

REVIEW SCIENCE AND  
TECHNOLOGY CAPACITY AND  
POLICY OPTIONS IN BRUNEI  
DARUSSALAM

June 20<sup>th</sup> – July 1<sup>st</sup>., 2005-06-30

# **UNESCO MISSION TO BRUNEI DARUSSALAM TO REVIEW SCIENCE AND TECHNOLOGY CAPACITY AND POLICY OPTIONS**

## **Background:**

The Ministry of Development, Brunei Darussalam holds responsibility for overseeing the nation's science and technology (S&T) effort. The country's Eighth National Development Plan (2001 – 2005) makes explicit reference to the role of S&T in underpinning development but does not explicitly outline structures or processes for such achievement. In the lead-up to the Ninth National Development Plan the Ministry's Department of Research and Development, has been exploring options for developing a more strategic approach to S&T. A particular focus of their efforts are the development of a policy strategy to underpin national development in the priority sectors and 'clusters' currently being promoted through the Brunei Economic Development Board.

The Department's concern is that S&T Policy should aim at applying science, technology and innovation to develop and strengthen R&D primarily in the 6 promoted sectors where applicable, by focusing on key areas for policy action. These include establishing platforms for the development of 'enabling technologies', improving infrastructure services, improving higher education in science and engineering, promoting business activities in science, technology and innovation, and improving the general S&T policy environment.

Targets for policy development include:

- generating new knowledge through support for R&D;
- Increasing funding for R&D;
- Using research to create spin-off firms;
- Development of capital formation projects such as technology parks and business incubator facilities;
- matching education, employment opportunities and immediate and future manpower requirement in knowledge-based industries.

## **TOR for the Consultant**

The consultants were required to liaise with the Research and Development Unit of the Ministry for Development to gather information from interviews with key policy maker and drawing on experiences within the OECD and ASEAN prepare an analytical report that would:

- Identify key areas and policy issues;
- Identify areas of expertise, skills requirements and man-hours required to formulate S&T Policy;
- Prepare the TOR of the experts;

- Prepare a comprehensive project proposal that could be submitted to His Majesty's Brunei Government for consideration.

Two consultants were commissioned by UNESCO: Professor Tim Turpin, University of Western Sydney and Professor Jane Marceau, University of Technology, Sydney.

## **Activities**

The consultants completed a mission in Brunei from June 19 to July 1<sup>st</sup>. A series of discussions were held with Offices of the Research and Development Unit. These discussions were used to identify contemporary issues, collect current data and policy documents of relevance to the task.

- Meetings were held with a range of Government officials, Ministers and Deputy Ministers, higher education representatives, industry and professional groups. The schedule of meetings is attached as Attachment One to this report.
- Toward the end of the first week the consultants presented a summary report to the Research and Development Unit summarising issues and emerging options. This served to guide further information collection during the second week.
- On June 30<sup>th</sup> the consultants presented the Research and Development with an overview of the proposed report and recommendations. At this meeting it was agreed that the consultants would prepare a draft report which would be sent to the Research and Development for comment.
- A draft report was sent the Research and Development for comment on June 17<sup>th</sup>. After receiving some feed-back on this draft the consultants prepared a revised draft. The revised draft *Creating Brunei's future: science, technology and innovation development in Brunei* is included in this report to UNESCO as Attachment Two.

## **Recommendations**

It is recommended that UNESCO submit the Draft Report *Creating Brunei's future: science, technology and innovation development in Brunei* to the Ministry of Development for their consideration and future action.

## Attachment One: List of Meetings and Round Table Discussions held June 20 to July 1

Date	Agency	Contact
Mon 20 <sup>th</sup> am	Ministry of Development	Eddies Sunny and Rosita
Mon 20 <sup>th</sup> pm	Institute of Technology Brunei (ITB)	Acting Director, Dr Haji Kassim Bin Haji Daud, and round table meeting
Tuesday 21 am/pm	Ministry of Development	Eddies Sunny and Rosita
Wed. 22 am	Perm. Sec. Ministry of Development	Matassan MD Daud
Wed 22 pm	Brunei Economic Development Board	Hj Murni Hj Moham, Dep Chief Exec. Officer Planning and Coordination
Thurs 23 am	University of Brunei Darussalam	V.C Dr Haji Ismail Bin Haji Duraan Dean of Science Dr Zohrah Haji Sulaiman Dr Tan Kha Sheng and others
Thurs 23 pm	Dep Minister of Development MoD.	Data Paduka Dr Mat Suny
Sat 25 pm	Ministry of Education	Dr Omar Hj Khalid
Mon 27 am	Ministry of Development	Eddies Sunny and Rosita
Mon 27 pm	Brunei Shell Petroleum (BSP)	Asset Director Hj Salleh-Bostaman Bin Hj Zainal-Abidin and Technology Manager
Mon 27 pm 2	Brunei Liquid Natural Gas (BLNG)	MS (Said( Ahmend – Senior General Manager.
Tues 28 am	Dept of Technical Education	Ms Jennifer Hiew Lim and others.
Tues 28 pm	Minister for Development	Pehin Orang Kaya Hamzah Pahlawan Dato Paduka Awang Haji Abdullah bin Begawan Mudim Dato Paduka Haji Bakar
Wed 29 am	Ministry of Industry and Primary Resources	Head, Industry Promotions Unit Pg. Metali bin Pg. Hj. Damit; Agro Technology Dev. Division, and

		Brunei Agric. Research Centre, Pg Hajah Rosidah Binti Pg Hj Metussin and others. – Forrestry and Fisheries.
Wed pm	Ministry of Industry and Primary Resources	Permanent Sec. Mohd Hamid Mohd Jaafar
Wed Pm.	Prime Minister's Dept, Department of Economic Planning and Development (JPKE)	Hajah Rosini Haj Tungkat
Thurs. am	Ministry of Industry and Primary Resources: Deputy Minister	Hamdillah Wahab
Thurs. pm	University Brunei Daussalum Dean of Research	Dr Harinah
Thurs pm	Ministry of Health	Dr Yussof Hamba Senior Official

## **Attachment Two: The Report**

# **DRAFT**

## **CREATING BRUNEI'S FUTURE: SCIENCE, TECHNOLOGY AND INNOVATION DEVELOPMENT IN BRUNEI**

### **1. INTRODUCTION**

Innovation is internationally recognized as the key to long-term competitiveness for OECD nations as economies shift towards a greater reliance on knowledge of many kinds for the development of their economies. Innovation, which critically involves science and technology but also organisational and process changes, is now at the centre of policy attention in OECD countries and developed economies in the Asian region.

Successful innovation depends on a package of activities – product development, process upgrading and organizational change and the skills of the workforce at all levels, from managerial to shopfloor. Overall, Brunei will continue to rely in good part on inwards investment for its future and in an era of global activity and reliance on innovation as a major strand of competitiveness, companies will increasingly see the availability of innovation-related skills as a critical component of their investment decisions. Innovation, whether generated through Foreign Direct Investment or by home grown entrepreneurial activity, depends to a considerable extent on science and technology in the development of new products and processes. Some of this scientific knowledge is embodied in machines which can be imported but much depends on the local development and use of new scientific and technological knowledge. If Brunei is to remain competitive it must ensure both that initial, upfront, education and training are available and that lifelong learning opportunities are promoted in scientific and technological fields relevant to the areas chosen for priority development and to keep abreast of international changes and the development of new products. It must further ensure that a high level research capacity is developed and maintained, in areas selected as national priorities in particular.

As the Brunei economy develops over coming years, both in manufacturing and services, more investment in science and technology and in the skills for innovation will be needed. All sectors of the economy, whether 'old' or 'new' will need to raise the skill levels of employees, whether shop floor, white collar or managerial, scientific or professional, and to do so continuously over time. New jobs will require new skills, perhaps in fields which are only just emerging, such as the science-based bio- or nanotechnology which have the potential to transform the operations of many enterprises, or in the materials on which new dies for manufacturing are based as well as in new financial products and services, especially for the export market.

Nor is innovation related only to manufacturing or engineering-intensive fields. Services, which may provide a further basis for the future economic prosperity of

Brunei, are now innovation-intensive. Science and technology are also involved in these. People with high level mathematical skills are needed for the development of new financial products and tourism, notably eco-tourism, may depend on the skills of people trained in biological and environmental sciences to underpin the development of sites and visits which are of international quality and which can broaden the experiences available over time, for example. Each field will need to develop assessments of what is needed and how to obtain the skills identified. To gain jobs, the local mix of people, skills, institutions and infrastructure resources is critical for it is local resources that underpin the capacity of a country to compete in increasingly demanding international market places in all sectors of activity.

Brunei has been very successful in developing literacy levels in the population which are now very high. That is an excellent basis for further development. Moreover, Brunei has given formal recognition to the need for investment in science and technology. In its eighth national five year plan, the government placed considerable emphasis on the role of science and technology (S&T) in underpinning economic and social development. That plan sketched out how, through the years 2001-2005, the 'integration of science and technology in people's life and employment' would serve as an '...indicator of advanced development' (Eighth National Development Plan 2001: 5).

A number of steps were proposed for expanding the national S&T capability. These included: increasing the proportion of science students in upper secondary schools; upgrading equipment in primary and secondary schools; retraining teachers for the delivery of maths and science education; providing incentives for students to undertake science and professional qualifications; increasing the capacity of technical and vocational institutions to overcome a shortage of vocational workers; and providing students with information on career opportunities, 'particularly in the field of science and technology (8<sup>th</sup> Plan 2001: 60). These initiatives clearly represent awareness of the need to build a broader S&T base for Brunei's economic development but no course of action was set out for implementation and there was no clear strategy to guide, coordinate and evaluate progress in the S&T field across public service portfolios.

In order to stimulate growth and demand the government has set in place a strategy for diversifying the economy and relying less on the production and sale of oil and gas. The Brunei Economic Development Board, established in 2001, has developed a two pronged approach to diversifying the economy. Firstly, a concerted effort is being directed toward attracting foreign investment to develop the manufacturing and service sectors. The second part of the approach concerns the identification and support of industry clusters. The government recognises the need to strengthen the countries S&T capacity in order to provide a platform for a diversified industrial competitive edge in a small number of key areas. But a coordinated strategy, across government, for achieving this is yet to be developed and currently Brunei has very little demand in the non-oil and gas sectors for the employment and career progression of scientists and engineers.

### ***Global Development in S&T***

While Brunei has been seeking to strengthen its S&T base for development global trends in the relationships between science, technology and industry have also been

undergoing change. This introduces new challenges but also new opportunities. For Brunei, it is important to ensure that measures are introduced that can deal with the broader global trends in science, technology and industrial development in the unique economic and cultural context that characterises the country today.

As nations endeavour to maximise global competitiveness they have increasingly sought to strengthen what have come to be called their *national systems of innovation* (NIS). It has become clear through OECD and other international analysis that countries do better economically if their innovation institutions work well together so as to maximise investments (see eg OECD 1997 and 1999). The elements of innovation systems include all science, technology, training and educational organizations but also labour market rules, governmental regulatory systems, such as those concerning the protection of intellectual property, and the kinds of bureaucratic and contractual practices that make the creation of businesses easier and the provision and functioning of intermediate organizations that ensure the rapid diffusion and uptake of new knowledge.

The term 'innovation system' came from analysis of the success of Japan in the 1980s and later the Republic of Korea, Singapore and Taiwan made great use of this approach to drive their impressive economic performance through the 1970s, 80s and early 90s. In parallel, the less developed economies of the region looked towards these successes, observed that most scientific and industrial capability was concentrated in industrially developed countries and responded by building national science and innovation institutions of their own in order to gain access to and contribute to global science.

Under the stimulation of a market place that since the early 1980s has been increasingly hungry for leading edge scientific breakthroughs, the way that scientific knowledge is constituted and used has also been moving rapidly, not only in pace, but more fundamentally, in *kind*. In many leading edge scientific fields it is now relatively difficult to distinguish between basic and applied research, as the basic research problem may be set within industrial application parameters, as for example, in biotechnology and electronics. The practice of research has become increasingly multidisciplinary, while those who could best put together teams across a range of disciplines and capitalise on flows of tacit as well as formal knowledge have been able to find integrated solutions to key research and industrial problems. Much now depends both on institutions and the presence of complex webs of personal relationships across institutional and national boundaries. Coordination in the search for new knowledge and in its diffusion has become critical and all countries need to tap into global science as almost no single country has the resources to reach cutting edge levels in all relevant discipline and inter-disciplinary fields. A national science, technology and innovation system needs to be structured so as to participate as effectively as possible in global knowledge creation and diffusion networks. This is particularly important for economies making a 'transition' to a new economic base.

The 21<sup>st</sup> century now presents an industrial landscape dominated by strategic networks. These networks draw together skills and knowledge about science, technology, products, services and business systems into 'innovation webs'. Key actors in the networks include firms, research institutes, training institutes and other knowledge intensive institutions such as universities and hospitals. The innovation webs are constantly changing as the dominant players make decisions as to whether to expand or reduce access to the networks, whether to open entry to new members or to

‘pull up the drawbridge’. But most significantly these innovation networks transcend national boundaries. In this context strategies for gaining and maintaining access to human resources for key technologies *in global demand* need to be collaborative rather than competitive.

Science, technology and innovation policies in Brunei Darussalam need to align with these developments. The new order is about the mechanisms and modes through which knowledge is produced, transferred, adapted and applied to generate successful innovation rather than science and technology as such. It is in this global and local context of transition that UNESCO has supported this preliminary review of S&T capacity in Brunei.

## **2. AIM OF S&T IN BRUNEI’S DEVELOPMENT**

As Brunei moves toward the implementation of its Ninth National Development Plan, the economic objective is growth through diversity. Currently oil and gas comprise around 90 per cent of exports and account for about 40 per cent of the country’s GDP (Brunei Economic Development Board 2003: 9). The government’s economic diversification program has targeted potential growth areas, including notably international finance, tourism, transport and logistics, ICT, halal food. The Plan also includes the development of selected oil and gas downstream industries which are currently under consideration.

If these areas are to become regionally competitive and sustainable they will need underpinning from a package of innovation programmes and investments for *creating Brunei’s future*.

Successful knowledge-producing and transmission institutions, including the national university, the institute of technology, hospitals, a small number of key enterprises, public private partnerships, and the production arms of government, including major utilities, are already in place. In contrast, there is limited cooperation between some of these organizations, and no comprehensive strategy to invest in and draw collectively upon the strengths of these organisations to underpin a concerted national innovation effort. One of the challenges for the future is to develop the mechanism for achieving this.

### ***Five key tasks***

1. The first is the building of a carefully targeted *national program for investment in research and innovation*. Experiences elsewhere have shown that small countries can achieve international competitiveness in some areas providing there is a science and technology base to ensure sustainability and continuing innovation. In Brunei’s case, the aim will be to identify areas for research investments and developing a strategy to ensure the knowledge benefits can flow along the value-chain.
2. There is a need to establish a *coordinated a science, technology and innovation strategy* across all arms of government in order to underpin programmes for national development with current and potential national S&T and innovation capacity.
3. Brunei is a small nation with a resource-based economy, currently dominated by oil and gas, and seeks to diversity as well as build further on these

resources. In a small country in particular it is critical to build policy and institutional mechanisms to maximise the potential of organisations and personnel to work collectively to build a national science, technology and innovation platform. This will require developing programs that can *draw together teams of experts across a whole range of organisations*.

4. The new order of science and technology relies heavily on the parallel inputs of the physical, life and social sciences. Indeed, the priority sectors already identified for promotion, require strong input from the social sciences as well as the managerial and natural ones. The mechanisms for *creating Brunei's future must include building on the best of the country's science and social science capabilities*.
5. The fifth task is to establish a system for *monitoring and evaluating progress through an agreed and appropriate set of science, technology and innovation indicators*. Given the predominance of the public sector in Brunei, in diversifying the economy the government must make significant investments in carefully targeted programmes. A country the size of Brunei cannot afford to make such investments without setting in place a system for monitoring and evaluating the results. There already exist some appropriate regional and internationally comparable indicators and these need to be adopted and adapted to Brunei's situation as it develops.

### **3. BRUNEI'S KNOWLEDGE ASSETS**

#### ***a) The University***

Brunei has a university that in 2003 had around 3446 enrolled students, the great majority at undergraduate level. Almost all these students study full time. The faculty of Science had 502 students enrolled in 2003 but over half of these were studying for the Bachelor of Science Education and a further 75 were preparing the Bachelor of Education (General Science). Many were thus not studying a scientific discipline per se. There were 58 students enrolled in Maths/Computer science, with a further 11 in the Bachelor of Science (Computer Science) and 30 in the Bachelor of Engineering (Electronics and Electrical). There are several departments in the natural sciences but several departments, including notably biological sciences and computer sciences field, are relatively new and had not yet graduated any students by 2003 (last year data available to us). There is one clear area of excellence where a Chair has been funded by Brunei Shell in petroleum/ geoscience and that department now runs Master degree courses (20 enrolled students) and in 2003 had three doctoral students. Interviews with the Asset Manager of Brunei Shell and a very senior manager at Brunei Liquefied Natural Gas suggested that the standard of the students on graduation is very good.

The UNESCO team interviewed the Vice Chancellor, the Dean of Science and the departmental heads in physics and chemistry and another senior scientist. The team also interviewed the newly appointed Dean of Research and Research Training and arranged a further meeting which unfortunately fell through. We did not meet any graduate students. The impression gained from the meetings was that the university can draw on well qualified and enthusiastic staff. The staff in the natural science sections in particular seem well qualified, mostly having gained a doctorate in a well

respected university outside Brunei, usually in the UK or North America. Scientific equipment does not seem a major issue. The university staff have several international links. The main international links for the university are in the UK and Canada, with an agreement with the University of Queensland underpinning the recently created medical school (Institute of Medicine). The degree courses in engineering (computer science) and biosciences are linked with universities in the UK and Canada.

Many staff are formally qualified to conduct research and supervise graduate students as they have obtained doctorates. The amount of research, and its quality as measured by international peers, is less clear as there has been no overall audit. The number of publications in ISI science journals is quite low, on average around 30 articles per year between 1990 and 2005 (see ISI Web of Science). In the research area, there is some interaction between the university and government and industry and government sponsors some research undertaken by university staff. The Vice Chancellor confirmed that the university itself has some research funds but the amount remained unclear to us.

The university has a Field Studies Centre at Kuala Belalong which has an international reputation and could develop this further as a centre which contributes to the development of one or more of the clusters selected as of national priority.

### ***b) The Institute of Technology***

The university campus also hosts the Brunei Institute of Technology (ITB). The Institute had 631 students in 2003 studying for HND and HNC courses. It is not clear how many are studying full or part time. Of the HND students, 145 were studying business and finance subjects, while 64 were in computing, with a further 90 in communications and computer system engineering and 50 in information studies. An additional 70 were in civil engineering and 81 in mechanical engineering. Most students have reached the Institute via the technical and vocational education stream but there is now a push to obtain the 'better' students graduating from the general secondary school system. Many of the students seem to be older than those in the university, with 167 students over the age of 25 in 2003. As there were only 52 under the age of 20 at that time, the age distribution suggests that students may have gone there when their other options had been exhausted. It may mean that many students are part time and study while working but it was suggested to us that this is not the case.

ITB trains students up to the British Higher National Diploma (HND) level, with some students graduating at the lower level Ordinary National Diploma (OND) level. The Institute has also established a degree course in computer engineering in conjunction with the Queen's University, Belfast. Many students at ITB do marketing and commerce-related studies but these are not linked to the science stream and not to similar studies in the university. Some research is being conducted by ITB staff, especially in the field of sustainable housing.

### ***c) Research in the government sector***

Several Ministries have research capabilities. The Ministry of Industry and Primary Resources funds and oversees the work of three rural industry research institutes. The most active is in agriculture/horticulture which is focusing on tissue culture for orchids, wild fruits and seed testing and rice for Brunei conditions as well as biotechnology for bananas, research into local mushrooms and similar areas of

interest. It is assisted by the arboretum in Temborong. The Forestry Institute does no R&D. The Fisheries Institute focuses on testing activities related mostly to aquaculture and verification of technology on the fish capture side. The Ministry has just approved 15 further staff for these institutes and is creating an accreditation centre for all labs in Brunei.

The Ministry of Development has an R&D Unit which is not focused only on R&D and has a broader monitoring role for projects carried out elsewhere in the Ministry. In 2005 it awarded research funding to projects proposed by staff in the university and ITB. This Unit presently has some of the capability needed to serve a broader role in the development of Brunei's S&T and innovation platform.

The Ministry of Health and the university are creating a Medical Institute but this so far has only a medical sciences focus and is not a research institution and currently remains only partially developed. Nurses are trained in Brunei but senior clinical personnel are all trained either outside the country or (now) in the new program operated jointly with the University of Queensland. The medical laboratory undertakes pathology tests. No medical research is undertaken. The Ministry also has a public health laboratory.

Very little public sector research and training related to the clusters and other priorities identified for Brunei's future growth in the 8<sup>th</sup> Plan is underway. *We recommend that urgent attention be paid to this issue. We further recommend that attention be given to the potential for medical research and eventually of spin off firms from that research or from the needs of clinicians.*

#### **d) The school system**

Brunei has achieved very high levels of literacy through concerted investment which has involved the university in a very considerable focus on teacher training. Now seems to us to be the time for re-investing in the school system as the basis for the development of the skills needed for the innovative and diversified economy Brunei is aiming for.

The education system is organised as a structure of six years of primary education and five plus two years of secondary school. There are several critical transition points along the way. The first occurs in primary education year four when the predominance of teaching in Malay changes to a predominance of teaching in English. Many children apparently have difficulties at this point. The second is the transition to secondary school in year seven of education and after an examination in five core subjects at the end of year six. If children fail any one subject they fail the examination and will usually not make the transition to the secondary school until they are proficient in all subjects. Presently, we were told that overall 15-20% fail first time but that this proportion is much higher in rural areas. This means that many are considerably older than their peers when they enter the secondary system. There is no system for children with special needs. Most children will then remain in secondary schools and study for their 'O' level and 'A' level examinations. 'O' level is taken after year five. At that point about 30% take at least two science subjects. The proportion taking a science at 'A' level is not clear but is thought to have dropped somewhat recently.

After three years in secondary school children take a further examination. At this point perhaps 20-30% of children enter the vocational education system (there are

apparently no definitive figures). They then spend time in vocational schools before entering ITB to study for OND and HND diplomas or going out into the labour market. In 2002 there were almost 3000 students in the technical/ vocational system, the great majority between the ages of 17 and 23.

Consideration is being given to broadening the curriculum in 2008. A broader curriculum with a more extensive range of possibilities for examinations may encourage more students to stick with science at school and hence have the choice of studying science at further and higher education levels.

Unfortunately, at present retention rates from year one to the end of high school are not known.

There are seven technical institutes and currently efforts are being made to strengthen the technical side of secondary education. The technical and vocational education system is aligned with the priorities in the current Plan where transport and logistics (mainly aircraft maintenance) are concerned while there is a taskforce considering the needs of hospitality and tourism (the proposed Brunei hotel school never took off) and one working on the training needs of business services in which vocational education is involved. Industry is involved in program advisory committees. Given that the construction industry is such a big employer in Brunei, it could be useful to train further this field. It is not clear how much vocational curricula are currently focused on innovation and innovative technologies. There is now an institute for management training.

## **4. KNOWLEDGE DEVELOPMENT ISSUES**

### ***a) Higher education***

The university in the past has been at the service of the country in focusing on training teachers for the primary and secondary education levels.

#### **The university's mission**

The past orientation to the secondary education sector raises the first issue concerning the university and the contribution that it can make to the development of Brunei. The university seems to have fulfilled the teacher education role well but now is seeking a broader mission. It is currently not clear what that mission is. The people we interviewed suggested that they do not know what is the best direction for the future and especially that they are not sure now what the government wants them to do. This was especially true for staff who are or would like to be undertaking research.

The university needs to have a clear mandate, approved by the government and well understood by staff at all levels. The expected relationship between teaching and research activities needs to be clarified and funding adjusted accordingly. Clear performance measure need to be agreed and set in place.

The university has a ten year strategic plan and we recommend that this be reviewed in the light of the national priorities to be selected.

## **Funding and administrative arrangements**

The university and ITB are funded principally for teaching, although some staff in each institution are undertaking research. Budgets are line-item and very specific. Making changes as the year progresses seems to be difficult and there is not enough flexibility to make ordinary academic decisions smooth and fast. Difficulties arise when making even small changes in budget priorities and in executing research projects.

More importantly, the two institutions are funded and treated administratively as extensions of the Ministry of Education. This means that the Vice Chancellor of UBD and the Director of ITB are appointed by the Minister and transferred from their existing posts in the Ministry as part of a government service career path. While the personnel thus chosen may be excellent, it may also be easier for the VC and Director to focus on the specific needs of their institutions if they are selected by those institutions and are able to follow a career path that takes them through different academic and academic administration career paths as there are significant differences between administering an Act and strategically developing an academic and training institution, let alone trying to build a significant research presence from a low base.

*Attention needs to be paid the funding and administration arrangements for both UBD and ITB so as to smooth the funding arrangements and make them more compatible with the functioning of teaching and research institutions. Consideration needs to be given to the procedures for selecting the academic leaders of both ITB and UBD and to the focus and conditions of their role.*

Funding differences between disciplines may be needed since science subjects are much more expensive to teach and research.

## **International linkages**

Both UBD and ITB currently have international academic linkages, mostly with the UK and Canada. These have served them well in the past and enabled them to create new degrees, such as the new chemical engineering degree under development with the University of New South Wales, in collaboration with their international partners. Now, however, it is difficult to see the justification for some of the selections made in earlier days and it may enable faster growth and more efficient and broader research options if these partnerships are made more strategic in terms of current needs. It is important that once choices of direction for the expansion of both teaching and research have been made, the international partnerships selected reflect these specific choices. They should, for instance, enable high level graduate teaching to be commenced and developed quickly in line with the needs of Brunei as defined by the government in partnership with the university and ITB. Similarly, they should reflect the best choices for the development of new and emerging research directions. This may mean that partnerships should be developed not with institutions as a whole but with the elements of the institutions selected that are best suited to furthering the concerns of particular courses or particular research projects or programs concerned.

We recommend therefore that, once the choices of direction and priority have been made, specific partners be chosen and arrangements be developed that will have the most benefit for the teachers, students and researchers concerned. Ease of access to major items of equipment and to top researchers and sharing of some elements of common interest may mean that partnerships within the Asia Pacific region usefully

be given priority. There could be the expectation that the relationships be local and a special case be made out for links with organizations further away.

## **Research development**

Institutional arrangements for the regular and systematic funding of research are everywhere critical to the rapid development of research within universities and similar organizations and to the development of desired foci for research activity.

Within the university, some research funds are also available and it seems that around 20 research projects are currently underway in science fields (we do not know the direction and scale of these projects but there is some suggestion that since the funding is small, the scale is also small). *It is important for the University to set in place a transparent system of assessment of applications for research, including a committee which manages the funds, receives applications and decides internal priorities and operates as the basis of the internal review system.* The committee should be composed of active researchers, possibly using an external review system if there is insufficient local expertise, and the results of grants awarded should be closely monitored. The committee should be chaired by the Dean of Research and Research Training. The Committee should decide on the scale of projects it can fund and assist academic researchers to find complementary sources of funding. The emphasis should be on applying for international funding, in partnership with regional research partners where appropriate. The university could see itself as seed-funding projects which can then achieve greater funding from external sources.

The University's research-funding pool could be shared with staff at ITB who are research-active and the same committee could then undertake the assessments and management of the funds concerned.

In determining the elements and directions of the research-funding system, it is important that there be full involvement of research-active staff so that confidence in the system is established and maintained. It is similarly important that an explicit balance be sought between encouraging a broad range of research endeavour and focusing on selected fields and on building critical mass. This is a difficult balance in any country and an especially difficult one in a small country with few human resources. This is why it is critical to build international partnerships so that Brunei can develop expertise in many fields as well as bring researchers to the leading edge in selected areas.

Some Ministries also have research funds, notably those which have recently been distributed via the R&D Unit of the Ministry of Development, but the scale of projects these can currently fund is also small.

Academic staff also require time to undertake research. Research in most countries is often carried out during periods of sabbatical leave and/or as a condition of workload agreements which may include specific periods of time for research, such as the third and fourth quarters of the 'quarter' system in place in some institutions in the USA or as a weekly allowance of hours. A variant of the sabbatical leave common in other countries has recently been introduced but it seems to be more a system of leave without pay than the funded sabbatical leave common elsewhere. If that is the case, we recommend that funding for such research leave be put in place and that attention

be given to workload agreements which recognize the time spent on research and publication activities and teaching of post-graduate students.

A system of funding for staff to upgrade their skills through preparing a doctorate outside Brunei is also in place and the university is apparently trying to increase the number of staff taking up this option.

### **Laboratory equipment**

Most modern science depends critically on the availability of up to date equipment (Irvine et al. 1997). In Brunei, funds for such equipment seem to be available but since priorities for research have not yet been established investments in relevant equipment have not been systematic. Moreover, there seem to be few arrangements in place for the sharing of equipment through co-location of staff and joint decision-making about what is needed and by whom. Given that staff at both ITB and UBD are research-active, consideration needs to be given to ensuring that equipment purchases are of maximum value and are located to ensure ease of access and management for all interested Brunei researchers. There are also government research organizations, notably in agriculture and fisheries, that could benefit from such equipment and so upgrade their research activity and overall capability. Ease of access for these researchers should also be taken into account.

*We recommend therefore that consideration be given to creating a common government laboratory which could provide convenient, well-funded and maintained instrumentation for all Brunei's scientists and research students.*

### **Higher education capacity**

The two institutions of higher education in Brunei, UBD and ITB, are small in terms of student numbers and each could benefit from developing new areas of teaching and research. Numbers of undergraduates in the areas of science taught remain small to very small and there has been no attempt as yet to link the directions taken in the National Plans with the development of capacity in these two important organizations. Biological sciences are those which are receiving most attention internationally and could be especially useful in Brunei which has still much to do in terms of understanding and managing its ecosystems and its animal and plant activities. The government has two or three small research institutes in the biological field but these seem to focus on testing and little attempt has been made to link them to the university or ITB or even to the directions selected for development in the Eighth Plan. The university has only recently established a school of biological sciences and as yet has no department of botany or zoology. There seems therefore to be a 'mismatch' between the needs of the nation and the trends in and speed of development of the two higher education institutions.

*We suggest therefore that consideration should be given to devising a strategy for developing much faster in the areas of priority selected for both ITB and UBD and for funding a much greater number of student places in both institutions. ITB told us that they have a waiting list of 200 qualified students for their HND courses (which may have come about as the university has raised its admission requirements). Those students have no other options and their large number relative to the age group of*

qualified students suggests that Brunei is currently facing a significant wastage of the human resources needed for the diversification of the economy and the further development of the science and knowledge base which could ensure the future of the country.

### **Position of UBD and ITB.**

UBD and ITB are co-located on the same campus but seem to operate largely separately, although there are cases of consultation between them, especially in relation to the development of an engineering degree course. While both institutions have separate missions as currently expressed, the interviews we conducted suggest strongly that ITB is following a path which will bring it closer to university operations – the degree course in computer engineering is just the first step in this process.

While there may currently be differences in the qualifications of staff in the two institutions, at least some staff in ITB conduct research and see that as part of the mission of the institution. The number of people in Brunei is so small that we feel that there should be no risk of overlap and hence waste of resources in strategy and practice between UBD and ITB.

*We therefore suggest that urgent attention be given to consideration of linking ITB much more closely to UBD – incorporation as a semi-independent college of the university, with staff on joint appointments and students undertaking joint degrees or diplomas where relevant and with common access to research funding could be one possibility.* The status of ITB would be enhanced and students given more than one pathway to their future. We understand that a similar suggestion has been made before by a consultant and indeed that there may be discussions of this issue currently in progress.

There seems to be some current consideration of whether or not there should be a second university, more specialised in the sciences and technology. Whether or not the decision is taken to create this university, the same investment will be needed in additional staff, student places and equipment.

The Minister of Education currently chairs the Council of the university and the Deputy Minister is the chair of ITB. These arrangements should be re-examined as part of consideration of the relationships between the two institutions and their administrative structure.

### ***b) School system issues***

It was suggested to us that further development is needed in science and technology laboratories in schools and that teachers may need retraining in more student-oriented, hands-on science teaching if the number of students attracted to and developing skills in science and technology in particular is to rise substantially. Action also needs to be taken to ensure that students from all areas of life in Brunei receive the same opportunities to benefit fully from education and thus are able to contribute fully to the shift in the Brunei economy to one which maximises the use of knowledge as a competitive tool. We understand that the curriculum is to be reviewed in coming years.

*We suggest that the review of science curriculum and teaching methods be undertaken as soon as practicable. Reviewers should include both the university and the technology Institute.*

## **5. FURTHER INNOVATION-RELATED ISSUES**

A skilled labour force and the maximisation of the skills available are critical to innovation in both public and private sectors. Brunei has major issues with respect to this.

### ***Labour Force Issues***

The government sector is by far the largest employer in Brunei. Public administration and education alone accounted for some 34 per cent of the workforce. If health and other community/social and personal services are included the proportion is over 40 per cent of the total workforce. The next largest employers are manufacturing (which is expected to decline sharply in the near future as it is mostly in garment manufacturing and will be adversely affected by the end of the Multi-Fibre Agreement), construction and retail, each at around 8.7 per cent of the workforce.

While oil and gas (mining) is by far the biggest revenue earner (88 per cent of all exports), it employs only 3 per cent of the workforce. This is a comparatively knowledge-intensive sector with more than half of those employed either professionals or technicians.

The number of workers in Brunei with a university degree or diploma at the time of the last census was 10,711 or 7.3% of the workforce. These ‘highly skilled’ workers are heavily concentrated in two main areas: education (28%) and public administration (27%). In mining, construction and manufacturing, only 5.9 per cent, 5.3% and 3.5% of the workforce have a bachelors degree or above.

Because the government is the largest employer and employing across almost all sectors, to some extent, over 60% of the highly skilled are employed directly or indirectly in government or education/community services. While this does not differ remarkably from many other countries, there are three important factors that are different in Brunei.

*First, the proportion of the workforce with a bachelors degree or higher is comparatively low.* According to OECD figures, in Australia, Denmark, Iceland and Korea, 20 % of the 25 – 64 year old population hold a bachelors or advanced research degree (see [OECD.org/edu/eag2004](http://OECD.org/edu/eag2004)). In Brunei, as shown above, the proportion is 7.3%. The data for Brunei on this indicator refers to the *proportion of the workforce* rather than the *total population* aged 25 to 64 so the difference between Brunei and the other three countries is all the more stark. That is, if the OECD data were presented as a percentage of the *workforce* rather than the *total population* aged 25-64 then the indicators for those countries would be significantly higher.

The Table in Appendix One presents comparative data for Brunei and Australia showing the proportion of the total workforce in selected industries with a bachelors or higher degree. The difference between Australia’s and Brunei’s levels of knowledge intensity in many of the sectors is stark. Australia serves as a good OECD comparator because it is generally in the mid-to-upper range of OECD rankings on

educational data. *The issue for Brunei is that in order to stimulate continuing innovation there is a need to deepen knowledge intensity across almost all sectors but in particular in education, health, finance, mining and manufacture.* In the OECD countries mentioned, higher education is now a mass system and the proportion of graduates in the labour force is rapidly increasing. In Brunei, in contrast, we were told that only about 9% of the age group leaving school at the end of secondary studies continue on to further and higher education.

Related to this issue of skills is the second issue which differentiates Brunei from the other OECD countries mentioned above; the proportion of the population with science and technology qualifications. The OECD produces data on the proportion of the workforce aged between 25 and 64 years who have completed a tertiary degree in *an S&T field* (see Commonwealth of Australia 2004), Chart 68). Proportions with such qualifications in OECD countries range from 13 – 45 per cent, with most countries around the mid-to-high 20 per cent. Directly comparable data for Brunei are not available but those with a university degree in *all fields* only account for 7 per cent of the work force. People with another form of tertiary qualification represent an even smaller proportion. *A reasonable estimate, therefore, is that the proportion of the workforce with an S&T qualification in Brunei is, at most, somewhere around 8 per cent.* This is lower than any of the OECD countries (the lowest is 13%) and considerably lower than Iceland (42%) which has a similar population to Brunei.

Third, and more significantly for the longer term, is the very considerable dependence of the highly skilled for on-going employment on the oil and gas sector. Brunei's skilled workers may be directly involved in the oil and gas sector or depend on it indirectly because the public sector in which they are presently employed is almost entirely dependent on revenues raised from that sector (90% of all government revenue is now derived from these resources). *The comparatively low skill levels of the workforce and the reliance on oil and gas for private sector employment for those who are skilled present major challenges for transforming Brunei into a knowledge-intensive economy in many areas.*

## **6. BROADER SYSTEM ISSUES**

Despite the emphasis in the Eighth National Plan on science and technology, the Plan included no clear implementation strategy. At the end of that Plan there thus remain some important system issues which need resolution. These concern both the fast development of the science and technology which are an important part of innovation and the selection of national priorities for S&T effort and those concerning the efficient and effective administration of the S&T and innovation platforms put into place.

The first issue concerns institutional arrangements for maximising and developing investments in S&T and in innovation more broadly. This is a complex issue and has several components. These include:

- no operating Science Council or S&T investment co-ordinating committee linking ministries, industry and research organisations and hence
- no overall research policy or national priorities
- no research funding council (and hence no systematic funding stream for academic research)

- poor or non-existent collection and exchange of information concerning research/teaching strengths, knowledge inputs and outputs
- a current R&D Unit which is understaffed and insufficiently focused

The second issue concerns availability of reliable, consistent and internationally comparable science, technology and innovation data. At present various agencies collect some information. JPKE, for example collect census data and carry out labour force survey. Universities collect information on higher education and Ministries such as Industry, Health and Development collect information on their programs and target groups. So far there is not comprehensive national data base on S&T capability. The Research and Development Unit in the Department of Development has made a good start toward collecting national data. There is a need now to identify key S&T indicators appropriate for Brunei and implement a coordinated strategy for on-going collection, monitoring and evaluation of science, technology and innovation indicators.

## **7. RECOMMENDATIONS**

### ***Institutional arrangements***

#### **a) Research development**

Once they have recognized the importance of research to attaining national goals, most countries have set up a research-funding council with a dual mission: first, to fund and encourage research of the highest quality possible in local circumstances and second, to ensure that the needs of the nation as seen in the selection of national priorities for investigation. Australia, for example, has the Australian Research Council which is funded by the government each year over a rolling five year period. The Council uses a peer review system to sift applications made for funding and to ensure that the best are chosen. Specific criteria apply to the judgements made and a transparent process is followed. Such a process normally includes national and international research proposal reviewers and a local panel that weighs the proposed projects against each other and across disciplines. The extent of the budget is part of the government's decision-making about its own priorities. In recent years, there has been increasing emphasis on four national priority areas and projects which fall within those received 'bonus points' in the review process. Current priorities are: An environmentally sustainable Australia; Promoting and maintaining good health; Frontier technologies for building and transforming Australia's industries; and Safeguarding Australia. Each of these has numerous sub-priorities. The same Council is also responsible for the founding, funding and monitoring of centres of excellence in selected fields and of major equipment items as well as monitoring the progress, outputs and outcomes of the research projects funded.

*We suggest that a country where there are resources to invest in science, technology and an innovation platform but where the human capital available is greatly limited by the size of the population needs to think especially carefully and clearly about where its knowledge generating and diffusion priorities lie. It is essential that close attention be given at very senior levels in the government about how to strengthen*

*Brunei's national innovation system, how to link the components in a more effective manner, how to coordinate investments made by different public sector partners and consult industry on emerging and longer term needs.*

Brunei already has the bones of that institutional structure. It has an overall planning structure, some government research institutes, a university with research-ready staff, a good quality education system, with technical and vocational components up to tertiary level, a highly educated public service, the beginnings of a medical school and a medical laboratory and a museum. It also has also selected some areas as priorities for future national economic development. Most importantly here, it also has on the books a high level Science Committee, chaired by the Minister of Development.

Unfortunately, that Science Committee has not met in recent years and its potential composition is unclear as are its roles and responsibilities in relation to the development of science, technology and innovation in Brunei. At lower levels similarly, there seems no mechanism for coordinating the investments made in the science and technology field and for ensuring the collection and flow of information concerning performance in any science, technology and innovation fields.

We therefore suggest that urgent consideration be given by the Brunei government to the following steps as a way to move forward and align the institutions of the technological and science side of the Brunei national system of innovation more effectively. Together these steps constitute major elements of a package of programs for **Creating Brunei's Future**.

***We propose that Brunei should:***

- create a *Brunei National Science, Technology and Innovation Council* (or recreate the existing one but in that case review the membership) as a high level national council chaired by an experienced (senior) minister. This Council would be composed of all Ministers relevant to innovation and of industry leaders. It would include ex officio the Vice Chancellor of the University, the Chair of the Brunei Research Council and the Chief Scientist. The principal mission of the Council is, taking into account the objectives of the National Plan, to establish national priorities as a five year strategy in relation to NDP objectives, especially as these relate to agreed economic development initiatives (currently transport and logistics, hospitality and tourism (eco-tourism and sports tourism in particular), halal food, ICT. In addition, the government is considering port-related development (trans-shipment) and downstream oil and gas-related industries, notably aluminium smelting, methanol plant and an ammonia/urea production and tyre recycling).
- create, in consultation with the Science, Technology and Innovation Council, of an *interdepartmental coordinating committee* to ensure the implementation/coordination of S&T activities in each ministry concerning the priorities selected.
- establish a *Chief Scientist* position to oversee S&T development throughout the national innovation system. This could be a full or part-time position and could be held part time by a person from industry (potentially from overseas if desired) to raise awareness at high levels of innovation activities and receive reports and information for reporting to the Council.

- establish a *Research and Innovation Council* to provide a regular funding stream for researchers and to monitor the performance of the research / innovation system as a whole. The Board of the Council should be composed of relevant senior government officers, university academics and business (and regional representatives if considered necessary) and would decide, in collaboration with the Science Council's decisions, the creation of new centres of excellence in science, technology and innovation. The Council must have control of an adequate budget for funding the major research activity of the country in all disciplinary and multidisciplinary fields and in accordance with the priorities selected by the Council.
- The role of the Council is to select and fund high quality research proposals, assist with the creation of major centres of expertise and ensure appropriate development of research-oriented international linkages in the fields selected for development. It will receive and assess, using the peer review approach, research project and program proposals sent to it by researchers from anywhere in government, business or academia and monitor outputs and impact using expert panels and peer review. The Council must therefore have a research budget. *We suggest an initial allocation of \$B2.5 million, rising to \$B6 million by the end of the first five years after a review after year four.* This is to fund research project/programs – if it is decided to create centres of research and graduate teaching excellence, the budget needed will be higher.
- The Council will also promote demand from S&T research users, building on government's role as producer in fields such as construction, public works, Royal Brunei Airlines and other government departments.
- create a specialised and focused Research, Innovation and Development Unit to support the Councils. The role of this Unit would be to:
  - service the major Councils and committees
  - receive and organise the peer review of research proposals and administer the funding of successful projects
  - develop draft policy options, either when requested by the Councils or following intelligence on international policy developments
  - monitor and evaluate progress in the research and innovation system
  - receive and prepare reports on developments within the system or beyond as needed
  - contribute to 'Action Agendas' for S&T input into the development of selected as these proceed
  - establish a national Science, Technology and Innovation indicators system.

The R&D Unit could eventually be *located* in the ministry represented by the Science Council Chair and be *staffed* by officers with S&T policy development and evaluation skills. Initially, the R&D Unit in the Ministry of Development could assume this role. We suggest an initial staffing of four people, to rise to six or seven people as the Councils come into full operation and the indicators and further information gathering and dissemination activities are needed. The cost will reflect decisions about the level of staff to be recruited and the level of public service salaries allocated. We suggest

that the Director of the Unit be a senior staff member, at the same level as the leader of the existing R&D Unit, and there he/she be supported by a further reasonably senior staff person. The Unit will also need an operating budget. Decisions about the budget for that must reflect local operating costs for a unit of the size selected.

*In order to monitor and evaluate progress toward enhancing S,T&I capability a national indicator system should be established and a strategy for collecting, data for monitoring and evaluation purposes should be established under the guidance of the proposed Science, Technology and Innovation Council.*

We further propose that *Brunei should establish a central independent laboratory to provide common scientific facilities for all researchers.* Because the sharing of equipment and major facilities generates collaboration and communication such a facility would also serve to provide a focus for integrating outcomes from projects carried out in higher education, government and industry Further, it could provide a base and focus for scientific societies and serve as a national science promotion centre with special events and presentations open to students and the broader population more generally.

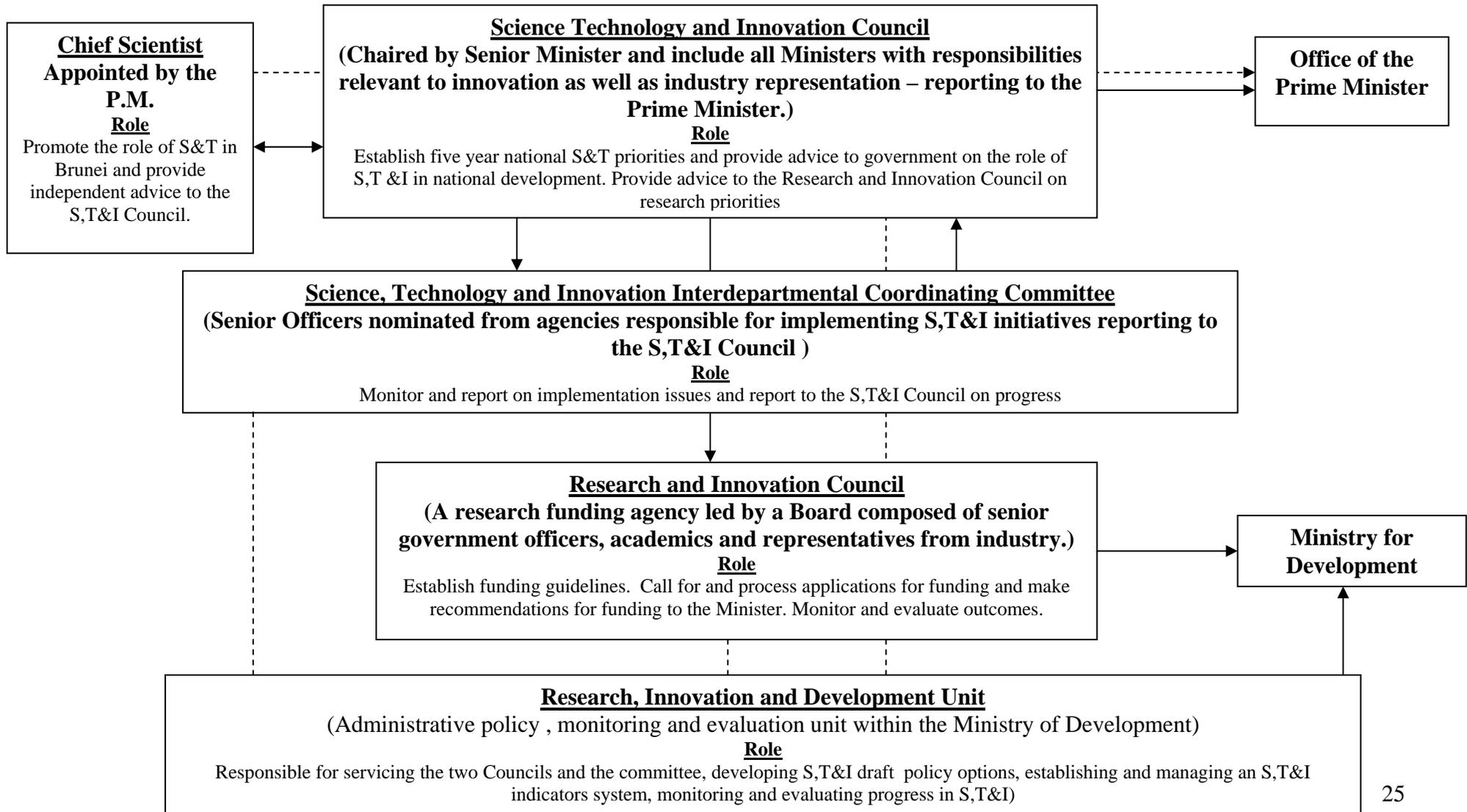
Figure One illustrates schematically the separate roles and responsibilities of the organisational arrangements

#### **b) Higher education**

The recommendations for expanding the higher education system are longer term and would need to be approached and implemented in stages after a thorough investigation of priorities. As outlined above, we propose that attention be given to;

- expanding the number of places available for undergraduate students in higher education institutions
- expanding in particular the number of science and technology places
- linking UBD and ITB much more closely together, if not incorporating ITB in the university so that Brunei's most strategic knowledge assets run no risk of duplication in their development, that the research capabilities and opportunities of staff at both institutions are maximised
- integrate graduate teaching and research, for example into centres of excellence in selected fields

Figure One: Schematic Summary of the Proposed New Structure



## **8. STEPS TOWARDS IMPLEMENTING/SUPPORTING THE RECOMMENDATIONS MADE ABOVE FOR THE CREATION OF NEW INSTITUTIONAL S&T AND INNOVATION ARRANGEMENTS**

### ***Base-line studies***

A first step toward achieving the objectives outlined above would be to commission a series of baseline studies. We suggest that four of these are required to provide an informed way forward. These are:

1. A higher education enhancement study;
2. A feasibility study for establishing a centralised laboratory that could also serve as a base for a Science Promotion Centre;
3. A bench-mark study for establishing a system of S,T&I Indicators; and
4. A graduate careers study

Draft terms of reference for these studies are included in Appendix Two of this report.

We propose that an international panel be established to review the results of the baseline studies and, with particular reference to the S,T&I indicators system, report on the information and recommendations emerging for Brunei from both a local perspective and a perspective that locates the country in its regional and global context. An appropriate mechanism for establishing an expert panel could follow OECD or UNCTAD Procedures.

### ***Procedural Options***

The first procedural step for implementing the strategy outlined in this report should be to establish the Brunei National Science, Technology and Innovation Committee. Membership, terms of reference and a set of key objectives and tasks for the next five years should be drafted as part of the S&T program under the Ninth National Development Plan

The Brunei Research and Innovation Council will need to be established with an operating budget as proposed above.

Both of these new initiatives will need to be provided with administrative support through an appropriately Resourced Research, Innovation and Development Unit.

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## APPENDIX ONE

*Table One: Level of qualification of the workforce, Brunei and Australia, 2001.*

<i>Selected Industry Sectors</i>	<i>Brunei</i> <i>% of</i> <i>total workforce</i> <i>in each sector</i> <i>with degree or</i> <i>diploma</i>	<i>Australia</i> <i>% of</i> <i>total workforce</i> <i>in each sector</i> <i>with degree or</i> <i>diploma</i>
<i>Agriculture</i>	1.6	
<i>Fishing</i>	1.1	7.7*
<i>Mining and quarrying</i>	16.1	24.0
<i>Manufacturing</i>	3.0	9.9
<i>Electricity and gas</i>	4.4	0.8
<i>Construction</i>	4.5	5.0
<i>Wholesale/retail and motor repair</i>	4.1	6.0
<i>Hotels restaurants</i>	4.1	4.4
<i>Transport</i>	6.6	8.9
<i>Finance</i>	11.4	25.0
<i>Real Estate</i>	12.9	27.7
<i>Public Administration</i>	7.3	26.3
<i>Education</i>	28.0	36.3
<i>Health and social work</i>	11.1	28.7
<b>Total workforce</b>	7.3	16.8

\* Fishing and agriculture combined.

Source: Brunei Population Census 2001, Table 8.22 a; and Australian Bureau of Statistics, 2001 Catalogue 6278.0 Table 12.

## **APPENDIX TWO: PROPOSED BASELINE STUDIES**

### **Study No 1: UBD/ITB Integration Study**

**Priority: medium**

**Objective:** Provide government with a set of options for deepening knowledge intensity by strengthening the higher education sector and building closer links between research investments and socio-economic development.

**Tasks:**

- Review financial and administrative structures and procedures and research inputs and outputs in UDB and ITB.
- Identify collective institutional strengths and limitations for providing research and research training to underpin the National Plan and socio-economic priorities for development.
- Identify separate institutional strengths with potential to benefit from closer integration.
- Provide recommendations including:
  - (a) options for upgrading ITB to university status;
  - (b) options for integrating ITB with UBD;implementing a research evaluation plan for monitoring outputs and outcomes.

**Consultant requirements:** A local Brunei consultant with a knowledge of:

- Higher education management
- Organisational management
- Research and innovation policy
- Brunei's national development strategy

A regional technical consultant with experience in research policy and higher education may also be required to guide the study and assist in the overall analysis.

**Input:** One regional technical consultant with extensive experience in higher education and research policy :and strategic planning: 5 persons, one month each

One local technical consultant : two persons, one month each

**Output:** A report submitted to the Ministry of Education and the Science, Technology and Innovation Council

**Timeline:** Three months

**Budget:** regional international airfares and  
Professional fees

Local consultant: 40 days = BND Regional technical consultant: USD 950 – 1200 per day x 10 days plus per diem \$B200 per day

## Study No. 2: Central Laboratory Feasibility Study

**Priority: medium**

**Objective:** Provide government with advice on the feasibility and options for establishing an independent National Science Laboratory with an associated Science Promotion Centre. The study should take into account recommendation emerging from the UBD and ITB integration study and be carried out in parallel with that study.

**Tasks:**

- investigate options for establishing a National Central Laboratory that will complement the work carried out by UBD and ITB and other national research centres.
- provide recommendations for establishing a National Laboratory including:
  - \* financial estimates and potential source of funding;
  - \* management administration responsibilities;
  - \* a strategy for interaction with the private sector and national authorities
  - \* location of the laboratory;
  - \* options for establishing a Science Promotion Centre associated with the facility;
  - \* mechanisms for incorporating Department of industry labs within the national lab;
  - \* a research evaluation plan for monitoring outputs and outcomes.

**Consultant requirements:**

A local Brunei consultant with a knowledge of:

- Brunei's science system;
- industry analysis and organisational management;
- Brunei's national development strategy

A regional technical consultant with experience in research policy and higher education may also be required to guide the study and assist in the overall analysis.

**Input:**

- One local technical consultant : 1 person for a month
- One regional technical consultant: 5 persons, one month each

**Output:** A report submitted to the Ministry of Development

**Timeline:** Two months

**Budget:**

- *Professional fees*

Local consultant: BND (20 days = ?)

Regional technical consultant: USD 950 – 1200 per day. (**10 days = >USD12,000**)

- *Regional international travel and per diem of \$B 200 per day*

## **Study No 3: Science, Technology and Innovation Indicators System Benchmark study.**

**Priority: highest**

**Objective:** To provide government with a current status report of science, technology and innovation capacity; establish a set of ‘benchmark’ indicators for monitoring and evaluating progress of science and technology in Brunei in the context of national development plans and industry diversification; and establish a national system for collecting and monitoring S&T data for national and international comparison.

The study should generate information and the involvement of key stakeholders through a mechanism similar to the OECD S&T review but be directed toward Brunei’s unique local economic, cultural and demographic context.

### **Tasks:**

- review the status of science, technology and innovation data currently collected by government agencies, UBD and ITB identifying core data appropriate for international comparison such as OECD S&T reviews and monitoring national S&T capability development.
- prepare an S,T and innovation survey to be carried out through JPKE building on the recent work carried out for the Ministry of Development and directed toward capacity analysis through the Ninth National Development Plan.
  - identify appropriate S,T&I indicators for monitoring and evaluation progress

toward S&T capacity enhancement for national development;

- propose a national system for the on-going collection of S,T & I data. To be done in collaboration with JPKE.

### **Consultant requirements:**

- A local Brunei project team with a:
  - \* knowledge of science, technology and innovation indicator systems;
  - \* familiarity with international S&T data sets such as those compiled by UNESCO, OECD, ASEAN and APEC;
  - \* understanding of Brunei’s national development strategy;
  - capacity to carry socio-economic analyses
- A regional technical consultant with experience in developing international S&T indicators for application, monitoring and evaluation.

### **Input:**

- one regional project team: four person months
- one local technical consultant: one person months
- commissioned survey and data analysis.

**Output:** A report submitted to the Ministry of Development and the Science, technology and Innovation Council.

**Timeline:** Four months

**Cost:**

• *Professional fees:*

- \* Local consultant: BND (two person team): 80 days = BND
- \* Regional technical consultant: USD 950–1200 per day (15 days = >USD18,000) plus per diem of BD200

• *Regional international travel:* International airfare plus accommodation/per diem.

• JPKE Survey and data analysis = BND?

• *National Workshop:* one day event involving representatives from government and industry perhaps with an international consultant assisting. Cost depends on this decision.

## **Study No 4: Education transition and graduate careers**

**Priority : high**

**Objective:** Provide the government with an assessment of where and in which capacities Brunei is currently using its graduates with science and technology qualifications and the possibilities for the future. At present the vocational education field has the beginnings of a 3-6 month tracer study but there is very little other

**Tasks:**

- review the results of existing tracer studies
- assess the number of S&T-qualified staff currently working in government departments (through public service HR department plus a special questionnaire if needed)
- review the tasks on which they are engaged with a view to assessing the degree to which their special skills are being utilised in the public sector and their remuneration levels
- collect and assess any information available on private sector employment of such graduates
- provide recommendations to the government concerning the more effective utilisation of S&T skills if there is seen to be room for improvement in current career paths in this respect

**Consultant requirements:** A local Brunei consultant with knowledge of organisational career paths and the workings of the public service in Brunei in respect of HR development in specialised areas. The consultant may need to develop and use a questionnaire for requesting further information on career paths, preferences and expectations of S&T-qualified personnel and analyse the results. He/she should therefore have expertise in empirical quantitative social science research.

**Output:** A report to the government in the existing situation regarding the use of special science and technology skills and recommendations for action if needed.

**Timeline:** One month fulltime (??) for local consultant. Three days assistance from external expert if needed.

**Cost:** Local consultant to be paid 20 days @ \$B??? per day. International consultant: 3 days at \$B1000 a day plus per diem of \$B200 per day and a return international economy airfare.

## APPENDIX THREE

### List of Meetings and Round Table Discussions held June 20 to July 1

Date	Agency	Contact
Mon 20 <sup>th</sup> am	Ministry of Development	Eddies Sunny and Rosita
Mon 20 <sup>th</sup> pm	Institute of Technology Brunei (ITB)	Acting Director, Dr Haji Kassim Bin Haji Daud, and round table meeting
Tuesday 21 am/pm	Ministry of Development	Eddies Sunny and Rosita
Wed. 22 am	Perm. Sec. Ministry of Development	Matassan MD Daud
Wed 22 pm	Brunei Economic Development Board	Hj Murni Hj Moham, Dep Chief Exec. Officer Planning and Coordination
Thurs 23 am	University of Brunei Darussalam	V.C Dr Haji Ismail Bin Haji Duraan Dean of Science Dr Zohrah Haji Sulaiman Dr Tan Kha Sheng and others
Thurs 23 pm	Dep Minister of Development MoD.	Data Paduka Dr Mat Suny
Sat 25 pm	Ministry of Education	Dr Omar Hj Khalid
Mon 27 am	Ministry of Development	Eddies Sunny and Rosita
Mon 27 pm	Brunei Shell Petroleum (BSP)	Asset Director Hj Salleh-Bostaman Bin Hj Zainal-Abidin and Technology Manager
Mon 27 pm 2	Brunei Liquid Natural Gas (BLNG)	MS (Said( Ahmend – Senior General Manager.
Tues 28 am	Dept of Technical Education	Ms Jennifer Hiew Lim and others.
Tues 28 pm	Minister for Development	Pehin Orang Kaya Hamzah Pahlawan Dato Paduka Awang Haji Abdullah bin Begawan Mudim Dato Paduka Haji Bakar
Wed 29 am	Ministry of Industry and Primary Resources	Head, Industry Promotions Unit Pg. Metali bin Pg. Hj. Damit; Agro Technology Dev. Division, and

		Brunei Agric. Research Centre, Pg Hajah Rosidah Binti Pg Hj Metussin and others. – Forrestry and Fisheries.
Wed pm	Ministry of Industry and Primary Resources	Permanent Sec. Mohd Hamid Mohd Jaafar
Wed Pm.	Prime Minister's Dept, Department of Economic Planning and Development (JPKE)	Hajah Rosini Haj Tungkat
Thurs. am	Ministry of Industry and Primary Resources: Deputy Minister	Hamdillah Wahab
Thurs. pm	University Brunei Daussalum Dean of Research	Dr Harinah
Thurs pm	Ministry of Health	Dr Yussof Hamba Senior Official