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Mongolia: Higher Education Reform Project

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Consulting Services for Higher Education Reform

Consolidated Outputs of Research Policy and Strategy Team

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Guidelines for Establishing Research Center of Excellences

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Background and Rationale

R&D activities play substantial roles not only on the development of science and technology, but also on the competitiveness and economic development of a Nation. It should be recognized, however, that R&D is a complex and multifaceted issue. It encompasses issues such as human capital, science and technology ecosystem, economic system and infrastructure. Thus, at the macro level, unless systematically developed and rigorously planned, such R&D activities will be bound to fail and lead one to nowhere.

Unlike research institutes, universities are to carry out both teaching and research mission. To excel in the two missions at the same time is indeed a very tall order. It is therefore a common strategy that university pursues its research excellence by carefully select a specialized area of focus and mobilize its resources to the chosen area. Such research focus is usually institutionalized in the form of a center and is commonly known as the center of excellence.

This document provides general guidelines for university as well as the government to establish an R&D center of excellence contingent upon available resources and expertise.

Description of Research and Development Center of Excellence

A research and development center of excellence or abbreviated as (**RDCoE**) is broadly defined as a place or an organization that is known for doing a R&D activity very well, and that is involved in new developments, new ways of working, etc. For this particular purpose, by an RDCoE we mean an academic unit (center) that is established and managed by a university or consortium of universities, that carries out specialized, state of the arts (academic frontiers), and highly relevant research activities.

An RDCoE may be characterized by the following natures: firstly, it is oriented toward problems instead of based on academic disciplines. As it is generally true for real world problems, an RDCoE is therefore usually multidisciplinary in nature. It constitutes a pool of experts from different areas of disciplines and nurture interdisciplinary research and innovation. Secondly, it promotes linkages between universities and external stakeholders, where university is placed as a center of innovation spheres. It perfectly models the so-called triple or quadruple helix, where university is forging its external collaboration addressing and endeavoring substantial problems and issues facing the society. And thirdly, it is the meeting point between opportunities available outside and the potentials own by the university. University shall therefore recognize and systematically develop its academic potentials to match the needs of its stakeholders. An RDCoE shall therefore proactively and cunningly identify such needs and make necessary alignment continuously.

The establishment of a RDCoE may be based on the government initiative and appointment (Top Down approach) or the university (ies) initiative (Bottom Up approach). The Top Down approach will in one hand be perfectly in line with the government development strategy but on the other hand run the risk of lack of ownership by the implementing institution. The Bottom Up approach will have better ownership and thus has better chance of sustainability. Examples of such two centers are the Core Laboratory and the Fertility Clinics that are established in Mongolian National University of Medical Sciences. The report presented by the Vice President for Research of MNUMS at the workshop we held in 2015 clearly reveal that the Fertility Clinic Laboratory is showing much better performance.

The following table presents the summary of SWOT analysis done by MNUM regarding the Core Laboratory which was established by the government:

Strengths	Weaknesses	Opportunities	Threats
-We have the research and training center, which was funded by the Government of Mongolia and the Millennium Challenge Account of USA. It was equipped with high-tech lab facilities. -We have created comfortable environments for the research study at the Core lab. - High amount of educated HR from the abroad -We are conducting a several projects for the research and training. -Supporting to cooperating organizations and researchers and making a joint scientific	- Not enough number of HR - Not good quality of the laboratory building such as ventilation, electricity, water supplying system - No additional power generator when out of electricity - No accreditation of laboratory - Not enough supplying system of reagents A high amount of costs of chemical reagent - Amount of grants for research projects is very limited - Lack of technical staffs to be responsible routine maintenance of lab equipment - Top priority of scientific research is too general.	- to expand other sources of finance for scientific projects - to develop international cooperation and relation - available international accreditation of laboratory -To do unique clinical testing. -Supervise and lead scientific projects of doctor and master degree. -to support young researchers and coordinate student club -Available to produce biotechnology production -To publish scientific article in the Mongolian and international journal	-No accreditation due to no acceptation in international level -No cooperation with other governmental and private organizations. -Salary is not enough -No medical equipment engineer. -No specialist to take care experimental animals. -Quality of the plumbing installation is bad -Air conditioning system is unsatisfactory.

The above examples clearly suggest that for the top down approach, rigorous assessment and careful alignment with the university interest should be done prior to the establishment. It is also critically important that either way, a comprehensive plan proposal should be developed by the university (or consortia of universities) and be rigorously evaluated by expert panel appointed by the government.

To function well, such center should be properly governed, managed and resourced. The following sections will explicate how such center shall be established and developed.

Mission and Strategies

In line with the university's mission, i.e. teaching, research and outreach services, an RDCoE should also carry such overarching mission, where research and services should of course be placed as its prime mission. By and large, the following aspects should be considered when formulating the mission of an RDCoE:

- As a center of excellence, an RDCoE should significantly contribute to the improvement of quality and relevance of the university. It should therefore utilize as much as possible academic potentials existed within the university. Faculty members with relevant expertise as well as students from relevant subject of disciplines shall be programmatically involved in the center activities.

- The center shall place national interests and priorities as its prime focus. Furthermore, it should be highly relevant to the needs of the society. It develops science and technology not merely for the sake of science and technological development, but more than that it should produce solutions to the problems faced by the society and the Nation as a whole.

- Such center should be financially viable and thus be able to generate sufficient income to support its activities, independent from the university. Thus, income generating may also be considered as one of its missions.

In order to successfully carry the above-mentioned missions, an RDCoE shall be guided by a sound and clear strategy comprising long, medium as well as short terms strategies. Proper and well-documented strategic planning should be established and be referred to for its operation and development. Such strategy should be developed based on a clear policy which includes aspects of academic and non-academic.

Governance and Management

One of the main characteristics of an RDCoE is that it has the authority to influence actions, which is provided through its governance structure. While it grows from an academic environment, a more progressive corporate-like model of governance may be considered. This is particularly true as the center should also act as a knowledge enterprise. As an entity with high entrepreneurial spirit, agility and autonomy are very important aspects of the governance of such center.

Considering the nature of its activities, a function that sets forth and establishes scientific policy and direction should be put in place within the governance. This is to complement the main governing body which is usually more focus on non-academic matters when setting up the general policy for the center. Thus, the following three functions may be considered as the key elements of the governance of the RDCoE:

a. Function to set general policy, direction, appoint and discharge leadership of the center (**board of trustees**)

b. Function to set academic policy and research direction, and oversee overall academic performance of the center (**scientific board**)

c. Function to execute and run the center (**executive board**)

In the aspect of management, the center should professionally managed and implement best management practices in all areas of functional management. Some form of internal quality assurance system should also be effectively functioning. Its organizational structure should be made as lean as possible for agility, while ensuring its external as well as internal accountability.

Funding and Financing

As stated before, the center shall be financially viable for its excellence academic undertaking. Academic excellence does not come cheap. It requires substantial funding for its operational as well as developmental expenses. There are basically two major sources of funding for such center, i.e. public and private funding. Public funding comes from the government as a quid pro quo for its excellence performance in addressing national interests and priorities. Its presence should be of strategic importance for the Nation as a whole. Unless allocated for specific rendered services, the government funding usually comes in the form of development or capital investment.

The allocation of public funding to an RDCoE should be based on rigorous evaluation of a comprehensive proposal. Competitive or performance-based contract scheme may be considered as mechanism for such allocation. The performance-based contract can be used if the government has a clear and specific set of indicators to be met by the center.

Private funding mostly comes from business and industries resulted from contracted services or royalties for IPR. The nature of the contract is pure business relation and for professional services. As an autonomous entity, the center shall be capable to engage itself in commercial contract with a third party. In this regard, all rules and regulations appertain to commercial contract shall be followed by the center.

A center of excellence should develop and promote revenue generating activities to ensure its financial sustainability. A sound and prospective business plan should be clearly developed by the center's management, which explicates vividly how the center's revenues are to be generated. Examples of such revenue generating programs are:

- Matching the interest of philanthropists: Some philanthropists are very keen in supporting research and development in the areas of their specific interests. Such interest may be related to their personal or family experiences. Many

philanthropists are spending huge amount of money to support research, for example, related to cancers or hereditary illness, because their family members developed such kind of illness. The center should therefore identify and approach such philanthropists that are interested in supporting the center's area of researches.

- Submitting proposal to international funding agencies. Some international agencies have the mission to support the development of R&D activities in developing countries. Such agencies regularly announce call for funding proposals to be supported. Some agencies require that a center shall not only be academically competent to carry out quality research but also implement standard financial management practices to be eligible for submitting a proposal. The center should have the capacity to develop high quality proposals to be submitted to such funding agencies. Such agencies may be governmental or non-governmental bodies. Examples of such agencies are: IDRC (Canada), EU-FP7 (Europe), EPA (US), DIISR (Australia), and many more.

- Startups. Commercialization of research results can be done through the establishment of startups companies. The establishment of startups will at the same time hinder the center to be distracted by activities which lies outside their focus. When successful, revenues from such startups may be used to support research projects.

In case the government does not provide salary for the center's permanent researchers and staff, the self-generated revenue should be adequate to support the center's operational expenses including personnel, consumables, and assets maintenance.

All in all, funding from contract and services shall be the main funding sources of an RDCoE and its expenses profile should be primarily determined by its income from such contract. Thus, fixed operational spending of the center should be kept minimum.

The government may need to set a special regulation for such center for instance in relation to income tax for the center or to incentify private sectors that support the center in the form of CSR.

Staffing and resourcing

An RDCoE should use its resources as frugal as possible. The following considerations shall be taken into account when staffing or resourcing an RDCoE:

- Permanent researchers should be limited to principal investigator only. Other researchers should be hired as contract researchers based on research projects. Permanent researchers shall form research groups where its membership may include also contract researchers.

- Management team supported by professional administration staff will be running the center in the most efficient and effective way. In case deem necessary, some temporary support or technical staff may be hired for supporting a particular project.

- All spaces and facilities should be optimally utilized. Sharing of resources should be adopted as the main stream. Research equipments are usually expensive and consume substantial operational and maintenance costs. Thus, procurement of capital research equipment should be financially justified and rigorously assessed for its ROI.

Typical organization structure and management functions of an RDCoE constitutes:

- Academic Board or Steering Committee

  The main function of the board is to oversee the center on academic matters covering the full spectrum from planning, setting standard, monitoring and evaluation.

- Core functions within the center include
  - Sales and Marketing
  - Research and Development
  - Commercialization and Enterprising
  - Internal management (resources)

Critical Success Factors

Based on past experiences the following factors are critical for successful development of an RDCoE:

- Policy

  The center should be established based on a sound and clear policy from higher authority. Clarity of such policy is deemed important for setting up direction and strategy for the development of such center. The authority here may refer to the government or board of trustees.

- Leadership

Strong and visionary leadership with high entrepreneurial spirit will be one of the key determinants for the success of such center. In this regard, leadership should be a combination of academic and managerial leadership.

- Involvement and commitment

  The development of an RDCoE requires a strong and continuous support and commitment by at least three different parties, i.e. the government, private sectors, and university. Such commitment should go beyond personal commitment. It should be committed institutionally. The government commitment is not only in the form of providing resources, but also in setting up policy and regulations that are conducive for the center to grow.

- Distinctive niche (focus)

  An RDCoE shall play the role of spearhead and trend-setter in the chosen area. Its activities should reflect the cutting edge scientific and technology development. In order to be able to play such role, the center shall capitalize and mobilize its resource toward the development of research and innovation in a specific area and stay on the chosen focus for some period of time to develop its portfolio.

- Strategic Partnership

  RDCoE cannot be developed by university alone. So, partnership is essential and is part of its main strategy for development. It is through partnership research programs are developed and carried out. Funding is usually resulted from such partnership. Such partnership should be developed on reciprocal and mutual-benefits basis.

Performance Indicators

There are at least two sets of indicators that can be used to measure the performance of an RDCoE, i.e. academic and financial. Academic performance is usually measured by the following indicators:

a. Publication in reputable scientific international journal

b. Patents or other form of intellectual property right (IPR), particularly those already adopted by industry or commercialized.

c. Adopted policy by the authority in case of policy research;

Financial performance is simply measured by the amount of annual research income or its proportion to the center annual income. Another measure that can be used is the amount of income from royalties.

Pitfalls to avoid in order to maximize potential for success

The following lessons are learnt from the fields and may be used as caveats to avoid doing the same mistakes:

- Must not too bureaucratic

  Universities particularly public ones are known for their conservative culture and are used to with a lengthy and bureaucratic decision making process. As opportunities never knock twice, and RDCoE must be agile and capable of making quick but prudent decision to optimally grab any prospective opportunities. Therefore the governance and management model should not be too bureaucratic. In addition, the center also needs some level of autonomy but with high accountability.

- Balancing KPI

  The performance of an RDCoE cannot be measured only on academic or non-academic aspect alone. There should be a right balance between the two. While income generating is essential for the center operation, too much emphasis on income will certainly kill the center. Academic reputation is of course very essential for the center sustainability.

- Maturity of the surrounding industries

  In the developing country, most industries are still in their early stage of development. Collaboration with such industries may lead the center to be trapped in activities with very low academic contents. In this regard, the center should implement the so-called salmon-leap strategy, i.e. always go up stream for academic substances.

Getting Started

The following steps of actions may be considered as starting point for the establishment of an RDCoE:

- Policy setting

  Motivation for the establishment should be clearly stated as the basic policy, which will be used as the main reference for future development. It should not be only for money making (or income generating), for sure. The main intention should be for improving the quality and relevance of the university.

- Rigorous self-evaluation

  In order to accurately and objectively identify potentials, opportunities as well as challenges, a comprehensive and rigorous self-evaluation should be done

preceding the establishment of such center. This will also provide strong basis for the development of the center's long term as well as strategic plans.

- Strategic planning

  As explained before, an RDCoE should be managed and developed according to professional management and developmental practices. In this regard, strategic planning is one of the key steps to be done at the beginning of operation. An ambitious plan will require enormous amount of resources, it is commendable to start small and simple.

- Building strategic partnership

  Strategic partnerships with external stakeholders have to be systematically built commencing from the beginning, and to be sustainably developed throughout the development of the center. Such partnerships should be developed particularly with industries, professional organizations, and similar research or academic institutions.

  There are a number of strategies that can be exercised to promote external partnerships. The inclusion of external stakeholders in the academic board or steering committee is one of them. Another strategy is to hold a regular stakeholders' forum. Such forum can be made on informal setting such as breakfast meeting. In this forum, PI may present their current ideas or preliminary results of their works for obtaining attentions and possible supports from interested parties. Likewise, outside parties may be invited to share their ideas to the internal audiences.

  The center should also proactively identify and approach potential and prospective partners. The partnership should not always be on institutional basis. Individual philanthropist may be considered as potential and strategic partners for supporting research programs.

Examples from developing countries

The followings are examples of CoEs resided in Indonesia with some variations and modality, ranging from regional center of excellence, national center of excellence, and university-industry based, to a single university-based center.

- SEAMEO BIOTROP – Bogor Indonesia

  This is an example of regional research center of excellence, taking the tropical biology as its focus. Established by South East Asian Ministers of Education Organization, the center sets its mission to provide scientific knowledge and capacity building in conserving and managing tropical biology sustainably for the

well-being of communities and the environment of Southeast Asia. It's main areas of research covers comprehensive area of application, including: agriculture, forestry, biodiversity, wildlife, etc. The center is resourced with state of the arts laboratory equipment and is successfully attract many students and faculty members from various universities in the region to carry out research in the relevant areas. It major financial supports come from the member countries. The center main outputs are scientific publications.

- Eijkman Institute of Molecular Biology – Jakarta Indonesia (http://www.eijkman.go.id)

  The institute was formally established in July 1992, commenced operations in April 1993 and was officially inaugurated by President in 1995, named after the Nobel laureate Christiaan Eijkman who initiated the center back in 1888 as a research laboratory. As the name stands, the center put its research focus on molecular biology (or microbiology). Although located inside the University of Indonesia premises, the center is directly under the ministry and thus does not belong to the University. But most of research works undertaken in the centers was done in collaboration with researchers and students from several universities, particularly the University of Indonesia. Aside from the government funding, the center is highly successful in attracting research funding from international sources. The center main outputs are scientific publications and patents.

- SEAFAST (Southeast Asian Food, Agricultural Science, and Technology) Center - Bogor Agricultural University. (http://seafast.ipb.ac.id)

  The center sets its mission to promote food quality, security and safety in the region particularly in Indonesia. Was originally established with the support from The Texas A & M University, but have now fully developed as a strong and internationally recognized research center in the area of food quality, security and safety. The center is fully operated by faculty members at the Department of Food Technology – Bogor Agricultural University. Its main financial sources come from contract and services with domestic food industries as well as the government food and drags agencies, and research grants from international agencies. Its major outputs include scientific papers, policy recommendation, as well as patents and other form of IPR. It also recruits graduate students as RAs.

- Center for Fitofarmaka – Airlangga University

Standardization and Accreditation for Research Laboratory

There is a global trend to standardize and accredit research laboratory particularly in some areas of research. There are at least two main reasons for the needs of such standardization and accreditation: first, for safety measures, and second for recognition. Research labs that are dealing with hazardous materials or pathogenic viruses will have to be standardized and accredited for safety purposes. Bio-Safety is one of the standards used worldwide for measuring the level of safety for laboratory dealing with microbiology (virus or bacteria).

The second purpose of standardizing or accrediting research laboratories is to do with assurance and thus recognition of research results. In some field of researches requiring accurate diagnostic test or measurement, such as in basic sciences or engineering, measurements will be considered as acceptable only if they are done using standard equipments. Such equipments need to be calibrated and tested by authorized bodies.

Standardization is usually done through accreditation or assessment by an authorized and reputable body, which in most cases should be recognized globally. In this regard, accreditation is the "Procedure by which an authoritative body gives formal recognition that a laboratory is competent to carry out specific tasks". Unfortunately, the cost for undergoing such assessment or accreditation process is very high that only a few organizations can afford the cost. Thus, in some countries, the government establishes such accrediting agencies and promotes them for regionally or even global recognition.

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Integrating Research within Graduate Education

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Introduction

Mongolian higher education sector constitutes around 100 higher education institutions wherein 9 of them are leading public universities established by the government. The remaining are private institutions which are mostly small in size. R&D activities within HEIs in Mongolia are mostly concentrated in the 5 public institutions, namely: NUM, MUST, MNUMS, MULS, and MUE.

An online survey on R&D activities in Mongolian HEIs was conducted between Sept and Dec 2015. The survey was responded by 246 respondents comprising 176 from public HEIs, 56 from private HEIs, and 13 from public research institutes. The survey addressed four main areas namely: funding, facilities, capacities, and performances. On each of these four areas, the survey gave rise to the following findings:

1. On funding:

   Majority of the respondent consider that the current research funding provided by the government is far from adequate. Furthermore, more than 80% of the respondent considers that the competitive research grant lack transparency and fairness. In addition, funding from private sources is not easy to find.

2. On research facilities

   In terms of research facilities, 60% of respondent considers that Internet access is sufficient, but 61% think that research equipment both in terms of quality and quantity are not adequate, 58% of respondent think that scientific journals are not easily available, 70% of respondents consider that lab and office spaces are not adequate. Furthermore, 72% consider that government regulation to support effective R&D undertaking in HEI is not adequate.

3. On capacity to undertake research

   Almost all respondents (more than 87%) agree that R&D activities improve quality and relevance of teaching and learning process and contribute to the advancement of their academic career. Furthermore, majority also agree that interdisciplinary and relevant aspects of research are important, and that research works should preferably be done in group instead of individual one. More than 87% of respondents also think that R&D skills development should be part of curriculum. Interestingly enough, however, only 36% of respondents consider that students (particularly graduate ones) should be involved in staff' research. More than 78% respondent claims that they have adequate exposure to industrial research. However, more than 60% respondents consider that the university does not have

a clearly defined research focus, neither encouragement and relevant regulations appertain to research commercialization.

4. On research performance

   Despite all constraints, it is very encouraging to learn that the overall performance is good. More than 90% of respondents are involved in at least one research project during the last five years. At least 65% of them even claim to have done at least one research project in collaboration with industry. In terms of research outputs during the same period of time, 57% of respondents have published at least one article in international journal, and 76% of them presented at least one paper presentation in international seminar. Furthermore, 37% of respondents have produced at least one IPR, and that at least 92 IPRs have been adopted by industry. Crosstabulation also indicate that such performance is more or less similar amongst field of disciplines.

R&D undertaking in Mongolian universities are in most cases done by the faculty members individually with little evidence of the involvement of graduate students. This inevitably leads to serious burden for the faculties considering that their heavy teaching loads due to large students' population.

In order to minimize context switches and to optimally use the scarce FTE own by faculties, universities usually integrate R&D activities with education programs. This document provides guidance for such integration strategies. As not every single university is aspiring for research, we first describe possible scenario to differentiate mission of universities. Academically excellence and world class university not necessarily becomes a research university. There are examples of internationally acclaimed university which only focus on teaching.

Mission Differentiation

In order to understand the different roles that universities can play in economic development, we refer to the framework which distinguishes four types of institutions: basic research institutions, relevant research institutions, teaching focused institutions and practically oriented institutions. As shown in figure below, these four types are distinguished by two dimensions which define the nature of their research interest: application orientation and fundamental-science orientation. [1]

1 The framework is proposed by Sachi Hatakenaka et.al.

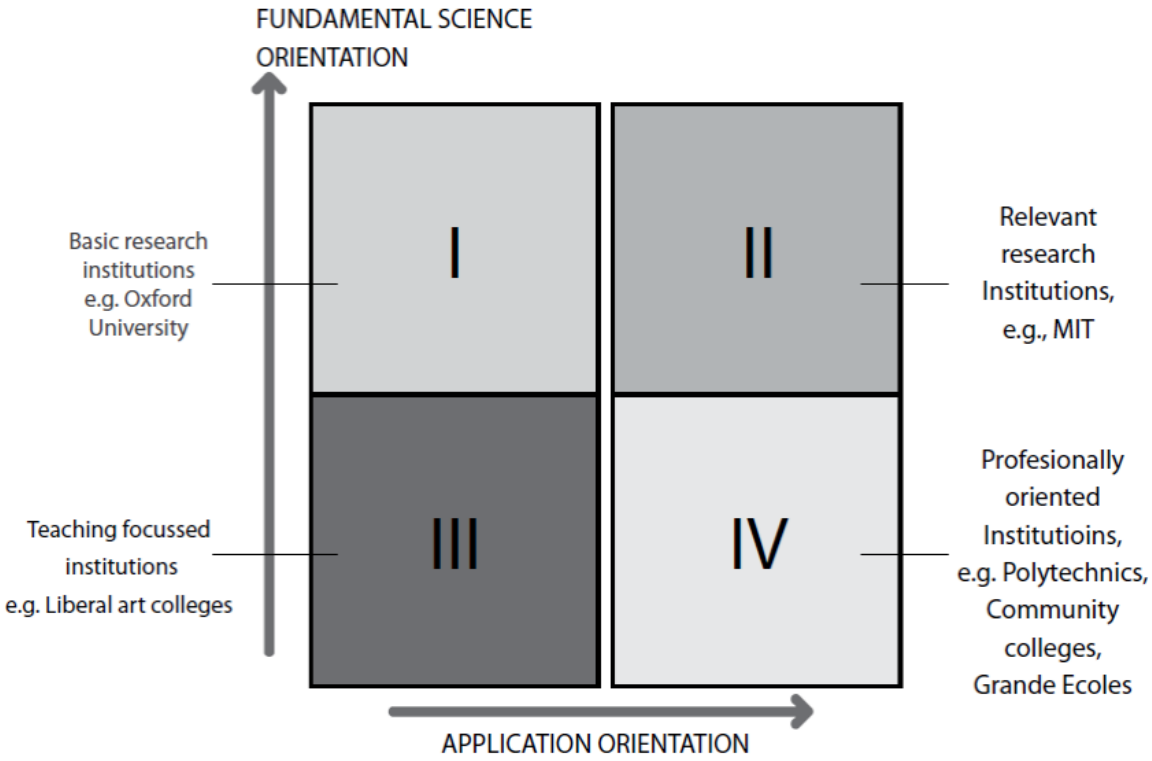

Figure: University Characteristics (Hatakenaka, 2008)

In relevant research universities (quadrant II), academics conduct fundamental research that creates new knowledge to unravel fundamental principles but that is inspired by its relevance to society and possible application. Primary examples of relevant research universities emerge from a small group of American research universities which embrace the value of relevance such as MIT, Stanford and land grant universities, which have the tradition of serving the needs of the society. Such institutions typically have extensive institutional systems that support academics in working with industry and other stakeholders in society. These institutions also emphasize and have institutional mechanisms that support interdisciplinary research relevant to societal challenges.

Basic research universities (quadrant I) are driven principally by the core values of fundamental science. In these universities, there is little interest in or institutional capacity for responding to external needs. These universities give rise to the idea of the classic ivory-tower university with well-developed research capabilities. Indeed, the great majority of research universities in the world have belonged in this category, at least until recently, when economic relevance became a global catchphrase.

The bottom right-hand cell represents the professionally oriented (quadrant IV) institutions which aspire to meet the economy's needs for practical skills and knowledge. These universities offer courses that teach skills which produce workers relevant to the needs

of employers, and they often conduct consulting and application-oriented research with and for industry. The objective of their research is not to discover fundamental principles for publication, but to develop solutions to specific problems. Examples of these universities are diverse, ranging from the grandes écoles in France, which were designed to provide elite professional education (although they have begun to develop basic research capacity in the past couple of decades), to the German universities of applied sciences (previously fachhocheschules) and many polytechnic schools and their equivalents in other countries. Such institutions may have multiple and direct linkages with employers and industry.

Characteristics of R&D Activities in Universities

It is universally agreed that the main mission of a university is to undertake teaching and research. Unlike in research institutions, the training aspect of R&D activities in a university is critically important and is the integral part of the university mission. Students involvement in R&D is not only intended for developing their knowledge in the area under consideration, but of equally important for improving students skill in carrying out scholarly and scientific works which are to follow a rigorous scientific method.

In addition, engagement in R&D activities provides also the opportunities for students to learn the implementation of academic norms, values, as well as principles in real life situation directly from their master. The true meaning of academic freedom and autonomy as well as its implication to the society will also be learnt from R&D activities. Such attributes will be less effective to be learnt from classroom lectures.

Particularly in graduate education (master and doctoral levels), competency to undertake scientific research is part of the intended learning outcomes. Such competencies should therefore be developed throughout the course of the study as part of the program curricula.

Horizontal Integration

According to international good practices, there three broad schemes for integrating R&D activities within graduate education programs, they are: research led, research oriented, and research-based graduate programs.

- ***research-led***: In this case, the graduate program curriculum is dominated by faculties' research interests. Course offering are highly influenced by research projects undertaken by faculty members. Teaching staff will develop their course contents and materials based on their research findings.
- ***research-oriented***: This model has the objective of preparing students to become researchers. Here students intensively learn about research processes, how

knowledge gets created, and the 'mind-set' of a researcher. Students will be exposed to different kinds of research models and paradigms as well as standardized tools and methodologies for undertaking each category of research.

– ***research-based***: This model is commonly known as graduate program by research. In this case, students act as researchers, learn associated skills, and curriculum is dominated by inquiry-based activities. Sometimes, students do not have to take any coursework at all as the program is entirely done by research.

The implementation of a research-based graduate program will require sufficient research skills to be acquired by students when admitted to the program. This is usually not the case. Thus combination of the above models may be necessary. During the early stage of the programs, students are assigned to preparation courses such as research methodologies, fundamental courses etc. For the doctoral programs, designated fundamental courses may later on be required depending on student's comprehension on theory appertain to the particular area of research being studied.

In practices, the integration of R&D activities within graduate education takes many different forms, ranging from a full-fledge research-based program to a mix of courses and researches based program. Examples of such integration can be seen both in the developed and developing countries. **Master by Research** programs which have been implemented by many universities in the European countries are examples of full-fledge research based program. In the UK and Australia, for example, doctoral programs do not require any coursework at all and thus the students' load is entirely in the form of research works.

Examples of research-based graduate programs in the developing countries can be found in University of Malaya (Malaysia), University of Chulalongkorn (Thailand), and University of Indonesia (Indonesia). Case in hand is M.Sc. and Ph.D. in Computer Science – University of Indonesia, as described in the following case.

M.Sc. and Ph.D. in Computer Science – University of Indonesia

The Faculty of Computer Science, University of Indonesia offers three graduate programs namely: Master of Information Technology, Master of Science in Computer Science, and Ph.D. in Computer Science. The Master of IT is a professional oriented course-based program, with no research element in the curriculum. The M.Sc. and Ph.D. in CS are considered as research-based programs, where courses requirement is kept minimum and limited to those necessitate to supporting students research in a particular area of research. The curriculum for the M.Sc. program constitutes 40 credit units, comprising 30% common compulsory courses, 30% thesis work, and the courses or individual studies which are related to the thesis work to be taken under the direction of the thesis supervisor. The curriculum of the doctoral program consists of 50 credit units, where compulsory courses are only 10% and the remaining 90% are research related works including dissertation (40%).

The research-based graduate programs are supported by 7 research groups (laboratories), i.e. *Computer Networks, Architecture & High Performance Computing; Digital Library and Distance Learning; Machine Learning and Computer Vision; e-Government and e-Business; Information Retrieval; and Information Management.* Research projects are carried out within these research groups. Each faculty member belongs to at least one of these groups. Each research project recruits graduate students as research assistants. A Ph.D. student is assigned to a research group when she/he is admitted to the program, which is automatically recruited as a research assistant. Master students are recruited later when they decide on their research topic some time in the second semester. Funding for RAship is included in the research grants available in the research group.

The integration may be considered successful for it proves to be effective in improving quality and efficiency of the graduate programs under consideration. The quality improvement can be seen from the increased number of research papers published by graduate students. The integration also helps the students to complete their degree faster as the research topic for their thesis are readily available.

Academic Structures

Research undertaking is a long and complex process and thus requires a proper institutional setting and management system. Such institutional setting may necessarily be different from the one for fostering teaching and learning activities. There is no a standardized format of academic structure which most optimum for the development of

R&D activities within a university. The following examples are however commonly found in universities worldwide.

- **Research Group**: this is the least formal structure of research activities and sometimes is also referred to as special interest group (SIG). Here researchers with common research interest form a group of the same research interest. One of the members, usually the one with highest expertise in the area, is assigned as group leader. The group leader leads and organizes the activities of the group. Students are recruited as research assistants in the group, doing researches for their theses or dissertation under the supervision of the group members. No formal resources such as administrative staff or research equipment are allocated to the group, but the group has access to any needed resources within the department or faculty. The life time of a group depend entirely on the interest of the member.

- **Research Laboratory**: This is not the usual physical laboratory which consists of equipment. A research laboratory is a group of researchers working on a specific theme of research. The theme can be based on the academic discipline such as Algebra, Signal Processing, etc. or application area/problems such as Medical Imaging, Rural Development, Aging Society. Research Lab is more formal than Research Group, usually chaired by a head of the lab appointed by the Head of Department or Dean. It main activities are carrying out research under the respective area, including research capacity development for young members of the lab. Usually it has dedicated resources such as annual budget and relevant research equipment. It may manage its research incomes generated through research projects. The life time of a lab usually more than 10 years, depending on the needs and commitment of the academic authority in the university. Academic Senate or similar body at the faculty or department level is usually consulted for the establishment or closing of such lab.

- **Research Center or Research Institute**: This is the most formal structure for accommodating research activities within a university. The main function is to carry out substantial research sustainably. Research activities undertaken by such center may cover wide areas of spectrum, from fundamental research to experimental development. Usually, a research center has a specific area of focus, which is determined based on real-world problems (instead of academic discipline). A research center is fully resourced with full management function. The center is usually established at the university level and is multidisciplinary in nature. Thus it has access to researchers (faculties) from different schools/faculties, and possibly from outside the university. The key performance indicators of such center include academic (research performance) and non-academic (financial and management performance). It usually has adequate level of autonomy as far as management and governance aspects are concerned, and the performance of the director is appointed and discharged by Rector or President of the university. The

establishment of a center usually requires approval from Academic Senate and/or Board of Trustees as it has academic and resources implication.

Graduate students are the main sources of research assistants for the above mentioned structure. In case of Research Center, the involvement of graduate students should be carefully designed and planned. Research projects are usually to follow a very strict schedule with clearly defined deliverables. Such deliverables are usually not in the form of theses or dissertations. In some instance, research results are to be kept confidentially (not for public consumption). Thus, some kind of interfacing or internal arrangement between the department and the center may need to be established.

Developing a research-based graduate program

The development of graduate programs requires rigorous and complex planning and management functions. Starting from its establishment, to curriculum development, program implementation, to resource development, all involves procedures comprising academics and non-academic aspects. The followings are aspects to be considered for the development of graduate programs:

- **Establishing or opening up a graduate program**

  This can be using a bottom up or top down approach. Either way, a team of faculty members should initiate the process by composing a comprehensive proposal for the establishment of the graduate program under consideration. The proposal should at least constitute: a background and rationale for establishing the program, readiness of resources for running the program, curriculum design and expected graduates competencies, projected enrollment for the first five years, and resources and management plan. The team is composed of subject experts from relevant disciplines which may come from one department or several schools in case of a multidisciplinary graduate program.

  Depending on the academic governance in the university, the proposal is evaluated and approved by different bodies such as Curriculum Committee, Academic Senate, and Internal Quality Assurance. The final decision is usually taken by the President after taking into account recommendation from the abovementioned bodies.

  The general principle is that a new program may only be established if it fits within the university overall plan, feasible resource-wise, and prospective in terms of demand.

- **Curriculum development**

It is critically important to have a regularly reviewed and updated curriculum particularly to keep abreast with the fast changing science and technology as well as changing in the society. Particularly for graduate programs, such review and update should be done more frequently something like once in every two to three years. The head of school or the respective department head should establish a team for the curriculum development.

During the review process, the team shall consult both internal and external stakeholders. It is also commendable to get feedback from representative of alumni. Inputs and feedback from stakeholders are usually gathered through in depth interview or focus group discussions. In some areas, there exists professional organization or international body which produces standard curricula that is used as reference by academic community globally. Example of such organizations are ABET for Engineering, ACM/IEEE for Information and Communication Technologies, AMS for Mathematics, etc. The team shall use such curricula for reference.

Graduate program curricula should instill research capacity and culture into graduate students throughout the education process. Therefore, the curriculum should be designed in such a way that students are equipped with research skills and that it provides opportunities for engaging students in R&D activities.

In case of research-based, research-led, or research oriented graduate programs, the design of the curriculum should be adjusted accordingly. For Mater or Doctoral program by research, for example, element of coursework in the curriculum should be kept minimal.

Unlike in the development of undergraduate curriculum, the relevant aspect of research-based graduate programs should be reflected in its sensitivity to the demand for graduates with the competencies to carry out scientific research. Thus, in addition to subject matter competencies, the intended learning outcomes should cover also competencies to undertake R&D activities. In addition, in the aspect of learning process, learning methods in graduate programs should be designed in such a way that it not only caters for adult (matured) learning paradigm but also promote conducive academic atmosphere through collegial interactions in a research team.

- **Students supervision and research skills development**

As described earlier, students should be equipped with sufficient research skills in order for the integration to be successful. Of equally important is the supervision of graduate students should be implemented in such a way that it at the same time

cultivate students' research capacity. The following strategies may be considered to achieve the aforementioned goals:

- ***Research methodology course***: One way to develop students' research basic skills is to devise a research methodology course and make it mandatory for every graduate student. The learning objective of this course is to provide an opportunity for students to establish or advance their understanding of research through critical exploration of research language, ethics, and approaches. The course introduces the language of research, ethical principles and challenges, and the elements of the research process within quantitative, qualitative, and mixed methods approaches. Students will use these theoretical underpinnings to begin to critically review literature relevant to their field or interests and determine how research findings are useful in forming their understanding of their work, social, local and global environment. This course should provide balance between theory and practices, with sufficient hands on practical works to be done by students.

- ***Research Assistantship***: Graduate students engagement in research undertaking may easily be implemented by recruiting them as research assistants (RA) in research project. Funding for RA recruitment may be taken from research grants. RA positions should be made public and students are recruited based on open recruitment. Students' involvement in the research project should be part of their study load, such as thesis or other form of assignment.

- ***Scientific writing***: One of the needed key skills to be acquired by graduate students is the ability to communicate their ideas in a formally written scientific paper. It is therefore commendable to have special course on scientific writing for graduate students. This course teaches students to become more effective writers, using practical examples and exercises. Topics covered in the course usually include: principles of good and effective writing, tricks for writing faster and with less anxiety, the format of a scientific manuscript, and issues in publication and peer review. This course may also be used to improve English writing skills.

- ***Seminars***: Graduate students need to develop their knowledge and skills in communicating their ideas in scientific communities, rigorously analyzing works of other scientists, as well as responding to critiques from other scientists. Such knowledge and skills are believed to be effectively developed through a seminar course.

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- **Infrastructure and facilities**

To run a research-based graduate program, proper research infrastructure and facilities should be put in place. Graduate students should be provided with adequate space to work and most importantly access to research facilities and equipment. In some areas, students spent most of their time in research laboratory.

In some cases, research resources may be accessed remotely by means of ICT. Access to online journal or digital library should be provided for students. Thus sufficient bandwidth for Internet connection should be sufficiently provided to all graduate students. Current practice for the bandwidth requirement is around 512Kbps per student.

In other cases, relevant research equipments are available outside the university such as in the government research institutes or in industries. Thus external linkages and networks should be developed to make students' access to such facilities possible.

In addition to equipment, in some areas of disciplines, research works requires certain consumables such as chemicals or other materials or experimental animals. Such consumables should be made available any time needed by students, and thus may requires special storage or warehouse to keep the stock safe.

All in all, to effectively support the implementation of research based graduate programs, a proper management function to manage research infrastructures and facilities is of paramount important. This function certainly needs to be supported by professional administrative staff and technicians.

- **Funding and financing**

Running research-based graduate program is indeed a costly business. Yet students' tuitions and fees alone are by far adequate to support a good quality of graduate programs. Particularly for research-based graduate programs, charging students for supporting research activities will be unjust. On the contrary, students are normally waived from tuition for their contribution in research undertaking. In some countries, doctoral students are recruited as research assistants and are paid as regular employees.

Research grants or contracts are usually considered as the main sources of funding for supporting research-based graduate programs. It should be noted, however, that such grants and contracts usually cover operational research

expenditure only. Expenditures for development and particularly for capital investment are covered by the government.

Science ethics and academic conduct

Судалгаанд суурилсан ахисан түвшний хөтөлбөрийн нэг гол зорилго бол судлаач болох чадамжтай төгсөгчдийг гаргах юм. Шинжлэх ухааны судалгаа гэдэг бол өөрийн гэсэн үнэт зүйлүүдтэй гэдэгтэй хүн бүр санал нийлдэг. Тиймээс суралцах явцад нь ахисан түвшний оюутанд шинжлэх ухааны ёс зүй, үнэт зүйлийг ойлгуулах нь маш чухал юм. One of the main objectives of implementing research-based graduate programs is to produce graduates with the competencies to become researchers. In this regard, it is universally believed that scientific research is not a value-free zone. It is therefore very important to instill science ethics and values in graduate students throughout the process of the study.

Үүний тулд тусгайлсан хичээлийг бий болгох шаардлагагүй бөгөөд ёс зүйн үнэт зүйлийн талаар судалгааны багийн удирдагч эсвэл гишүүд нь оюутныг тодорхой жишээн дээр зааж сургаж болно. Их сургуулийн зүгээс багш нар, судлаачдыг шинжлэх ухааны ёс зүй, эрдэмтний зан байдал…. талаарх дүрэм журмыг хатуу дагаж мөрдүүлэх ёстой. In the research-based graduate programs, such ethics and values may be effectively instilled in students through providing examples which are directly exemplified by PI or members of research groups. Thus, there is no need to devise a special course on the matters. The institution should, however, make sure that faculty members (researchers) are strictly adhered to and in compliance with the university regulations regarding science ethics and academic conduct.

Их сургууль нь халаасны ном эсвэл гарын авлагыг боловсруулан гаргаж, судалгаанд оролцож байгаа оюутнуудад тараахыг зөвлөж байна. Энэ шинжлэх гарын авлагын агуулгыг боловсруулахдаа тухайлбал, “the Ethics of Science” by David B. Resnik гэсэн интернет дээр байгаа үнэгүй номыг ашиглаж болно. Их сургууль нь ёс зүйг үргэлж дагаж мөрдөхийг шаардахаас гадна зөрчсөн тохиолдол бүрийг тухай бүрт нь анхаарал хандуулж, зогсоож байх хэрэгтэй. It is advisable that university develops some form of pocket book or practical guide to be distributed to students upon their involvement in the research group. Key substances in the pocket book can be adopted from textbook on science ethics, for example “the Ethics of Science” by David B. Resnik, which is available for free on the Internet. The university should at the same time enforce the ethics and conduct consistently. Any form of misconduct or irregularity should be properly attended and deterre

Mongolia: Higher Education Reform Project

ADBProject No. 43007-023

Project Code: HERP MON Loan No. 2766

Consulting Services for Higher Education Reform

Funding Model for R&D Activities in HEIs

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Background

 The Government of Mongolia assisted by the ADB Loan No 2766-MON commissioned the higher education reform project called HERP. One of the development objectives of the project is to improve the quality and relevance of higher education programs, which includes the improvement of the quality and relevance of R&D activities within higher education institutions in the country.

 Our online survey which was conducted between September and December 2015, participated by 246 faculty members of Mongolian HEIs, clearly revealed that significant number of respondents considered that the current scheme of funding allocation for research is not satisfactory (66% consider that the competitive grant scheme is not transparent, 53% consider that the funding scheme is not fair). In addition, 72% of respondents considered that research funding is not easy to get. Meanwhile, the same survey also revealed that faculty members of Mongolian HEIs are potential pool of productive researchers, as indicated by 78% of respondent are engaged in at least two research projects during the last five years. Furthermore, 90 respondents published at least two papers in international journal, and 110 of them presented at least three papers at scientific international conference during the last five years. Interestingly enough, during the same period of time, 93 respondents claimed to have produced at least 1 IPR product, where 57 of them have been adopted by industries.

 Considering such research potentials and shortcomings of the currently implemented competitive research grant, we recommend the following funding model for supporting the R&D activities in Mongolian HEIs.

Mobilization of Research Funding

 The Government total Expenditure on Research and Development (GERD) for 2015 is around 0.17% of GDP[2]. This figure is significantly below the stated target prescribed in the Government master plan on Socio-Economic Development 2021, which was set at 1.5% of GDP as its final target. In 2013 fiscal year, for instance, the total GERD was around 41.5 bln. Tugrics. Out of which 24.8 bln Tugrics were administered by NSTF, where around 17 bln. Tugrics of which goes to salary of researchers working for the government research institutions. This implies that there are very limited Government research budget available for universities to carry support their research activities.

[2] Quoted from the Vice Chairman of the Mongolian Academy of Science, during the interview on 26 Jan 2015

- Our recommendation is therefore that the Government gradually increases its GERD i.e. 0.22% annually to reach the stated target of 1.5% of GDP by 2021. There are at least two major reasons as to why the government should allocate funding for R&D activities in HEIs:

    1) Fundamental and/or academic researches are public goods and of strategic importance for the Nation economic and S&TI development. Universities are the best place to cultivate and undertake such kind of works.

    2) Universities have the mission to prepare human capital including scientists for the future. R&D activities in HEIs are highly critical for carrying out such mission.

- Considering that business and private non-profit sectors lack of interest in undertaking R&D activities in this country, there will be only two major performing sectors which will carry out research undertaking i.e. the government and higher education institutions. The government is expected to allocate its GERD based on and proportional to the past performance of the two sectors.

Allocation Schemes

- Competitive scheme for research funding has been widely implemented in many countries. It is not only effective in the sense that it stimulates quality improvement but also is considered fair in the perspective of public financing. However, competitive scheme alone will widen the gap between less and more experienced researchers, and is leaving the weak with none.

- For the above reasons, we propose three schemes for allocating Government funding for R&D as follows:

    a. Research capacity development grant

- The main objective of this grant is to develop research capacity within the target institutions (can be universities or research institutes). It can be used for training of research methodologies or research proposal writing, improving research management, supporting small research for young academics, establishment of research groups or research centers, etc. This grant window is directly allocated to the targeted universities (HEIs), based on some predetermined criteria. Such criteria may include: past research performance of the institution, soundness of the institution's research plan and strategies, number of researchers, etc.

 This grant is granted based on the quality of the proposal submitted by the proposing institutions (individual is not eligible to submit proposal). Since it is not a competitive grant, theoretically all good proposals will be granted. The grant implementation period may take one to two years, where funding is disbursed in tranches based on the implementation performance.

Typical performance targets for this grant are:

- Improved internal management of R&D activities
- Improved capacity in carrying out R&D activities (e.g. increased number of research awards or grants, number of trainees, etc.)

b. Performance-based Center grant

 The objective of this grant is to support the development of substantial research program in one particular area of focus. It is meant for providing multi-years and substantial research funding for a research center (or institute) within HEIs. It is allocated based on the quality of proposal submitted by the research center. Criteria for evaluating the proposal may include: the overall quality of the proposed research plan, research capacity and past performance of the center, relevance of the proposed deliverables, etc.

 This grant window is usually a multi-year grant range between 5 to 10 years. Funding is granted based on a contract, which explicitly states the performance target to be met annually and at the end of the grant period. The contract reflects a mutual agreement between the government and the awardees, regarding the performance target.

 Eligible cost components for this grant may include: procurement of research equipment, hiring research assistants (graduate students or postdoc), consumables for research activities, institution overhead cost, etc.

c. Competitive Research grant

 The objective of this grant window is to support individual or team of researchers to carry out specific topic of research. The currently implemented grant window can still be implemented with some revisions, as suggested in the last round of competition. As suggested before, this grant may be targeted at two major streams, i.e. academic oriented

research and industrial research. While the first one aims to promote knowledge creation through theoretical and fundamental researches, the second is to forge stronger linkages between universities and industries. Both types are of equally importance and needs to be continuously supported by the government.

- The academic oriented research stream may cover several thematic development such as basic or fundamental research, applied or developmental research, international research linkages, etc.

- As for the industrial research stream, some form of matching funds from partners industry or at least expression of interest to adopt research results shall be required. Industrial research will be benefiting the industry including monetary benefit. Therefore, contribution from partner industry to fund the research activities is highly logical.

- As the grant is implemented competitively, there should be sufficient level of competitiveness. It is usually required that the level of competitiveness is at least 33% which means that for every single award there should be at least 3 proposals being received.

- The grant is preferably linked to the teaching of graduate students. Thus, involvement of graduate students in the research team and evidence of improved completion rate in graduate program shall be imposed as one of the requirements for receiving this grant. Therefore, eligible expenditure items for this grant shall include budget for hiring graduate students as research assistants and possibly tuition and fees for Master or Doctoral students.

- The performance targets for each type of research should be clearly defined. Typical performance targets for academic research include:

  - Number of papers published or accepted for publication at reputable scientific journal

  - Number of papers presented at recognized international conferences or seminars

  - Number of theses or dissertations completed under the theme of the research project.

- Whilst the performance targets for the industrial research shall reflect the relevance of the research outputs to the need of real sectors, such as:

  - Number of patents (or other form of IPR) being registered

- Number of patents (or other form of IPR) being adopted by industry
- Proportion of funding contribution from industry for the project.

 The review process of competitive research grant should not only be fair and transparent, but it should also be seen as fair and transparent. Criteria used for proposal selection and procedures employed during the selection process should be publicly announced. In addition, there should be feedback for those who submitted proposal but did not successfully get the grant. The review panel shall preferably be peers from the same field or those with relevant competencies. In case of industrial research, review panel may include professional from industry knowledgeable on the area under consideration.

The implementation of the above three schemes should be audited and reviewed periodically, and shall be overseen by some board which is responsible for ensuring that the objectives of the funding schemes are met. The office or unit who implement the grant should be accountable to the board as well as to the government (MECS). Guidelines for each of the grant windows should be made public and consistently adhered to.

Utilization and Accountability measure

- Research undertaking is a complex business. Research methodology and thus its cost structure varied greatly between fields of disciplines. Therefore, any attempt to make standardized cost components for all types of research will be bound to fail. In this regard, funding schemes for research should be made so flexible that any type of research coming from any field of discipline may be accommodated. Rather than making a set of rigid allowable expenditure components, justification of the proposed budget may as well be better be required.

- Allocation of research funding should be in the form of block grant instead of line-item grant. The principal investigator (PI) will be responsible to make optimum used of the funding to meet the stated targets. Of course, the proposed budget outlay explicated in the proposal should be used as main reference, but changes in the course of implementation should be allowed with of course acceptable justification.

- While financial report is importance, the main measure of accountability for a PI will be to deliver whatever promised. Thus, performance evaluation or auditing of research grant should be emphasized more on outputs rather than process.

- Research is an exploratory encounter with some degree of uncertainty for success. Thus, unsuccessful research in academic pursuit may still have some merit. Penalizing unsuccessful PI should not be in the form of monetary penalty.

Scholarships for Postgraduate Students

- University researches and graduate students are inseparable. Thus it is critically important that university are attracting the best graduate students with adequate and relevance knowledge and skills. Some of them, particularly those who are keen in doing research, can be recruited as research assistants.

- In some cases, universities are having difficulties in attracting the best and brightest to their graduate programs due to competition from overseas universities. One way to attract such good students is by providing them with a package of scholarship. But for some universities, providing such scholarship is far beyond their capability.

- Just like what the government has provided for undergraduate students, the government is also expected to increase the number of scholarships for graduate students. Such scholarship may be tight to their involvement in research (e.g. being recruited as research assistants). The scholarship may also be targeted for graduate students studying in priority areas.

- By providing more scholarships for graduate students, the government will not only reduce the cost for supporting those studying abroad, but at the same time also promote the quality and competitiveness of domestic graduate programs.

- The abovementioned scholarship is preferably in the form of grant. However, some forms of income contingent loan may also be considered.

Example from Developing Countries

- The funding models discussed above are taken from good practices implemented in various countries. The Higher Education Funding Council for England (HEFCE) has been innovating and implementing various funding models for many years including the ones discussed in this report. In this section, examples of the implementation of the aforementioned funding models will be taken from Indonesia.

- The government of Indonesia's spending on R&D has been gradually increased during the last two decades, reaching up to around 0.1% of the national GDP now. The funding is predominantly managed by the Ministry of Research, Technology and Higher Education (was previously under the Ministry of National Education). The lion share of the research fund goes to universities, where most researchers are affiliated with. Information regarding this may be found in the http://simlitabmas.ristekdikti.go.id;

- The ministry divided the government research budget into two parts. The first part is managed centrally by the ministry and the second one is decentralized and is allocated directly to university, research institutes, and private university coordinating offices.

- The decentralized part is allocated to the executing institutions based on their past research performance. This fund is managed by the institution according to a general guidelines issued by the ministry. The guidelines outline the general principles, objectives, as well as KPIs to be met by the executing institutions. This fund may be used for institutional capacity development in R&D as well as for pursuing institution's research main thrust.

- The centrally managed part is allocated through competitive or assignment scheme. The competitive research grants constitutes a number of grant windows such as: basic science/fundamental research, graduate education grant, industrial collaboration grant, and international collaboration grant. Those grant windows are at the same time functioned as tiered system, so that researchers from different area of interest are not competing between one and another. The ministry already established a pool of experts (reviewers), mostly recruited from universities, to help the ministry in evaluating and reviewing proposals during selection process. The grant is directly allocated to the PI who is selected as the awardee based on a contract signed between the PI and the authority in the Ministry. Although the contract is multi-year, funds are disbursed annually in trenches. The next disbursement is subject to the performance or progressed of the work, as per agreed upon indicators stipulated in the contract.

- The assignment scheme is usually based on the programs formulated by the ministry. The institution which will carry out the assignment is chosen based on the institution's track record, research focus, and development plan on research. The government defines a specific medium to long term research project and asks an institution or consortium of institutions to carry out a specific topic of research which is of strategic importance to the government. Examples of such topics are: on dengue virus related diseases, aging society, food security, etc. which are usually multi and interdisciplinary researches. The size of funding is usually quite significant and covers capital investment as well as operational cost.

Implementation checklist

1. Guidelines for proposal submissionn→ NOL (approval) from ADB
2. Call for proposal announcement + workshops for proposal writer
3. Establish pool of experts panel (reviewers) → endorsed by MECS
4. TOR for proposal selection
5. Workshop for reviewers on Review Process (as per the TOR)
6. Proposal submission
7. Review process
8. Grant award decision → NOL from ADB
9. Announcement
10. Contract template → NOL from ADB
11. Contract signing and first installment of payment
12. Progress report + second installment of payment
13. Final report and output presentation (Seminar)

Checklist for Guidelines for Proposal Submission

The guidelines shall contain at least the following substances:

1. Grant development objectives
2. Size of the grant & Duration for implementation
3. Eligibility and criteria for proponent
4. Eligible expenditure item (if any)
5. Selection procedures and criteria
6. Format for proposal (unless it's free format)
7. Schedules for grant administration

TOR for Proposal Selection shall constitutes at least:

1. Selection process and procedures
2. Elaboration of selection criteria
3. Scoring system or qualitative judgement
4. Evaluation report format to be submitted by experts panel
5. Code of conduct for reviewer

Inputs for the implementation of the Competitive Research Grant (CRG)

With regard to the implementation of the Competitive Research Grant under the HERP, please consider the following:

1. Guidlines

- As per the request from the ADB, the guidelines shall state that the proposing team of researcher shall include at least one female member;
- Since the objective of this grant is to improve the **quality** and **relevance** of the research activities within HEIs, the grant may be divided into two categories of research, i.e. academic research and industrial (applied) research.
- In case of industrial research, some forms of matching fund (in cash or in kind) can be applied as condition for the award. The minimum proportion of the matching fund can be set at 25%;
- The guidelines shall explicate clearly what kind of outputs are expected to be produced for each type of research upon completion of the grant. I would suggest to measure the outputs using the following indicators:
    - Academic research: published paper in a reputable international journal (with SJR > 1.0 or H-index > 10)
    - Industrial research: registered patent/IPR or Formal Statement of Adoption from industry
- The guidelines shall encourage also collaboration between academic institutions. Joint proposal by team of researchers coming from two or more universities shall be considered as plus points.

2. Application forms

Due to the short period of implementation (which is of only less than 15 months), the grant can only be awarded to a team of researchers with strong research track record and good research plan. Thus the application form shall constitute the following:

a. Academic qualification of each member of the research team

b. Track record of the Principal Investigator during the last 5 years

- List of previous research projects
- List of publications or patents/IPR

c. Letter of intent from industrial partner in case of industrial research

d. Brief description of the research work

e. Rationale and justification on why the proposed work is important

f. Methodology/approach employed

g. Expected outputs

h. Work schedule

i. Proposed budeget outlay

3. Review Process

The following items should be included in the TOR for the review process of the competitive research grant

a. Brief description of the grant: who the applicants are (group of researchers from HEIs), size of the grant, implementation time frame, authorities in charge of the grant;

b. Objective of the grant: taken from the guidelines

c. Competition scheme employed: it is open/free for all competition (non-tiered) or stratified; one stage competition or thru pre and then full proposal;

d. Detailed explanation of the selection criteria: what they are and how to objectively measure each of the criterion;

e. Principles: objective, fair, transparent, no-conflict of interest.

f. Detailed procedures and steps of review process: one proposal will be reviewed by a panel of 3 experts; scoring system & evaluative comments; desk review (each member of the panel will work independently to evaluate and score the proposal); presentation (PI presented its proposal in front of the panel; time allocation for presentation, Q&A, scoring); consolidating individual score; resolution for any split decision;

g. Individual report format and Consolidated report format

h. Review schedule

i. Procedure for report submission by individual member of reviewer (expert)

4. Workshops for Prospective Applicants

The purpose of this workshop is to disseminate information regarding the CRG to as many prospective applicants as possible and to improve the quality of the submitted proposal;

Workshop constitutes two main substances:

a. Information regarding the grant administration and competitive process

b. Tips on how to write a good research proposal

Workshop materials particularly for item a. are to be posted in evey university's homepage. Brief info about the grant can also be prepared in poster format to be posted in evey university.

Application Forms for Competitive Research Grant

A. Identification

a. Title of the Proposed Project:

b. Name of the Principal Investigator:

c. Affiliation

- Department/Institute:
- School:
- University:

d. Type of the proposed project (choose one)

- Research & Development (Academic research)
- Experimental Development (Industrial research). + Name of the partner industry
- Initiation of an international research collaboration. + Name of the scientist/researchers and its affiliation.

e. Total proposed budget:

B. Project Descriptiton

a. Background and rationale

b. Objectives and target outputs

c. Description of the project (including novelty and sophistication of the proposed methods/approaches, state of the arts of the work, as well as level of innovativeness)

d. Resources required to implement the work and proposed budget outlay (including justification for each proposed expenditure component)

- The budget outlay can be categorized into four to five expenditure components such as personnel (salary), equipment, consumable, travel, and miscellaneous;

- In case of industrial research – please state the amount of matching fund committed by the industrial partners. Matching fund is on top of the grant.

e. Work schedule (monthly schedule)

C. Project Team (PI, co-PI, Research assistants, students; including also partners from outside)

a. Name and Gender

b. Field of expertise

c. Position in the team

d. Qualification

D. Annexes

a. CVs of PI and co-PI (please include only information relevant to this grant in the CV; PI for academic research shall have at least one publication in a reputable international journal during the last 3 years; and patent or other forms of IPR for industrial research). CV of the collaborating partners, in case of initation of international research collaboration, shall also be included.

b. Letter of statement from head of school regarding the full-time status of the PI, or from head of institute in case of PI is not a faculty members.

c. Endorsement letter from the respective University Academic Council;

d. Expression of Interest and letter of commitment for the matching fund from partner industry (only for industrial research);

e. Letter of support from the collaborating partner (overseas scientists/researchers) in case of initiation of international research collaboration.

Mongolia: Higher Education Reform Project

ADBProject No. 43007-023

Project Code: HERP MON Loan No. 2766

Consulting Services for Higher Education Reform

Public-Private Partnership for Supporting R&D Activities in HEIs

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Introduction

Research and development (R&D) activities are one of the core functions of universities (or higher education institutions in general). The objectives of the activities are twofold, to advance science and technologies, and to prepare students to become scientists. R&D activities in some cases are very costly due to expensive research consumables such as chemicals or operational cost for state of the arts equipments. In many instances, funding from government or tuition and fees are by far adequate to support such expensive undertaking.

In the mean time, industrial development even in the low tech industry, requires continuous innovation and supports from R&D activities. Particularly in this globally competitive world, innovations and industrial researches are very critical for industry to stay in business. As not many industries can afford to establish their own R&D division, such undertaking are usually done by universities.

As industrial research are meant for solving industrial problems and expected to significantly contribute to the performance of a company, funding for such researches are usually coming from the industry itself. Due to its significant and prospect contributions, companies are willing to substantially invest their money to support such researches. Financial supports and industrial problems are at the same time seen by universities as opportunities to support their R&D endeavors.

Some universities in Mongolia are already initiating and some even have successfully undertaken innovative researches which are then adopted by industries. Cases In hand is the herbal tea developed by Prof. J. Batkhuu from School of Engineering and Applied Sciences of NUM, which has been adopted by MONOS – a leading pharmaceutical company in Mongolia. Similar cases can also be found at MULS, MUST and MNUMS.

This document presents elaborately how to initiate, implement and escalate R&D based linkages between universities and industries so that such linkages will provide mutual benefits for both parties.

Triple Helix Model

The role universities can play in economic development depends not only on their current level of interaction with government and industry, but also on their capacity to play a proactive role with respect to other actors. Considering the capabilities of universities, the extended triple helix model for development is more suitable to be implemented. According to Etzkowitz's model, the three separate institutional spheres - universities, industry and government - will initially operate independently from each other. In the first

stage of the development of innovation systems, each sphere develops a ‘knowledge space’, where knowledge institutions begin to concentrate certain R&D activities related to the region, with some networks emerging around them. In the second phase, the region develops a ‘consensus space’, where actors from the three spheres begin to work together to generate new strategies and ideas. In the third phase, the region develops an ‘innovation space’, where new organizational mechanisms are developed or introduced to realize strategies developed in the previous stage.

The model has also been extended to describe the positioning of the three spheres with respect to one and another. In a statist regime (Triple Helix I), government plays the leading role in driving academia and industry. In a laissez-faire regime (Triple Helix II), industry is the driving force, and the other two spheres act as ancillary support structures. In a knowledge-based society, universities and other knowledge-producing institutions increase their partnership with industry and government, often leading such joint initiatives, in a balanced model (Triple Helix III). In a university-led developmental model, the university takes the lead and becomes the gravitational center that initiates partnership. In this case, the first step in forming a productive partnership is to have a preliminary encounter with industry and the government.

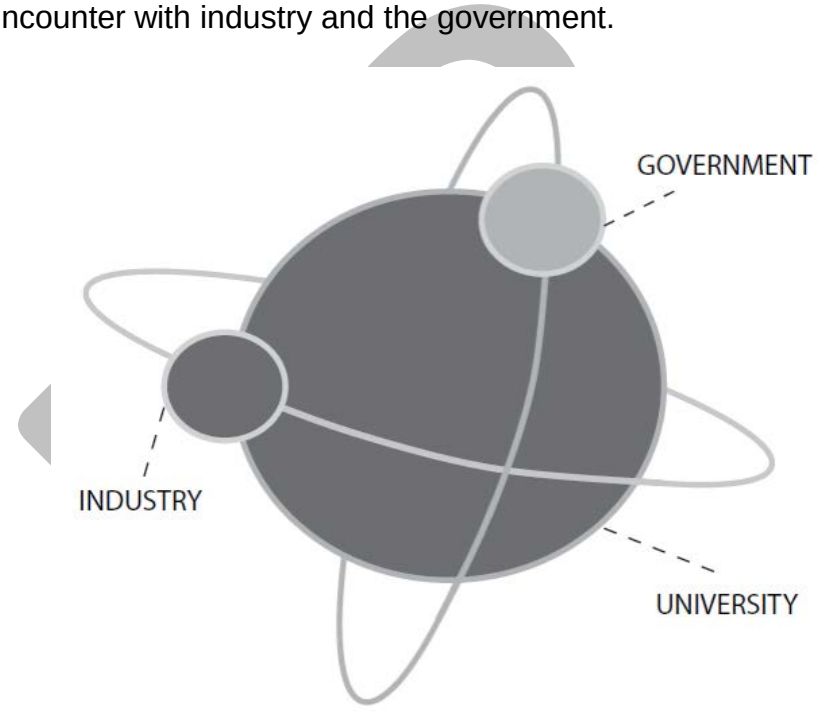

Figure: Triple Helix III Innovation Space

University-Industry Linkages

In the developed or industrial countries, university-industry linkages have been strongly established for many years. The interactions are mutually developed and are driven by

common interest between the two parties. In the developing countries, however, such linkages are not easily established. There seems to be a wide gap between the two. In one hand, the needs for research and innovations are not strongly present around industries as they are mostly still in the early stage of maturity, or in the case of multi-national companies, R&D activities are usually done by the principal company.

On the other hand, universities' research activities are still dominated by general or academic researches, which are done as part of the teaching activities. Faculty members are mostly overloaded by teaching assignments leaving very little time allocated for undertaking research activities. In addition, education programs including at graduate levels are dominated by course-based programs, where students' involvement in research work is barely minimal.

Cognizant of the above situations, special schemes of linkages between industry and universities should be designed and be systematically developed. University-industry linkages should be developed based on the following principles:

- **Mutual trust**: good linkages should be based on mutual trust between the two parties. Such trust must be intentionally developed as it cannot happen by chances. Universities should proactively approach industry and demonstrate their willingness to collaborate with sincerity. As external stakeholders, industry will also expect that universities are to implement professional management practices and adhere to the principles of good governance. Likewise, industries are expected to respect academic norms and values including academic freedom embraced by universities. In some cases, some forms of non-disclosure agreement (NDA) may be established to ensure secrecy of research results which due to its strategic important needs to be protected.

- **Mutual interest (needs)**: Universities should understand fully what kind of research works are needed by their industrial partners. In many instances, faculty members do not adequately comprehend industrial problems due to lack of industrial experiences. This is understandable for most academic faculties spend most of their time within university environment. Likewise, industry should have adequate knowledge on what kind of researches and innovations are happening in universities. It should be noted, however, universities and industries are sometimes using two different ways of describing the same things. Thus, some forms of interfacing may need to be put in place.

Keeping the abovementioned principles in mind, the following strategies may be considered by university that are aspiring for forging stronger research linkages with industries:

1. **Industrial board**: Industrial board is an advisory board which advises the university leadership on current development or trend in the world of industries. The board may be established at the university or faculty level or both. Members of the board are representatives from industries (usually CEO or Director) where universities have their interest in the sector. The board meets with university top management team regularly (say twice or thrice a year), to discuss and decide on strategic level issues appertain to university-industry collaborations.

2. **Industrial apprenticeship**: As described earlier, faculty members need to be exposed to and to comprehend fully industrial problems. One way of devising such exposure and improve such comprehension is through industrial apprenticeship, by giving the opportunities to faculty members to stay and work in industries for some period of time. Similar scheme may also be applied to students where students are working for 3 to 6 monyhs in industry under the supervision of faculty members.

3. **Industrial lecture**: University invites and provides opportunities to experts from industry to give lecture for students or presentation at seminar. The industrial lectures will not only benefit students or faculty members on the current development and issues in a certain industrial sector but also provide the opportunities to professionals from industry to learn how academe work and do their business. Topics covered in the lecture may also include industrial good practices related to entrepreneurship and business development strategies.

4. **Industrial research**: This is the ultimate goals of the linkages where industries are contracting their research needs to its partners' university. It's usually in the form of multi-year contract, where the research works are fully financed by the industry. In return, products of the research will be fully owned by the industry. Unless prohibited as stipulated in the NDA, researchers may publish academic substance of the research in scientific journal. Industrial researches are different in nature with academic researches, particularly in terms of deliverables and time frame. While academic research produces scientific papers, the main deliverables of industrial research are design or prototype or other form of intellectual property as prescribed in the contract. While the time frame of academic research is not clearly defined, industrial research has a very clear and tight time frame. Such time frame and detailed schedule are explicitly described in the contract.

5. **Joint development of startups**: Universities are encouraged to commercialize its research results in collaboration with industry (joint venture). Industry may play as a venture capitalist to support seed capital for new startups as well as provide technical knowhow on business development and management.

The roles of the Government

The university-industry stronger linkages will improve both the quality and relevance of higher education programs offered by the university. The government should therefore facilitate and put in place desirable environment for such strong linkages to take place. In this regards, the following roles are expected to be played by the government:

- The government must develop a consistent set of policies and public investments to support its vision of economic growth filled with innovations. The government, in particular, must ensure an effective development of industries with higher value added, particularly in the downstream industries of agricultural and mining products. Affirmative industrial policies are needed to support high value added strategic industries, such as the defense industries.

- The 'incentive structure,' arising from various taxes, subsidies and licensing conditions must be right to promote private investment in high value added industry. An appropriate incentive structure will also create a better environment for businesses, including some state owned enterprises, to compete in more sophisticated products and services. It is also critically important that foreign investors have sufficient incentives to work with local businesses and universities, so that key technology transfer takes place to pave the way for the future. Incentives should also be used to proactively promote philanthropic donation, as they can powerfully shape university development and provide an effective alternative to government funding.

- Governments should support key interactions between universities and industry, particularly with small businesses. These interactions provide experimental opportunities for companies to engage in research and to work with universities. In the US, for example, Small Business Innovation Research (SBIR) provides financial support for small businesses to engage in R&D; each of the multiple funding agencies designates a small proportion of their funding for this purpose. In the Netherlands, as another example, the government offers voucher support for small businesses to be able to gain consultancy help from universities. The government also helps the process of cultural change in industry – including the change in mind-sets- regarding the role of science. This cultural change must occur before industry can actively participate in collaborative work.

- Governments should be responsive to consumer demand for the public goods and services that universities can provide. The Department of Agriculture (USDA) and the Department of Housing and Urban Development (HUD) in the US provide good examples of making funding available for universities to provide service to the relevant communities (e.g. for agricultural extension or for community development).

Conclusions

- The involvement of private sectors in promoting R&D activities in universities will not only help the universities financially but will also improve the quality and relevance of the outputs of their R&D activities.

- University-industry linkages are benefiting both sides equally. Innovations and scientific advancement will increase the competitiveness of the industry which in turns will improve performance and increase profit. Likewise, industrial problems are academically challenging for academic communities (faculties as well as students) which when successfully solved will contribute to the advancement of science and technology substantially. Such linkages will have to be built based on mutual trust and mutual interest from both sides.

- The government will put in place conducive environment for such linkages to grow and provide incentives for universities and industries that are promoting industrial researches in HEIs. This includes consistent policies and strategies for the development of local industries as the main driver for national economy as well as for the development of higher education sector as one of the key elements in the national innovation system.

- Universities have to proactively approach industries and systematically develop capacity to deal with industrial and other real life problems. This includes the implementation of various initiatives such as industrial board, apprenticeships, exchange programs, business incubator, and of course industrial research.

Mongolia: Higher Education Reform Project

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Consulting Services for Higher Education Reform

Recommendations for Setting up National Research Priorities

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June 2016
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Background

It is a common practice that every country establishes its own research priority and agenda at the national level. The national priority and agenda are used as the main reference for the government as well as private sectors in mobilizing their resources and directing the development. In one hand, defining such priority will help the government to optimize the use of public resources by concentrating such resources to the chosen areas of focus. On the other hand, the priority and agenda will systematically steer R&D activities within the defined areas.

In 2010, the Government of Mongolia issued the Resolution No 202 regarding The National Program for S&T Development. It established 9 priority areas for the national S&T development, i.e.:

- Raw resources originated from the fauna, flora and minerals of Mongolia;
- Traditional and national progressive technology;
- Bio-technology;
- Chemical technology;
- Electronic and informational technology;
- New materials and machine production technology;
- Technology for using renewable energy resources;
- Mongolian human development and scientific education;
- Fundamental theoretical research studies.

The resolution explicates also in quite detail policy on financing, information system, and objectives for each direction. It is generally felt however, there has been no significant effect of the abovementioned priorities to the research undertaking as well as resources mobilization as yet.

The question is then how to correctly determine such national priority. Defining the priority is by no means simple and straightforward. It requires rigorous study involving extensive consultations with various stakeholders. Incorrectly defining the priority will run the risk of opportunity lost and waste of resources. This document provides some key principles and good practices for defining national research priority and agenda which may be used as reference for the authority in charge.

Defining National Research Priority Areas and Agenda

As described before, national priority areas should be determined based on rigorous study which includes extensive consultations with experts and stakeholders. The assignment to define such priority areas should come from the top government executive, or be part of the functions of an existing body within the government structure. As it will be explained later, the decision regarding the priority areas will have substantial resources implication. Therefore, it should be officially issued by the government in the form of Government Regulation or Government Resolution.

National research and innovation **policies**, **priorities**, and **management** constitute the three foundations of a research and innovation system. While the policies define the aims and values that guide national research and innovation development, the priorities inform on the key research and innovation areas where the country should focus its investment, while the management plan provides the operational framework necessary to ensure coherence between policies, priorities, and action.

Clearly defined national research priorities are essential to guide research expenditure, to promote science, technology, and innovation (STI), to stimulate human resource development for research, and to inform negotiation processes with external partners for targeted funding and long-term efforts.

The process of defining the national priority areas may follows different methods and procedures. Countries that have conducted priority setting processes have employed a range of methods from those developed by the countries themselves, to Delphi-like procedures, to those methods which have been externally developed and tested, the Combined Matrix Approach, the Advisory Committee Approach, the Ad Hoc Committee Approach, and many others.

The followings are attributes for good method in conducting priority setting:

- The process should be carried out within a clearly defined time frame;
- It should involve all sectors;
- Consensus building among stakeholders was given high importance;
- The process would have to be expert driven, as there were no financial resources for a situational analysis of research conducted in the past (nor was this information readily available); and
- The research agenda should be set for a period of 3 to 5 years, with a mid-term review to accommodate emerging priority issues.

One example of method that can be employed is through consultative expert workshops that would be guided by a clear process, criteria, and ranking framework. Since the

process will involve a number of workshops, coherence across these workshops should be ensured. The priority setting should be systematically done as numerous ideas may come out resulted from each of the workshop.

Another important step in the process is determining the stakeholders that will be involved in defining the priorities. The institutions affiliated with STI include both public and private research and development institutions, across all sectors, as well as institutions of higher learning and non-governmental organizations (NGOs).

Finally, in order for the process to be effectively done, there has to be a clear set of criteria for area to be chosen as a priority. Such criteria may include for example: linkage to the National Development Plan, feasibility for implementing the research; and the possibility for cross-sectoral work.

List of areas resulted from the workshops are then ranked according to the chosen criteria to be short-listed. The short-list will have to be sanctioned again and to reach consensus amongst stakeholders.

Resources Implication

Once the priorities and agenda are being set, there has to be commitment from the top executive of the government that the priorities are observed and the agenda is followed. It should therefore be included in the government National Research Agenda. Resources are then mobilized to support the agenda, with clear mechanism to monitor progress and achievement for each item in the agenda.

Particular resources need to be made available due to a priority setting are:

- **Research funding**: Funding is an effective policy instrument to steer and direct research directions. The government can simply put it in the eligibility and selection criteria that only research works within the priority areas that will be funded. The amount and sustainability of funding should also be secured so that the national research agenda can be implemented.
- **Human resources**: National priorities inevitably imply the need of building up critical mass of researchers within the chosen priority areas. There a need to have medium to long term projection of demand for skills and expertise appertain to the priority areas. Any shortage of knowledge and skills in a particular area should be anticipated and rectified by relevant organization and authorities. Universities will have to respond to it by opening up relevant programs and recruiting more students. Likewise, the government shall ensure that there are adequate resources for fulfilling the shortage.

- **Infrastructures and facilities**: Some research areas necessitate specific infrastructures and state of the arts facilities. The government should therefore make sure that necessary infrastructures and facilities to support research in each of the priority area are available and functioning properly.

End Notes

A national research priority setting process is necessarily shaped by the country's current reality; therefore, there are no specific recommendations on which approach or tool would be best to use. There is, however, agreement on key principles defining the development of a sound priority setting process.

Active involvement of the stakeholder groups helps create a sense of 'ownership' in the process and add much value to the research priorities identified as a result of such processes. An inclusive priority setting process will help ensure that i) important research topics and areas are not overlooked; ii) identified priority research is implemented, because the stakeholders themselves have selected research needs and acquired a sense of ownership over them; iii) priorities are a better match to societal and policy needs of the country; iv) duplication of research efforts and the resulting waste of precious resources are avoided; and v) there is shared responsibility for implementing the national research agenda.

Given the diversity of stakeholder groups participating in a priority setting effort, and their different perspectives, e.g., science and technology, economical, cultural, social, legal, political perspectives, the effort needs to consider how any potential conflicts between the various perspectives will be addressed.

Research priority setting involves a continuous process which requires coordination and periodic re-evaluation with feedback from the previous efforts for continually improving the process, to address emerging and shifting health and development issues.

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Consulting Services for Higher Education Reform

Guidelines for Requirement & Criteria to Evaluate Research Quality

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Background

Competitive or proposal-based research grant has been widely implemented by government as one the schemes for allocating research funding. Such scheme is by far considered effective not only in promoting quality of research but also in meeting the objective of public financing. The implementation of competitive grant, however, necessitates various instruments and rigorous procedures, one of which is the minimum requirements and criteria to evaluate quality of research.

This guidelines provides some good practices regarding the requirements and criteria to evaluate quality research particularly within the context of competitive research grant implementation.

University Researches

Research and development activities are considered as one of the key missions of a university. Such activities have been done as long as the history of higher education itself and the tradition is passed from generation to generation. Unlike in research institutes, along with creating new knowledge, universities use their research activities to educate students who will become the next generation's scientists, engineers, teachers, and leaders in government and industry. In addition, through research activities universities also provide solutions to problems in the society and industries. With respect to its spectrum, university researches cover a full spectrum of activities which includes basic research, applied research, and development.

Basic Research is aimed at gaining more comprehensive knowledge or understanding of the subject under study, without specific applications in mind. A few general examples of basic research would be research on the chemical properties of bacteria, analysis of the interaction of the oceans with the atmosphere, and investigation of properties of a certain algebraic structure in mathematics.

Applied Research is aimed at gaining the knowledge or understanding to meet a specific, recognized need. Following on the examples of basic research, parallel examples of applied research would be using bacteria to inoculate plants against particular diseases, developing computer models of the atmosphere to improve weather forecasting, and solving physical models that follow a certain algebraic structure.

Development is the transformation of research findings or knowledge into plans for new or improved products or processes. This includes product design, testing, creation of prototypes, and pilot projects. Development includes not only civilian products and processes, but also national defense weapons and systems.

University research is a vital building block of the nation's R&D enterprise. Universities performed significant percent of the nation's basic research. For applied research, universities contribution is usually of equally significant as those contributed by research institutes and industrial R&D divisions.

Quality measures

Based on the abovementioned description, quality of university researches should be seen from various aspects which include: academic, training, and relevance. Academic quality is usually assessed through rigorous evaluation by peers. Publication of scientific article in reputable and peer-reviewed scientific journal usually is a good example of such quality measure. High quality academic research addresses the frontiers of scientific and knowledge development and thus become trend setter in that particular area of development. Thus, good academic works will attract other academics to use the results as a stepping stone to pursue further advancement. Thus, number of citations is usually used as additional indicator of quality research as far as academic aspect is concerned.

Quality of training aspect can be seen from the ability of the work to attract (graduate) students to use the work as topic for their thesis or dissertation. A good training process will also improve the success rate for such students to complete their study on time. Therefore, the number of students involved in the research and the completion rate of graduate students are usually used to measure this aspect.

Relevance aspect of research reflects the degree of its sensitivity to the needs of stakeholders. Thus stakeholders' satisfaction is well representing the relevance aspect of research. Examples of such satisfaction include the adoption of research results by pertinent users, such as adoption of policy or procedures by the government, adoption of IPR by industries, etc. Therefore, stakeholders' contribution to research funding can as well be used as a good measure for this aspect.

University researches can also be seen as a systemic undertaking, which constitutes input, process and outputs or possibly outcomes. Thus another angle to measure the quality of university researches is through the quality and capacity of its inputs (researchers, facilities), quality of process (academic atmosphere, documentation), and quality of outputs (scientific publication, IPRs). The most difficult aspect to measure is of course the process as it tends to be dominated by unnecessary administrative process instead of learning and academic interaction.

The outcomes of research undertaking usually occur long after the work completed. Thus it is sometimes unrealistic to use this aspect as quality measures of the work under study. It may however used as proxy measure of quality of past activities.

In terms of spectrum, as already explained before, it should be recognized that basic research should be measured differently with applied as well as developmental research. Academic measures should have more weight in basic research, whilst relevance measures should be more for applied research and development.

Finally, university research is inevitably depending upon the characteristic of field of disciplines. Quality of research in science and technology fields is usually easier to measure than that of humanities, social sciences, and arts. Production of knowledge in social and humanities fields is usually reflected in the publication of books or monograph instead of scientific papers. Whilst in arts discipline, academic research could end up with the creation of masterpiece which is presented in arts exhibition.

Criteria to evaluate quality of research

Based on the quality measures explained earlier, the following criteria may be used to evaluate quality research:

a. Quality of research proposal
    - Significance of research topic (potential contribution to the field)
    - Potential application
    - Implementation readiness
    - Students involvement
    - Budget justification
b. Quality of research process
    - Progress and achievements as per approved proposal
    - Students involvement
    - Stakeholders satisfaction (if any)
c. Quality of research outputs
    - Scientific papers (conference, journal)
    - IPRs
    - Students completing thesis/dissertation
    -

Minimum requirements

University research is indeed a complex academic undertaking with high degree of sophistication. Thus not every university aspires for research. The following elements may be used as the minimum requirements for a good university research:

- **Principal investigator**: capacity to carry out research, adequate training and research experiences (e.g. qualification at least master by research or doctoral degree); including capacity to manage a research project effectively.
- **Basic infrastructure**: Internet bandwidth (access to scientific resources), relevant research equipment (laboratory). In case of research works that does not requires any equipment, at least access to relevant journal or books should be assured.
- **Research assistants**: upper level undergrads students, and graduate students where their involvement in research is part of their curriculum.
- **Institutional commitment**: university should put in place internal regulations that stimulate faculties to carry out research including those appertain to research capacity development, incentives for performers and supporting academic atmosphere.

Mongolia: Higher Education Reform Project

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Consulting Services for Higher Education Reform

Recommendations for Sharing Access to Research Laboratories

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Background

As part of its commitment to promote research quality, the Government of Mongolia has invested in the establishment of a number of advanced research laboratories. Examples of such laboratories are “Joint Laboratory of Natural Sciences” which is managed by Mongolian Academy of Science, “Medical Core Laboratory” which is established in Mongolian National University of Medical Sciences, “Food research center” at MUST, and some other laboratories. A number of research laboratories were also established under the current Higher Education Reform Projects, such as:

1. Bio-mechanical Research lab (MUST)
2. Bio morphology lab (NUM)
3. Ecology lab (NUM)
4. Bio-chemistry lab (NUM)
5. Lab of new material and chemical technology (NUM)
6. Genetics’ engineering lab (NUM)
7. Chemical technology lab (NUM)
8. Computing center on Science and engineering
9. Cloud computing (MUST), etc.

The establishment of the abovementioned research laboratories is expected to promote R&D activities and improve the quality of its outputs. It is also expected that such expensive investments are effectively used by researchers to produce quality research outputs optimally.

The operation and utilization of the laboratories are however quite problematic. It is generally felt that such resources are not optimally utilized. Lab facilities and equipment are primarily used by researchers within the same institution. Access to the facilities from outside the institution is still rather limited.

Some facilities are quite costly to operate and maintain. Such operation and maintenance cost should be borne by the institution where the lab is resided. Examples of such major facilities are: electron microscope, DNA Sequencer, **NMR spectroscopy**, GC/MS, etc. In most cases, operational costs are becoming heavy burden for the institution. Particularly when the utilization rate is low the maintenance cost, which is usually paid through contract maintenance, will become really costly.

Resource Sharing Mechanism

Standard facilities are critically important to carry out frontiers research. Such facilities are usually so costly that it will be uneconomical to invest on such facility by one single

institution. For this reason, it is advisable to make such investment accessible by users from different institutions on the basis of resource sharing.

Resource sharing mechanisms for research laboratory facilities under consideration should be quite simple matters. Resource sharing will not only increase the utilization rate of facilities but also help the institution in generating income for operation and maintenance costs. The following procedures may be considered for improving utilization rates of facilities through resource sharing:

- **Open Access Policy**: The government should obligate the institution where the research labs are invested to issue open access policy regarding the utilization of the laboratory under consideration. The institution then set forth such open access policy which will be followed by formal procedures for the use of the facilities for external users.

- **Unit cost**: Calculate the annual operational and maintenance cost for each of the major facilities. The maintenance cost may be taken from the annual maintenance contract if any. In case of no such contract, past maintenance cost may be used. The operational cost should cover consumables (such as chemicals or other materials), utilities (such as electricity and water), and institution' overhead cost which may include salary for technicians or administrative staff. Based on the above figure, determine the unit cost per use or per time unit for each of the facility. It should be noted that consumables cost will be based on the actual consumables used by particular user.

- **Information**: Information regarding the availability of facilities should be publicized, for example through homepage. The information should at least include specification of the equipment, terms and condition for users if any, cost per use, and procedures and mechanism for using the facilities, as well as contact person address.

- **Formal agreement**: For regular users, it will be better and easier if cost sharing mechanism is supported by some form of formal agreement between institutions. By having such agreement, administrative process which is applied to individual users may be simplified.

In order to make it easier for outside users to place order in utilizing the shared facilities, some form of ICT-based application system should be developed. This will make it possible for a request or booking to be online.

In this regards, since such major research equipments are invested by the government, cost sharing which should be charged to the users should not be intended for recovering the capital costs. In addition, charging mechanisms may take into account also the

purpose of use. The use for education or academic purposes will usually be charged lower than that for commercial purposes.

Resource sharing practices, particularly for expensive research equipment, are widely implemented in Indonesia. The first example is the Inter University Centers which were established by the government around mid 80's. The centers were established in major universities based on a specific theme of discipline, equipped with major research equipment which was intended to support research works in a particular area of discipline. The second example is the basic science laboratory initiative which was established in 2010. Major research equipments such as NMR, GCMC, electron microscope, etc. were procured and installed in some leading universities. Such equipments are open for use by faculties or students from any universities.

Recommendations

- The government issues policy mandating and encouraging the institutions receiving the government investment on research laboratory to make the facilities accessible for researchers from internal as well as external institutions.
- The government set performance indicators for each lab where the utilization rate of the invested facilities is one of the indicators. The number of users from external institutions may also be used as auxiliary indicator.
- Universities set up open access policy for each research laboratory invested by the government, to make them accessible by researchers from outside the university. Such universities should also proactively publicize information regarding major research facilities available in its laboratories which are open for external users.
- Universities encourage their researchers to use research facilities from other institutions if they do not have such facilities on their own.
- Universities shall collaborate with other universities where part of the agreement should include also sharing of research laboratory facilities.

Mongolia: Higher Education Reform Project

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Consulting Services for Higher Education Reform

Recommendation for Classifications of Academic Postgraduate Degrees

Research Policy and Strategy Team

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Background

Higher education system in Mongolia is undergoing transitional stage from the former USSR system to a more like Anglo Saxon model. The transition was marked by the issuance of the Higher Education Law in mid 90s which introduced the credit system. The implementation of the law was however only effective in the late 90s. Since then, the system gradually evolves and is perfected. The implementation of the new system at the graduate level is however rather late.

Quite recently, the government also introduced the new classification of academic programs based on the International Standard Classification of Education (ISCED) which is issued by the UNESCO. The implementation process to adopt the new classification is still undergoing.

To date, the graduate (or postgraduate) programs are still implementing mix between old and new systems. The credit system is adopted but the implementation is not fully using the credit system normally understood in the American system. Examples of such deviation include the interpretation of credit unit for laboratory-based activities, division between academic and professional degrees, etc.

Different Model of Higher Education Systems

Traditionally, there are several model of university systems recognized worldwide, such as the Anglo Saxon model, which is also known as the American systems, the Humboltian model which is also known as the German Model, and Eastern Europe model, etc. Nowadays, university systems worldwide are in the transition toward more market oriented system. Thus based on this perspective we may categorize them into three systems, i.e. Quasi-market system, State system, and transition system. The following table explicates the factors that drive the change and example of countries where such system is being adopted.

Countries	Factors for change	Current system
UK, US, AU, Japan, etc	Market pressures and competitive environment	Quasi-market system
Spain, Finland, Sweden	State influence State stressing the third task	State system with some transformations towards market model
Poland, Russia, Moldova	Adaptation to the market economy and its needs; Unclear role of the state Increasing demand for HE	Transition system with fast transformations towards market model (private sector)

There is also a strong movement in the European Union to establish a model which can easily accommodate and mutually recognize different systems in the world, i.e. the Bologna Process. The Bologna Process is a voluntary higher education reform process, which commenced in 1998/99, with the aim of making higher education systems compliant, and enhancing their international visibility. EUA plays an active role in the Bologna Process representing views of the universities, and participates in practically all its events and activities. Many of EUA projects are dedicated to the development of European policies and practice in the context of Bologna. EUA has also contributed to explaining and promoting the Bologna Reforms around the globe.

Major issues covered in the Bologna Process are:

- A converged degree structure: three study cycles of Bachelor, Masters and Doctorates, laid down in the EHEA Qualifications Framework, which is largely compliant with higher education qualifications in the EU Qualifications Framework for Lifelong Learning. In the Yerevan Communiqué, Ministers agreed to recognize short cycle degrees.
- A joint credit system, usually the European credit transfer system (ECTS) or a compliant system.
- Mobility of students and staff.

- Internationalization of higher education systems and institutions, the international visibility of the EHEA, also named “Bologna in a global setting” or “international attractiveness”.

- A European Dimension of Quality Assurance – based on the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) and the European Quality Assurance Register for Higher Education (EQAR) – so far the only institution created by the Bologna Process.

- Social dimension, lifelong learning and widening access and participation.

- Recognition of study periods, based on the credit system, and degrees, in line with the Lisbon Recognition Convention.

Regarding the degree structures, the Bologna Process introduces the three study cycles, which is also commonly adopted in the North American region. Detailed explanation regarding this matter can be found in the EHEA Qualification Framework. Particularly for the postgraduate (second and third cycle), it constitutes the following learning outcomes:

Qualifications that signify completion of the second cycle (Masters degree) are awarded to students who:

- have demonstrated knowledge and understanding that is founded upon and extends and/or enhances that typically associated with the first cycle, and that provides a basis or opportunity for originality in developing and/or applying ideas, often within a research context;

- can apply their knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study;

- have the ability to integrate knowledge and handle complexity, and formulate judgments with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgments;

- can communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences clearly and unambiguously;

- have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

Qualifications that signify completion of the third cycle (doctoral) are awarded to students who:

- have demonstrated a systematic understanding of a field of study and mastery of the skills and methods of research associated with that field;
- have demonstrated the ability to conceive, design, implement and adapt a substantial process of research with scholarly integrity;
- have made a contribution through original research that extends the frontier of knowledge by developing a substantial body of work, some of which merits national or international refereed publication;
- are capable of critical analysis, evaluation and synthesis of new and complex ideas;
- can communicate with their peers, the larger scholarly community and with society in general about their areas of expertise;
- can be expected to be able to promote, within academic and professional contexts, technological, social or cultural advancement in a knowledge based society.

As far as the degrees are concerned, postgraduate degrees are divided based on its orientation, whether its orientation is academic or work profession. At the second cycle the general degree is “Master”, but they can be “Master of Science or Master of Arts” which is academically oriented or “Master of Engineering, Master of Business Administration, Master of Public Health, etc.” which is oriented toward working profession. Similarly at the third cycle, the general degree is “Doctor of Philosophy” which is academically oriented. Whilst “Doctor of Business Administration, Doctor of Public Health, etc.” is oriented toward working profession.

The Doctor of Science (Sc.D. or D.Sc.) degree which was formerly granted by the Mongolian Academy of Science is becoming less and less found in most countries. There is a trend of using only two models as described above i.e. Ph.D. and professional doctor such as D.BA or D.Ph. Nonetheless, in the US, the D.Sc. degree is equivalent to Ph.D. except that the field is in the science discipline, whilst in the UK, D.Sc. is considered more prestigious than Ph.D. as it requires some kind of substantial contribution in the development of science.

Recommendations

- The government should establish National Qualification Framework (MQF) for Mongolia, based on which the classification of academic degrees at all level of educations shall bedefined. In doing so, the government should make reference to other NQF from other countries in the region. The EHEA framework which is part of the Bologna Process may also be used as reference.

- Universities should proactively adjust their academic degrees and programs, including learning outcomes for each program by referring to an internationally recognized system. It is also advisable to work closely with universities from the Central Asian regions, where the mobility of students and graduates are most likely to happen.

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Recommendation for National Scientific Publications

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Background

International presence of scientific articles publish in Mongolian journal is still very limited, despite the fact that there are quite a few scientific publications already published in this country. If we use the Scientific Journal Ranking published by Scopus or the Journal Citation Reports published by Thomson Reuters, for example, none of scientific publications published in Mongolia was included in the aforementioned two indexers.

Some universities in Mongolia have already taken initiative to publish scientific journals domestically. Some of them are already recognized internationally such as the Mongolian Journal of Biological Sciences which is published by National University of Mongolia, and the Central Asian Journal of Medical Sciences, which is published by Mongolian National University of Medical Sciences.

Meanwhile, there is also regional initiative called "**MongolJOL**" which is part of the JOL Project supported by INASP an international development charity working with a global network of partners to improve production, sharing and use of research information and knowledge. The main objective of this initiative is to promote publication of online journal. Examples of online journal under this initiative are: Mongolian Journal of Chemistry, Mongolian Journal of Agricultural Sciences, and Mongolian Journal of International Affairs.

Issues and Challenges

During the training for editorial board of national journal conducted in January 2016, it was clearly revealed that higher education institutions are striving to publish their journal sustainably. The main issue is not about funding, but more on attracting contributors to publish their article on their journal. Considering the size of Mongolia, the number of scientists who want to publish their articles are still limited. Scientists from overseas are having language constraints if the journals are published in local language. Even if the journal are in English (or other lingua franca), good scientists are more interested in publishing their articles in internationally reputable journal.

It was also conveyed that local journals are having difficulties in attracting members of editorial boards from abroad. Members of editorial boards are still dominated by domestic scientists, with limited international networks.

Sustainability of the periodicals is indeed still very vulnerable. Most are only able to publish two volumes per year. Financial supports for publishing scientific journal rely solely on internal funding. This also gives rise to serious issues on sustainability.

There has been no serious attention from the government with regard to the publication of scientific journal. No special funding is allocated neither the programs to promote the quality of national journal so far.

Recommendations

- The existing scientific journals published by various institutions in Mongolia are very potentials to be further developed to become internationally recognized publications.

- Rather than individually publishing journal of the same topic, HEIs are expected to collaborate and organize joint publication. Considering the size of populations of scientists in the country, one journal for each topic may as well be adequate.

- MECS is expected to facilitate and incentify HEIs that is able to promote their publications to achieve international recognition.

- MECS may also facilitate the establishment of national database of sciences to accommodate in country scientific publications. Such database may be used to index papers which are published locally or published by Mongolian scientists.

- MECS is expected also to systematically assure the quality of scientific journal published in country. Some forms of accreditation for national journal may also be considered. Other avenue is to support the existing publications which are published in English to be promoted for international recognition. Facilitations needed include the requirements set forth by international indexers such as Scopus or Thomson Reuter, i.e. publication of online version, regularity of publication, international diversity of members of editorial boards, etc.

- As it was suggested during the training program, MECS is expected to run regular programs for improving skills and competence of editorial boards members, as well as facilitate sharing of experiences amongst members of editorial boards from different journals.