the government's budget.

With regard to encouraging higher levels of research productivity, the Ministry's strategy includes an item intended to award a total of ID 20 billions between 2011-2020, i.e. an annual ID 2 billions to distinguished research output.[44]

The MoHESR strategy includes a project aimed at the establishment of science and technology parks and incubators at Iraqi universities. However, no specific locations are indicated as candidates for hosting these entities. Additionally, no information is available on budgetary resources to be allocated for the project's implementation. Another noteworthy project is designed to establish a number of permanent chairs at selected Iraqi universities. However, it is not immediately clear how many chairs would be established, in what specialisations and at which universities.

On the legislative and regulatory front, four projects within the strategy stand out. The first relates to a law stipulating an annual national budget assigned to scientific research activities as a percentage of the country's GDP. The second law is aimed art fostering scientists in Iraq and is expected to lead to improving their status as well as enhancing their contributions to sustainable development. The third law is aimed at establishing Iraq's Scientific Research Council, designed to promote scientific research across disciplines and institutional entities throughout Iraq. The fourth is concerned with establishing statutory basis for scientific research personnel.

More importantly, considering the purpose of the present Roadmap, are recommendations made by the Director General of Scientific Research at the Ministry of Higher Education and Scientific Research in Baghdad which are clearly in favour of the formulation of a national policy with the intention of unification of scientific research policies in Iraq as a whole and rebuilding Iraq's scientific research capacity in a manner that is consistent with international practices. See frame (3). Clearly the Ministry's recommendations would be served well by a comprehensive policy for science, technology and innovation.

IV. 3. Initiatives aimed at revitalising higher education and scientific in the Kurdistan Region

The Kurdistan Region made considerable progress in infrastructure and institution building during the past decade. [45] Reform of the higher education system appears to have been an urgent task that was approached with view to radical modernisation of the antiquated system that the Region inherited following many years of mismanagement and marginalisation. A recent document has been published by the MoHESR/Kurdistan attempted to chart a roadmap for reforming the Region's higher education and scientific research systems. [46] A principal aim of this document is to achieve higher standards in the fields of science, technology and management.

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[44] In this respect the strategy does not include further information on how the research would be judged as outstanding or whether the prise is linked to publications accepted by international refereed journals.

[45] The Fifth KRG Cabinet is in fact credited with making some serious attempts at modernising pre-University education. It also established the Ministry of Higher Education and Scientific Research in Erbil to help reorganise the Region's higher education system. The Sixth KRG Cabinet continued with the modernisation process, adopting a holistic approach in reforming higher education and scientific research institutions. It is expected that future KRG Cabinets will follow a similar path of modernisation and further reform.

[46] This document is titled *"A Roadmap to Quality Reforming the system of Higher Education and Scientific Research in the Kurdistan Region of Iraq; A Report on the Main Achievements*

This roadmap document[47] is notable in the level of attention it claims would be accorded to creating a system that guarantees social justice in general and to students' and staff human rights, in particular. Far reaching reforms of higher education, raising the capacities of professional cadres and investing in people are top priorities, emphasising quality and related assurance measures are stated as key issues raised by this roadmap document.[48]

In their approach to reforming the Region's higher education and scientific research system this roadmap document addresses the following principal domains:

- Administrative reform;
- Protection of human rights and establishment of system social justice;
- Reform of teaching to ensure quality;
- Reform of scientific research and related training, and linking Kurdistan's scholars with their international counterparts;
- Investment in higher education and establishing new universities;
- Changes in the management structure of the universities and the institutes of technical education.

Of note is repeated acknowledgement that the roadmap document, as authored by MoHESR/ Kurdistan, is a mere beginning, and that input is invited from all stakeholders with view to improved outcomes. Additionally, the roadmap document provides some guidelines for its own implementation, with universities and other institutes of higher education and scientific research expected to play a major role in fine-tuning and implementation of the roadmap.

Further details of issues to be tackled within each domain are listed in appendix (II). The following paragraphs present a brief account of issues closely related to scientific research raised by the roadmap.

The principal objective of the roadmap is the revitalisation of scientific research in the Kurdistan Region. Towards this objective several steps would be taken emphasising cooperation with research centres recognised as leaders in their fields of higher education and scientific research activity abroad.[49] Other related goals include:

From1stNovember 2009 to 1st September 2010." This document provides a summary of the KRG long-term strategy and aims to illustrate how this strategy has been implemented since November, 2009, when the Sixth Cabinet took office. It is also aimed at making the KR government's vision and strategy for the reform of the higher education system clear to all stakeholders. The document acknowledges that the strategy it intends to promote is "just the beginning of a long process of development that would not be complete without the assistance and efforts of all the teaching staff, students and other employees of the Higher Education institutions."

[47] The document, which was made available electronically in pdf format, did mot include many numerical goals or milestones. As it such, and assuming there were no missing addenda or annexes, it does not in fact constitute a detailed plan for getting from were higher education and scientific research in KRG stand at the moment to where they should be when implementation is finalised.

[48] While promoting quality as its prime objective, the strategy is stated as seeking to encourage inward investment in higher education. Close supervision of, and coordination with, investor institutions would be needed in order to ensure adherence to quality standards. This is especially important since the experience of neighbouring countries, in Syria, Jordan and even in some Gulf countries, with institutions seeking to invest in higher education has not be satisfactory, altogether.

[49] **T**he Council of the Ministry of Higher Education and Scientific Research appears to have played an important role in reaching several important decisions, the core of which was to initiate a quality

- reforming the Masters degree system and establishing a new system for PhD studies with the aim of opening up new channels of communication with international centres of excellence;
- identifying potential research supervisors and external assessors for graduate students from Kurdistan;
- expanding scientific networks and improving access to them by academics and researchers from the Region.

The following paragraphs are intended to capture some of the main features of the roadmap document pertaining to revitalisation of scientific research in the Region.

IV. 3. 1. Reforming the Masters degree system

Master studies in the Kurdistan Region are reported as having relatively modern foundations, with an introductory first semester followed another dedicated to core aspects of the topic of specialization, while the second year is totally dedicated to scientific research. Nevertheless, fundamental issues are still in need of special attention. For example, course content does not always reflect the Regions socioeconomic priorities, and there is plenty of room for better collaboration and coordination among universities with the purpose of exchanging experiences and sharing knowledge gained through interactions with universities abroad. Additionally, in the absence of Teaching Quality Assurance programmes, lectures are delivered in a traditional manner, and content requires a good deal of updating.

Reforms being implemented address all of the above issues. Thus, as of 2010, all state-funded institutions of higher education in Kurdistan were required to adopt content that is more responsive to the needs of public and private sectors. Additionally, over the years 2010-2013:

- most new placements would be set aside for newly established universities and technical institutes;
- the capacity of all Master study programmes will be increased; with 10-20 students in enrolled in each;
- academics from all the Region's universities will be required to cooperate with foreign experts in both lecture and research supervision duties.

Furthermore, academic boards made up from heads of departments involved in content delivery would be established to monitor the entire process. In order to ensure application of reform measures, heads of these academic boards are held responsible by the University's Committee for following up on its decisions. They would also be required to report to the Ministry's Higher Scientific Committee for Strategic Affairs, on issues regarding overall planning, curriculum development and teaching quality assurance. With regard to the latter issue, reform measures stipulate that the Teaching Quality Assurance programme will be applied to Masters courses in the same manner it is applied in BA/BSc courses.

IV. 3. 2. Establishing a new PhD pathway

One of the main shortcomings of PhD study programmes in the past has been that the three-year PhD study period offered students insufficient opportunities to acquire in-depth experience in research and acquire innovative abilities. Thus, the first year is virtually identical to the first year

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assurance process and establish the tradition of providing quality education and training in all institutions of higher education.

of Master's studies, while, during the following two years, they would be expected to initiate, conduct and complete a full-fledged research programme.

The PhD study system in Iraq has been revised by the Higher Scientific Committee at the Ministry of Higher Education and Scientific Research in the Kurdistan Region. Key objectives of the reform are to revitalize the research process with clear focus on socioeconomic needs of the Region as well as with focus on cutting edge science and technology, both in terms of topics of study and in terms of delivery and interaction modalities. Nevertheless, in order to provide for smooth transition between the old and the new PhD pathways, a transitional period of one year has been set with stipulations that need to be adhered to by institutions following the old system. See frame (4)

Frame (5); Transition from the old to the new PhD pathway

The Ministry's Council agreed to allow 2010-2011 as a transitional period, during which both the new and old programmes would run concurrently. However, the Council also stipulated that the following amendments/requirements be implemented:
- The duration of PhD studies are extended from three to four years, with the possibility of an extension by an additional period of six months.
- PhD candidates in the life and natural sciences would need to publish at least one research article in an international scientific journal, of an Impact Factor of no less than 1.000, during their four-year period of study/research.
- Repetition of Master's style didactic teaching and comprehensive examinations is disallowed.
- Students are required to spend at least six months at a centre of excellence during the period of their PhD studies. During this period they would be required to gain research experience specific to their research work.
- PhD candidates should not exceed 45 years of age at the time of their application for acceptance.
- PhD viva voce will need to conform to the quality assurance process in force.

The new PhD study program will consist of four years of full-time research, with no Masters-style courses or examinations. Rather, students' progress would have to be monitored through active joint supervision by scientists from a local institution as well as an international centre of excellence. Nevertheless, a certain degree of preparatory activities are still required in the first year of the reformed PhD course.

According to the reformed programme, students would have to attend lectures and become well-acquainted with content on research methods and ethics. During this preparatory year students would also be required to carry out literature surveys and familiarise themselves with the supervisors' and departmental research projects, as well as sharpen their language and personal skills. In addition to the above, students would also be required to prepares and submit an academic report including plans for their prospective research work. The report would have to be evaluated by a local and an international assessor. Based on satisfactory assessment, students would be required to travel abroad to work in the external supervisor's department, for a period of at least one year,[50] following which students would be required to return to their home institution to complete their studies. In this manner, students would in fact act as a bridge linking research being undertaken in both departments, thereby ensuring continued future collaboration.

The reformed PhD programme is essentially intended to ensure:

[50] The reformed system allows students an additional period of six months to master the language of the country in which they are supposed to initiate their research work.

- building a critical mass of scientists working as a team on a common topic of priority interest for the Region's socioeconomic development;
- initiating team-work by researchers at home and abroad, which should result in constant updating of research methodologies and attendant benefits for home universities;
- inculcating high research standards, with chances for dissemination of such standards throughout home institutions;
- joint publication of research outcomes in international journals with recognised impact.

The reformed system allows for a stream of students to be supervised by pairs of supervisors, one local and one from a foreign centres of excellence(CoEs). Thus, as the first student reaches his/her final
year, another may be adopted by the same pair of supervisors.

An additional boost to bridging research activities is provided for by annual visits by internal supervisors their students abroad. External supervisor are also be expected to reciprocate by visiting their students' home laboratory.

IV. 3. 3. Sabbatical programme for academics

In order to give faculty members serious opportunities to update their knowledge and teaching/research practices, the MoHESR/Kurdistan and Universities in the Region would provide financial incentives to encourage academics to go on sabbatical study for periods of 3-12 months, preferably together with their students, at selected international CoEs. This sabbatical programme was conceived with the following principal goals in mind:

- acquiring state-of-the-art academic and research experience;
- establishing networks and scientific links with view to promoting long-term research collaboration;
- identifying new scientific projects and new co-supervisors for jointly supervised PhD programmes;
- inducting new external assessors into teaching and research quality assurance programmes at home;
- promoting joint publication of research outcomes in international refereed journals;
- promoting Kurdistan's universities in the developed countries and creating linkages between departments in the Region and counterparts abroad.

IV. 3. 4. Goals of the Kurdistan Region's scientific research strategy

The Ministry of Higher Education and Scientific Research in the Kurdistan Region recently took steps to lay down strategic goals and modalities aimed at revitalising research institutions in the Region. Available documents[51] assign a high order of priority to the following goals:

- Establishment of scientific research centres in additional priority domains;
- Training a fresh generation of researchers with outstanding capabilities;
- Adoption of fresh modalities; institutional, legislative and regulatory, to ensure close links between scientific research activity and socioeconomic priorities;[52]

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[51] Relevant documents were obtained in April 2011 through direct communication with the Adviser to the Minister of Higher Education and Scientific Research in the Kurdistan Region's Government, Dr. B. Khailani. The above paragraphs were translated from a document in Arabic describing efforts aimed at formulating a scientific research strategy for the Kurdistan Region covering the period 2010-2030.

[52] Capabilities in these respects should not only allow close links between research activity and outstanding problems/issues. Rather, it would be essential to enforce such capabilities with prospective

- Promoting quality research output.[53]

The above goals are to be achieved through five-year plans including activities aimed at:

- training researchers, with particular emphasis on handling projects of wider international interest, thereby promoting closer cooperation with international partners in frontline research areas on unresolved problems;
- enhancing the capabilities of research labs in existing centres in step with moves towards tackling more advanced research topics as well as ensuring that new research centres are established according to highest possible standards;
- intensive cooperation and interaction with research centres undertaking research in disciplines/areas relevant to the region's priorities all over the world;
- improving English language abilities of the Region's researchers through specific programmes aimed at established as well as new research centres;
- encouraging researchers to seek joint research opportunities in the developed countries for periods of up to one year, with view to promoting stronger links with research teams abroad and publication in refereed international journals;
- attracting around 2000 researchers from universities across Iraq to occupy positions in existing as well as prospective research centres.

In addition, MoHESR/Kurdistan documents reiterate calls for all university professors to take part drawing up the strategy as well as elaborating its five-year plans.

IV. 4. Concluding remarks

The Ministries of Higher Education and Scientific Research in the Federal and the Kurdistan Governments have taken steps towards formulation of policies and strategies aimed at building fresh research capabilities.[54] Both Ministries have also taken a number of practical steps in this direction. Plans adopted by the former Ministry, appear to target a range of activities, including the implementation of national projects in public health and renewable energy technologies. On the other hand, plans drafted by the Kurdistan Ministry are more focused on training researchers, with emphasis on reform of the Masters and PhD systems.

In general, initiatives undertaken and planned by the Ministry in the Kurdistan Region appear to rely far more on cooperation with universities and research centres abroad in order to build the region's research capabilities. This is understandable, given the dearth of expertise in a variety of domains crucial to the development of scientific and technological capabilities in Iraq. Nevertheless, it would seem logical for both Ministries to share the results of such cooperation, through well-defined modalities.

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outlook and foresight, allowing the research community to tackle problems that are expected to arise in near- and medium-term futures.

[53] Suitable for publication in international refereed science and technology journals.

[54] MoHESR/Kurdistan has reported initial plans indicating that it is to seek cooperation with the British Council setting up a Project Management Office, which is to take part in drafting the Region's science and technology policy. While the Ministry may have very good reasons for choosing the British Council as its partner, it would seem that consultations with other institutions with much greater experience in the formulation of such policies might be called for. The British Council is certainly quite renowned for its many achievements in various fields, however, its expertise in this domain is hardly comparable to other international organisations with direct experience in this domain.

With regard to funding resources, documents so far made available by MoHESR/Kurdistan, address the issue in more general terms, indicating moves towards allocation of sufficient budgets by the Regional government as well as improved access to funding from other sources. The presentation made by the Director of Scientific Research at the Ministry of Higher Education in Baghdad points to expenditures on specific research activities amounting to several billion Iraqi Dinars.

A similar situation arises with regard to equipping laboratories and research centres. Thus, while no figures are given for allocations to this item in documents available from MoHESR/Kurdistan, MoHESR/Baghdad appears to have allocated ID15 billions for rehabilitation and furnishing laboratories and research units.[55]

MoHESR/Kurdistan reports steps taken to create improved linkages to international research networks as well as establishment of a research network for the Kurdistan Region in collaboration with UNESCO. No information was available on similar steps undertaken by MoHESR/Baghdad.

A recent report indicates that ccess to digital Internet-based libraries by researchers is an area of primary concern for MoHESR/Kurdistan. On the other hand, MoHESR/Baghdad reports considerable expenditure on the Iraqi Virtual Science Library (IVSL).

In conclusion, it would seem that a good deal would be gained through much greater collaboration and coordination between the Ministries of Higher Education and Scientific Research in Baghdad and the Kurdistan Region as well as improved coordination by these two ministries with the Federal Ministry of Science and Technology, which should ideally be a close partner in all efforts aimed at the rehabilitation of scientific research in Iraq.

[55] Figure quoted from table on slide 67 from the presentation made by Dr. M, Director of scientific Research at MoHESR in Baghdad. However, other slides in the presentation refer to two phases in the rehabilitating and equipping research laboratories with sums amounting to ID1.447 billion for the former and 2.35 billion for the latter.

Appendix I
Recent economic Indicators and population figures

AI. 1. Gross Domestic Product (GDP)

	2006a	2007a	2008a	2009a	2010a	2011b	2012b
Nominal GDP(US$ m.)	42,186	62,338	84,719	74,729	91,617	97,939	111,846
Nominal GDP (ID b.)	61,845	78,234	101,078	87,433	107,192	114,589	130,860
Real GDP growth (%)	6.2	1.5	7.8	4.5	5.5	9.5	10.9

AI. 2. Origin of GDP (% real change)

Sector	2006a	2007a	2008a	2009a	2010a	2011b	2012b
Agriculture	-1.2	2.3	-8.5	1.1	5.0	4.0	3.2
Industry	6.3	6.7	10.5	3.1	4.8	11.2	7.1
Services	10.2	-9.3	9.6	8.9	7.1	8.1	22.6

AI. 3. Population and income

	2006a	2007a	2008a	2009a	2010a	2011b	2012b
Population(m)	28.9c	29.5c	30.1c	30.8c	31.4	32.1	32.8
GDP per head(PPPUS$)	3,400	3,479	3,755	3,876	4,045	4,397	4,824

AI. 4. Fiscal indicators (% of GDP)

	2006a	2007a	2008a	2009a	2010a	2011b	2012b
Public-sector revenue	91.5	77.3	84.8	71.0	69.6	94.7	79.0
Public-sector expenditure	80.5	68.2	75.2	81.0	68.2	80.0	79.1
Public-sector balance	11.0	9.0	9.6	-10.0	1.3	14.7	-0.2

AI. 5. Prices and financial indicators

	2006a	2007a	2008a	2009a	2010a	2011b	2012b
Exchange rate ID: US$(end-period)	1,391c	1,216c	1,172c	1,170c	1,170c	1,170	1,170
Consumer prices (av. %)	53.2c	32.5c	2.9c	-2.8c	2.4c	6.2	6.1
Lending interest rate(av. %)	16.0c	20.0c	15.0c	7.0c	6.0c	7.2	8.0

AI. 6. Current account (US$ m)

	2006a	2007a	2008a	2009a	2010a	2011b	2012b
Trade balance	11,821c	22,964c	21,587	5,090	6,930	22,396	7,249
Goods: exports fob	30,529c	39,587c	58,806	40,857	48,063	72,907	68,873
Goods: imports fob	-18,708c	-16,623c	-37,219	-35,768	-41,133	-50,511	-61,624
Services balance	-5,133c	-3,998c	-6,385	-4,380	-4,630	-4,925	-4,970
Income balance	-3,545c	-3,067c	-2,050	970	1,105	1,209	-1,235
Current transfers balance	-1,892c	-1,843c	500	-100	-300	-600	-750
Current-account balance	1,251c	14,056c	13,652	1,580	3,105	18,080	1,969

AI. 7. External debt (US$ m)

	2006a	2007a	2008a	2009a	2010	2011b	2012b
Debt stock	99,160	102,308	82,635	72,995	52,582	45,293	44,505
Debt service paid	1,297	1,203	994	894	987	2,129	3,204
Principal repayments	1,275	1,024	828	710	830	1,900	2,970
Interest	22	179	166	184	157	229	234
Debt service due	4,718	6,924	7,334	3,016	2,664	2,864	6,125

a Economist Intelligence Unit estimates. b Economist Intelligence Unit forecasts. c Actual.

Source: IMF, *International Financial Statistics*. As quoted by the Economist Intelligence unit's Country Report, dated May 2011

Appendix II
Objectives of Higher Education and Scientific Research Reforms in the Kurdistan Region

(A) Reforming Teaching to ensure quality

(**A1) Establishing a Teaching Quality Assurance system to:**

- ensure quality learning and training.
- protect the rights of students and preserve the status of teachers.
- increase the trust in the awarded degrees and certificates.

(A2) Beginning a Continuous Academic Development to:

- raise the academic standard of the lecturers.
- open communication channels between academics and promote collaborative team work.
- encourage better research.

(**A3) Reforming the undergraduate and postgraduate curricula to:**

- modernise education curricula and make the training programs suit the needs of the market.
- enhance the capacities of individual students.
- encourage students to think and become more creative self learners.

(A4) Reforming the postgraduate Masters studies to:

- raise the quality of teaching and research projects.
- promote collaborative teamwork among the academicians and enhance teaching capacity of course organisers.
- prepare more quality teaching staff for the new universities and technical education institutes in Kurdistan.
- prepare well trained professionals for the market needs in the public and the private sectors.
- create income sources for the universities.

(A5) Modifying English language tests to:

- set objective and international standards for evaluation.
- increase the trust in our English language courses and examinations.
- establish social justice.
- keep in line with the outside world.

(A6) modifying the student admission system to:

- link student's ambition with the offered choices
- move towards an electronic system.

(B) Reforming scientific research training and linking Kurdistan's scholars with their international counterparts.

(B1) Establishing a new system for PhD studies to:

- improve training programs in PhD studies in the Region.
- open channels of communication between the scholars of the Region and their counterparts in international CoEs.
- establish a link between the scientific departments in Kurdistan Universities with their counterparts in international centres.
- Revitalise scientific research in the Kurdistan Region.

(**B2) modifying the old PhD system which remains functional in parallel to the new system for one final year to:**

- improve on the old system while it remains functional during this transitional period, before it becomes obsolete in 2011.
- give the academics and potential supervisors the chance to adapt to the new system.

(B3) Sending academicians abroad on sabbatical to:

- update their knowledge and skills, and acquire experience in the state-of-the-art.

- expand their scientific network and open new channels of contact and communication between the scholars and their counterparts abroad.
- help find potential research supervisors and external assessors for graduate students of Kurdistan.
- boost research potential of our local scientists.

(B4) Holding a conference to "revitalise" scientific research in Kurdistan to:

- expand the scientific network of our academics
- find potential scientific supervisors and external assessors for the students of Kurdistan.
- invite inward investment in Higher Education.
- Support the Human Capacity Development Project in the Region.

(C) Investing in higher education and establishing new universities.

(C1) Establishing four new universities to:

- increase the capacity of higher education institutes.
- increase the opportunities for top students, especially in the deprived areas outside the major cities where the people had sacrificed more for the Kurdish liberation movement. revive the suburbs.

(C2) Starting a Human Capacity Development Project that will:

- make the best use of the human abilities in the Region.
- train leading academic and professional cadres for the future.
- establish a competitive system of award based on merit.

(C3) Increasing the stipend for existing scholars who are studying abroad to:

- alleviate the financial difficulties of students and help them focus on their studies.
- support students and strengthen their loyalty to their homeland.

(C4) Sending scholars abroad outside the Human Capacity Development Project, to:

- fulfil the dreams of ambitious students.
- invest in the human capacities and increase the number of professional cadres.

(C5) Establishing a modern system for licensing and accreditation of universities to:

- find a transparent mechanism for assessing universities.
- increasing the confidence in the private sector in higher education.
- protecting the Region and its people from low quality education.

(D) Changing the management structure of the universities and the institutes of technical education:

(D1) Restructuring the existing two Institutes of technical education and transforming them into three Polytechnic Universities instead, to:

- raise the standard of technical studies.
- make the training compatible with modern technology and with the needs of the market in the Region.
- create a competitive environment for applicants of technical studies.
- encourage academicians to work in the technical studies institutes.
- allow graduates of the technical studies to continue their studies to postgraduate level.

(D2) Reforming the administrative structures of the colleges in Universities to:

- make the best use of the human abilities of academicians and the staff.
- minimize bureaucracy and waste of resources.
- reconnect the teaching and research roles to enhance academic creativity.
- offer the teaching staff the opportunity to take part in research and innovation.
- engage the full time researchers in teaching.

(D3) The future of the new system: helping the universities gain their administrative, financial and academic independence, to:

- grant the universities the freedom to develop and raise the quality of their services.
- grant the universities the freedom to generate income and reduce their dependence on the state-funding.
- create an atmosphere of competitiveness within the local universities and between the local universities and the international ones.
- minimise bureaucracy.
- engage students and staff in the management process.

(E) Administrative reform:

(E1) Changing the way we serve the public at the Ministry to:

- improve our service and reduce red-tape.
- Provide information more readily.
- improve the working environment inside the Ministry, for greater productivity.
- stop external interference and avoid managerial errors.

(E2) Establishing a website for the Ministry to:

-communicate information and instructions more effectively.
- answer queries directly.
- announce ministry news.

(E3) using electronic communication to:

- enhance communication and minimise delays
- reduce the financial burdens of the citizenry and to reduce bureaucracy.

(F) Protecting human rights and establishing social justice:

(F1) Reforming the recruitment system to:

- ensure equal opportunities and increase social justice.
- provide incentives that correspond to the skills and efforts of the employee.
- eliminate bias, exceptions and external interferences.

(F2) Establish a health and safety program to:

- improve the working and learning environment.
- protect the health of students, academicians and the staff in higher education institutes.
- Establish a culture of taking responsibility.

Appendix III
Phases, Key Steps and Support Action in Implementing STIP Process

Phase I	
Key Steps	**Support Actions**
In-depth analysis of STI status and desired/possible futures	
Finalise detailed report on STI status and priorities with detailed recommendations for the way ahead	• Discuss its recommendations in workshops across the country • Seek feedback from relevant ministries • Finalise Roadmap and its implementation plan
Present summary of the report to the Council of Ministers for discussion and approval	• Consult with prospective partners and heads of concerned institutions • Assist authorities during decision making process
Receive authorization to proceed with STIP process	• Prepare for setting up the central taskforce (CTF)
Initiating the ISTIP Process	
Initiate ISTIP process	• Conduct detailed fact-finding and analysis of assets and additional requirements • Identify initial legislative and regulatory changes required • Conduct detailed cost-benefit analyses on preferred options
Establish specialist taskforces	• Recruit high-calibre staff and assistants • Set up ISTIP offices
Assemble stakeholder and advisory panels	• Discuss results of in-depth surveys and fact finding studies
Formulate implementation strategies	• Seek feedback and support from concerned ministries
Finalise implementation strategies	• Clarify decision process
ISTIC Design and Staffing	
Complete ISTIC detailed design and assemble legal support package	• Elements, processes, authorities, roles • Start-up budget
Receive authorization to establish STI Commission	• Support authorities in decision process and obtain necessary guidance
Report to Council of Ministers on achievements and obstacles of Phase I	

Phase II	
Key Steps	**Support Actions**
Launching ISTIC	
Issue ISTIC charter and recruit Secretariat staff	• Identify top leadership; • Hold consultations on top staff appointments; • Ensure technical support;
Staff development training and integration	• Establish benchmarking and monitoring modalities • Initiate staff training programmes; • Act on relationship building within ISTIC Team and with concerned national institutions;
Inaugurate ISTIC	• Handover CTF duties to ISTIC Secretariat; • Publicise ISTIC and explain its mission and detailed objectives; • Create national and international Advisory Committees and establish national and sectoral teams;
Initiate ISTIP exercise	• Consult on and establish detailed priorities; • Hold consultations on institutional reform and restructuring plans; • Hold consultations on institutional inputs to IST ; • Commission surveys, in-depth analyses of key sectors as well as selected futures studies; • Hold consultations on overall IST funding issues;
Formulating ISTP	
Develop draft IST document and annual budgets	• Engage stakeholders in reviewing draft IST ;
Submit for authorization	• Support legislative and other authorities in decision-making process;
Receive authorization and/or revise ISTP and related budget	• Revise ISTP as needed; • Produce derivative implementation plans; • Publish and communicate ISTP for implementation.
Report to Council of Ministers on achievements and obstacles of Phase II	

Phase III	
Key Steps	**Support Actions**
Launching First wave of National and Sectoral Initiatives	
Annual and Multi-Annual Programmes	• Finalise reform and restructuring of existing STI institutions; • Create new infrastructural, operational facilities and capacity building initiatives; • Discuss and plans for STI funding and related monitoring modalities;
Initial Funding Cycle	• Initiate first funding cycle with corresponding programmes and evaluation modalities;
Evaluate and Improve Programmes	• Hold regular consultations within ISTIC, with principal STI and Government institutions; • Conduct revisions of work plans and implementation programmes; • Provide semi-annual reports on progress of work.
Report to Council of Ministers on achievements and obstacles of Phase III	
Further planning cycles and waves of restructuring and institution building with monitoring and evaluation modalities as before.	

Appendix IV
Examples of strategic objectives, actions, initiatives and outcomes

Strategic Objective	Strategic Action	Initiatives	Outcomes
Regional followed by global leadership in energy technologies	Establish a multi-national solar demonstration project in collaboration with world leaders and Iraqi researchers abroad.	• Build national consensus, plans, and commitment to a bold energy future; • Recruit established STI leadership; • Invest in strategic R&D initiative to create tangible capabilities; • Establish alliances with R&D partners and manufacturers	• Leadership in solar energy conversion, transmission and storage technologies; • Regional provider of solar electrical energy and relevant technologies; • New technology platforms and industries with enhanced job opportunities; • Reduced environmental impact.
Regional followed by global Leadership in water technologies	Establish partnerships for the development of new generations of water desalination and treatment technologies.	• Recruit established scientific and business leaders; • Build technology/business partnerships between concerned parties, the region and the world at large; • Invest in initiatives to build capability and create new technology; • Create commercialization partnerships.	• Leadership in desalination and water treatment and reuse R&D; • New export industry including hardware and know-how; • Transformed economics of urban and rural development; • Technology platforms that fuel other industries, creating additional employment.
Regional leadership in high value-added petroleum products	Establish state-of-the-art capabilities in hydrocarbon R&D and engineering.	• Build leading-edge centre for hydrocarbon R&D; • Recruit world-class technology and management leadership; • Strengthen Iraqi universities' capabilities in underlying sciences; • Establish long-term business partnership with relevant actors on the national, regional and international scenes; • Build strategic alliances with R&D partners and manufacturers.	• Increased returns on a national resource; • Enhanced value of major national resource through reduced environmental impact; • Addition of new industrial enterprises and employment opportunities; • Establishment of novel technology platforms.
Strategic Objective	**Strategic Action**	**Strategic Agenda**	**Strategic Outcomes**
Regional leadership in selected applications of biotechnology and genetic engineering in certain areas of agriculture and medicine	Establish requisite capabilities, human resources plus hardware as well as networking and cooperation modalities.	• Build world-class biotechnology and genetic engineering laboratories and other research facilities targeting selected application in agriculture and medicine; • Train researchers and technical assistants in relevant techniques at top-notch facilities around the world; • Establish partnerships with frontier research teams in renowned universities.	• Enhance Iraq's image on the international STI stage with benefits including wider future possibilities for collaboration with elite research groups and universities; • Enhance the level of services provided by Iraq's STI community to sectors of crucial impact on national development, such as agricultural business and health care.
Regional leadership in Arabic ICT applications, in selected fields, such as e-commerce, e-government and e-learning.	Establish national TCT teams and partnerships with world leaders in the field	• Acquire top-notch hardware as well as software and training facilities with view to developing relevant commercial applications in e-commerce, e-government and e-learning; • Establish firm partnership arrangements for testing and marketing Arabic e-commerce, e-government and e-learning applications.	• Iraq attaining leading positions in selected applications reflecting on improved performance; • ICT businesses created and enjoying leading status and commensurate profits; • Employment opportunities for youth and women in an expanding sector with excellent future possibilities.
Strategic Objective	**Strategic Action**	**Strategic Agenda**	**Strategic Outcomes**
Regional leadership in environmentally sustainable development	Establish a strong research base in environmental S&T plus consulting capabilities and business outreach.	• Strengthen delivery of environmental services; • Join international initiatives; • Strengthen business development skills and spin-off function; • Establish knowledge coordination and dissemination networks.	• Acquisition of resource-base to protect the public good; • Creation of a regional equipment/plant production and service industry; • Leadership in an area with regional implications; • Lower obstacles to economic growth through creative solutions;

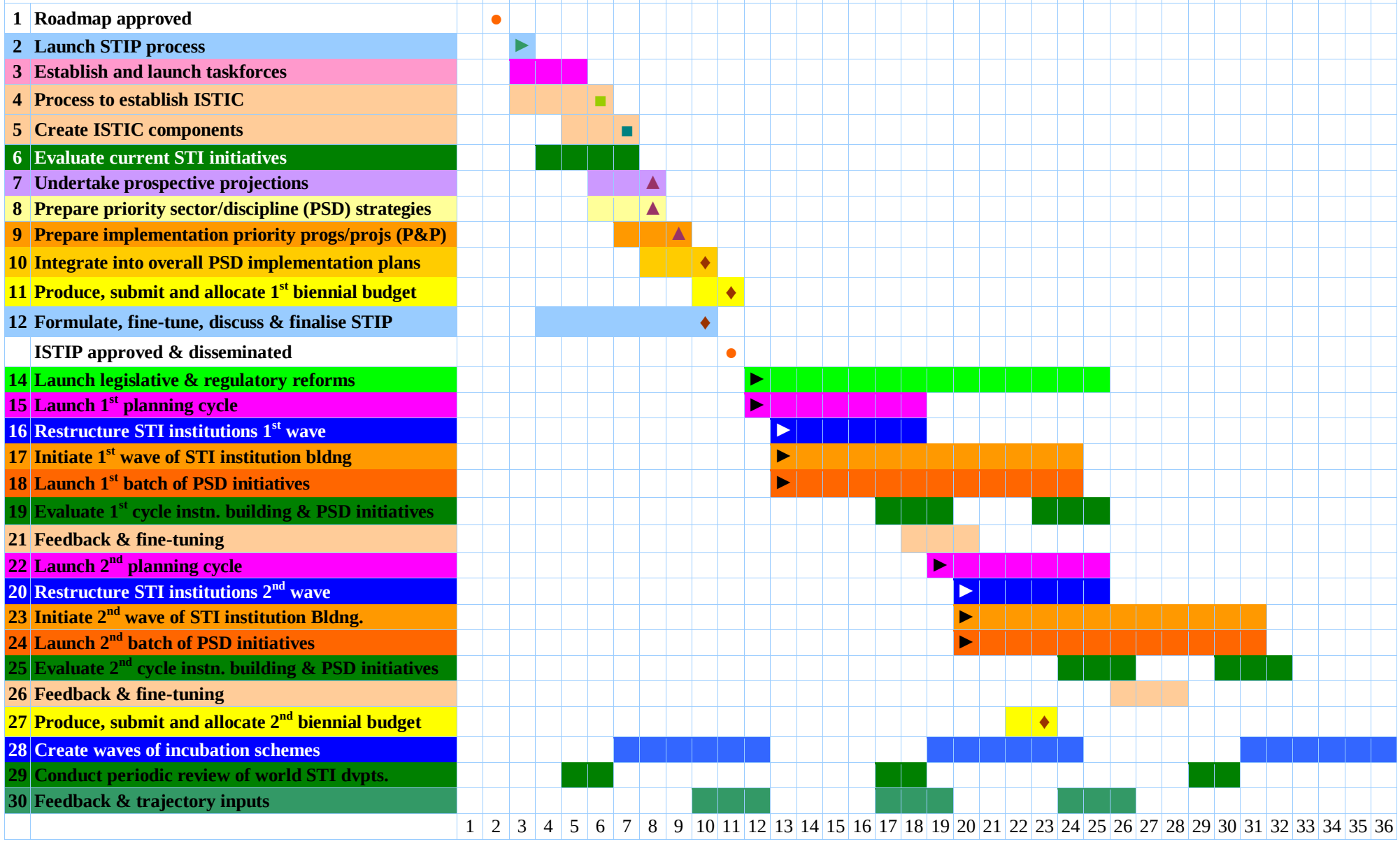
Regional leadership in technology commercialization	Establish core competency and infrastructure in technology commercialization	• Assess gaps in regional capabilities and formulate corresponding plans; • Develop national incubation, technology-based enterprise schemes, technology parks & CTREs; • Broaden venture funding options; • Strengthen technology scouting.	• Contributions to national and regional economic development; • Creation of new SMEs; • Increased capacity of innovation networks; • Growth in significant niche businesses; • Create an environment attractive to FDI.

Appendix V
Recommendations of the UNESCO meeting held during 12-14 December 2011

This meeting made recommendations firstly reaffirming the recommendation made as a result of the September meeting, with regard to the establishment of a supreme national commission for science, technology and innovation, linked to the Council of Ministers, charging it with formulation of a national science, technology and innovation policy and overseeing its implementation and calling for the preparation of a special law to regulate the above Commission's functions and submitting it for ratification.
The December meeting also called for accelerating procedures aimed at the establishment of science, technology and innovation centres and entities in line with recommendations made in the September meeting.
Importantly, the December meeting also recommended that concerned authorities adhere as closely as possible to the timeline proposed in the Roadmap submitted for its consideration.
Other recommendations of the December meeting were intended with view to:

- implementing programmes aimed at enhancing the capabilities of researchers based on specialised continuous training in all aspects of scientific research, including research methodology, effective research project formulation, supervision and management as well as research leadership and evaluation;
- continued emphasis on study abroad with priority accorded for PhD courses of study, while allocating greater interest to sending high performers among graduates of secondary schooling to study abroad
- stronger links between higher studies undertaken in Iraq with research undertaken in established research centres abroad;
- rationalisation of the research system in Iraq and encouraging technical education;
- adoption of competitive employment and promotion policies, and selection of research leaders on the basis of merit and the need to establish adequate and comprehensive capabilities within research teams;
- encouraging joint research collaboration through the establishment of specialised networks, benefiting from expertise abroad as well as expertise brought back by students and professors returning home following courses of study and research abroad;
- encouraging dedication to research duties among university lecturers and staff as well as research collaboration and cooperation with universities abroad and with the Network of Iraqi Scientists Abroad (NISA), with view to enhancing research quality and benefiting from accelerating development in science and technology;
- disseminating scientific research culture and the transfer of and adaptation of technology and innovation, based on modern methodologies, through specialist seminars, workshops and conferences as well as various walks of life and institutional settings, including schools;
- supporting collaborative research through adoption of novel finding approaches that encourage such collaboration among various research institutions;
- introducing novel sources of funding;
- establishment of scientific research, technology development and innovation parks and oases as well as centres for teaching and research excellence;
- organising special workshops to disseminate novel strategic planning methodologies, including SWOT techniques and quality assurance in scientific research;
- adopting a strategic national project in support of rebuilding the country's economy, based on allowing graduates access to easy loans to establish industrial and agricultural businesses that make use of scientific research results;

- establishing centres for science, technology and innovation enterprise incubation centres through cooperation between universities and major institutions concerned with creation of job opportunities;
- creating specialised units to undertake planning and monitoring of scientific research activities within research centres established by MoHESR as well as other concerned ministries;
- establishing a national centres for prospective and futures studies.

Appendix (VI)

Proposed timeline for implementation of the Roadmap