Preparatory Study
on
the Project for
Higher Education of Engineering
in Mongolia

Final Report

December 2013

Japan International Cooperation Agency (JICA)

Registered Non-profit Organization Asia SEED

Nihon Sekkei, Inc.

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List of Abbreviations

ADB	Asian Development Bank
ATVET	Agency for Technical and Vocational Education and Training
COMECON	Council for Mutual Economic Assistance
EJU	Examination for Japanese University Admission for International Students
EPA	Economic Partnership Agreement
GDP	Gross Domestic Product
GIZ	Deutsche Gesell-schaft fur Inter-natio-nale Zusam-men-arbeit (German Agency for International Cooperation)
GPA	Grade Point Average
GMIT	Mongolia-German University of Technology
HEIs	Higher Educational Institutions
INQAAHE	International Network for Quality Assurance in Higher Education
IT	Information Technology
JETRO	Japan External Trade Organization
JICA	Japanese International Cooperation Agency
JLPT	Japanese-Language Proficiency Test
JPY	Japanese Yen
LECO	Labour Exchange Central Office
MCA-Mongolia	Millennium Challenge Account-Mongolia
MCC	Millennium Challenge Cooperation
MDG	Millennium Development Goal
MECS	Ministry of Education, Culture and Science - Mongolia
MEXT	Ministry of Education, Culture, Sports, Science and Technology - Japan
MNCEA	Mongolian National Council for Education Accreditation
MNT	Mongolian National Currency, Mongolia Tugrik
MSK	Medvedev-Sponheuer-Karnik
MUST	Mongolian University of Science and Technology
NDIC	National Development and Innovation Committee
NGOs	Non-Governmental Organizations
NSO	National Statistical Office of Mongolia
NUM	National University of Mongolia
ODA	Official Development Assistance
OT	Oyu Tolgoi
PDSS	Program Development and Support Service
PIU	Project Implementation Unit
PPP	Public Private Partnership
PQ	Pre-Qualification
RA	Research Assistant

TA	Teaching Assistant
TVET	Technical and Vocational Education and Training
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNESCO	United Nations Educational, Scientific and Cultural Organization
USUG	Ulaanbaatar Water Supply and Sewage Authority
USD	United States Dollar
VAT	Value-added Tax

Introduction: Overview of the Survey

Background of the survey

In recent years the Mongolian economy has grown rapidly with 17.5% GDP growth in 2011, due to mineral resource development. As the economy grows, the need for industrial engineers has increased and higher education sector is also expanding rapidly. However, drastic quantitative expansion of higher education is not yet accompanied with quality upgrading. Only 24% of higher education lecturers are doctoral degree holders, which is a very low rate compared to that of developed countries including Japan which is almost 100%. The insufficient number of higher education lecturers is also a crucial challenge to be tackled. At the Mongolian University of Science and Technology (MUST), the number of students per one lecturer is 29.7 (5.17 at the University of Tokyo). In addition, many students in the higher education major in social sciences including business while there are only 23% of students involved in engineering courses which have limited enrollment capacity in spite of the high demand of Mongolian industry. Development of personnel in the field of science and technology is regarded as an urgent task to sustain a continuous economic growth of Mongolian economy.

The new Mongolian administration that took over in 2012 published “The Action Plan of the Government of Mongolia 2012-2016” which advocates diversification of economics and industry. It expresses that the government would promote; 1) Industrialization of mining, manufacturing, livestock, tourism, etc., 2) High technology, biotechnology, nanotechnology and IT, 3) Production of import substitute goods and exports, and mentions the necessity of human resource development to realize that goal.

To respond to such situation, JICA conducted the “Data Collection Survey on Higher Education of Engineering in Mongolia” from October 2012 to January 2013. The survey extracted priority issues on higher education of engineering and examined effective cooperative approaches to address them by investigation and analysis on industrial human resource needs, existing system, condition and challenges on higher education sector and vocational education and training. Based on the survey result, the Mongolian government (Ministry of Education, Culture and Science, MECS) and JICA discussed about future project formulation in February 2013. They reached a fundamental agreement to prepare for a Yen Loan project at two major universities in Mongolia, MUST and National University of Mongolia (NUM), both of which have schools of scientific fields. The project aims at quality improvement of undergraduate education program, enhancement of education and research ability of lecturers and development of related education and research equipment at these universities.

Objective of the survey

The objective of this survey is to conduct a preparatory study necessary to implement the Japanese Yen Loan project of higher education for engineering in which a fundamental agreement was reached between the two governments. In line with this, the project outline described here is proposed; objectives, cost, implementation schedule, procurement and construction methodologies, implementation organization structure, operation, administration and maintenance system, environmental and social considerations and other additional activities to promote the project's effectiveness.

Work schedule

The survey is planned to be conducted from June to October 2013 including two major field surveys. Listed below is the planned schedule outline with the main scope of work.

<u>Preparatory Work in Japan: Late May 2013</u>

- Preparation of the Inception Report
- Collection and mapping of current information
- Review of survey methodology, direction and plans
- Confirmation of survey plan

<u>First Field Survey: Early June to early July 2013</u>

- Presentation and consultation of the Inception Report with the Mongolian Government
- Survey on project background and necessity
- Planning of project outline and project proposal
- Survey on framework, administration, environment, and budget estimation for project implementation

<u>First Survey in Japan: Early July to late August</u>

- Reporting the outcomes of the first field survey to JICA and survey in Japan
- Survey on Japanese universities and relevant organizations
- Preparation for the next field survey based on the comments from relevant personnel in Japan and the first field survey result

<u>Second Field Survey: Middle to late September 2013</u>

- Follow up study of the first field survey
- Survey and review of the project outline and plan
- Survey on points of attention upon project implementation

<u>Second Survey in Japan: Early to late October 2013</u>

- Reporting the results of the second field survey to JICA and survey in Japan

- Follow-up survey on Japanese universities and relevant organizations
- Drafting and discussion of the final report with JICA
- Completion and submission of final report to JICA

Third Field Survey: Late October to late November 2013

- Follow up study on the second field survey
- Presentation and discussion on the draft final report with the Mongolian government

Third Survey in Japan: December 2013

- Discussion and completion of the final report

Study team member

This survey was conducted by the joint venture of Registered Non-profit Organization Asia SEED and Nihon Sekkei, Inc. with help from Earl Consultants Inc. The survey team members who implemented the survey are as follows:

No.	Responsibilities	Name	Unit
1	Team Leader Higher Education Project Planning	Mr. Masahiro HAMANO	AsiaSEED
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5	Procurement of Research Equipment of Engineering	Mr. Ryoji HARADA	Earl Consultants
6	Operation and Maintenance Management / Finance (1)	Mr. Hikaru SHOZAWA	AsiaSEED
7	Operation and Maintenance Management / Finance (2) : Study in Japan	Mr. Hideaki SHIMIZU	AsiaSEED
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Chapter 1 Background and Necessity of the Project for Higher Education of Engineering

1.1 Industrial human resource needs in Mongolia

1.1.1 Current economic situation in Mongolia

1) High economic growth rate and dependence on mining industry

During the Socialist era, the Mongolian economy was dependent on export of copper and pastoral farming, supported by loan and grant from the Soviet Union. After the fall of the Soviet Union in 1991, it transited to a market economy and liberalization policy was developed. In the late 1990s, Mongolia began to walk the path of economic growth driven by increasing global demand for minerals such as copper and gold, which are Mongolia's major export commodities. In 2006, Mongolia achieved a trade surplus for the first time.

In 2005, the economy shifted to a mining-centered structure, and mining industry has dominated the first place at the Mongolian GDP (Refer to Table 1-2). Due to the dependency on mining, the Mongolian economy has become sensitive to mineral resource price. In recent years, even the national budget has been modified in response to the price swing of mineral resources.

In 2008, although the Mongolian economy was negatively impacted by a sharp drop in resource price and price of cashmere raw wool due to the global financial crisis, it has recovered as a consequence of the recovery of Chinese economy which is its largest export counterpart, and a re-increase in resource price. The high growth rate of Mongolian GDP reached to 17.5% in 2011. In 2013, the Oyu Tolgoi (OT) copper and gold mine is scheduled to commence production and this is accompanied by an increase in government expenditure for the supporting infrastructure which affects continuous growth of relevant industries such as transportation, manufacturing, retailing, and wholesale. Currently, Mongolia can be said as one of the world's leading centers of economic growth with a GDP growth rate of 12.3%, the third highest in the world in 2012.

However, there exist some destabilizing factors on the economic growth. As the economy is dependent on export of mineral resource, the economy lacks stability due to resource price fluctuation. Also, inflow of investment fund causes construction rush which might cause construction bubble.

Table 1-1 Growth rate of GDP

	2009	2010	2011	2012
GDP Growth Rate (nominal %)	-1.3	6.4	17.5	12.3
Per Capita GDP (MNT/1,000)	2,449.0	3,072.5	3,979.3	4910.4
Per Capita GDP (USD)	1,855	2,065	2,562	3,335

Source：National Statistical Office of Mongolia

Table 1-2 GDP, Breakdown by industry (%)

	2009	2010	2011	2012
Mining	19.8	23.6	24.1	21.4
Wholesale.　Retail	12.2	15.6	17.6	16.3
Agriculture, etc.	17.9	14.3	12.3	14.8
Manufacturing	8.3	8.4	7.8	8.0
Transport/Storage	8.3	7.8	7.2	6.6
Real Estate	7.3	6.6	7.0	6.4
Education	4.7	4.0	4.0	4.7
Public Service	4.1	3.6	3.3	4.3
ICT	3.8	3.4	3.1	3.1
Others	13.6	12.7	13.6	14.4
Total	100	100	100	100

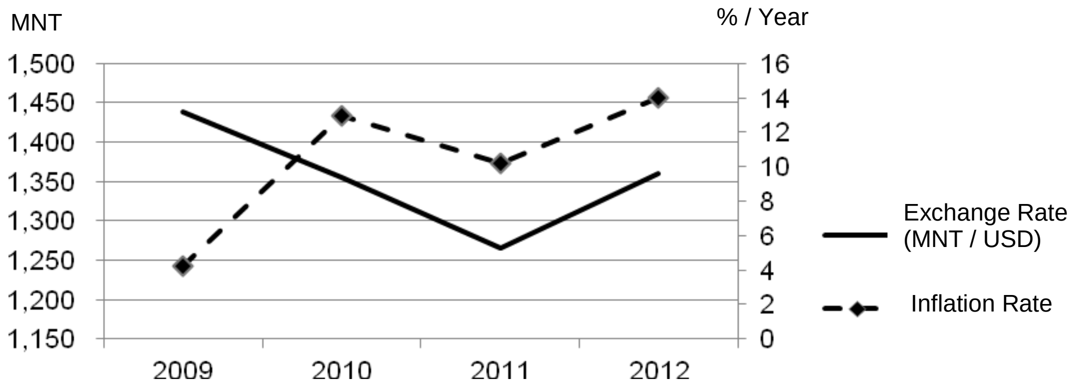
Source：National Statistical Office of Mongolia

2) Current situation of inflation and exchange rate

In 2011, domestic demand for fund increased as a result of construction investment brought about by booming mining industry, pay raise for government employees and increase in bank advance. However, in the same year, acceleration of consumption and price increase of Chinese food products[1] caused inflation. Price of goods in 2012 went up to 15% more than the previous year. The price increase continues into 2013 and inflation has become a main concern of the Mongolian economy.

The exchange rate of Mongolian currency, Mongolian Tugrik (MNT), against the U.S. dollar had shown an increasing tendency from MNT 1,442.84 in 2009 to MNT 1,359.40 on the average in 2012. Foreign currency reserves are also on an upward trend. In the future, the balance of payment is expected to improve as a result of high increase in mineral resource export produced at OT copper and gold mine which starts production in 2013.

[1] Mongolia’s food consumption, except meat, is dependent on the country’s import from China.



Source：National Statistical Office of Mongolia

Figure 1-1 Trend of inflation and exchange rate against USD

3) National Finance

Regarding national finance, in 2012, the revenue was MNT 4.952 trillion and expenditure was MNT 5.926 trillion, making a deficit of MNT 973.6 billion which is equivalent to 6.9% of GDP. The national budget was squeezed slightly to alleviate inflation, although policies such as raising salary of government employees up to 53% were executed.

The government established a stabilization fund in 2011 by the financial stabilization law which stipulates that the total amount of the fund should be accumulated up to 5 % of GDP by the year 2018. The law requires the government to allocate a part of the income from mineral resources and MNT 873.84 million was reserved in 2012.

4) Labor Force

The economically active population of Mongolia in 2012 was 1.151 million and the number of employees increased by 1.8% from 1.056 million in the previous year. Unemployment rate had shown trend toward improvement, 11.6% in 2009 to 7.7% in 2011, although it slightly increased to 8.2% in 2012. The capital, Ulaanbaatar, has the lowest unemployment rate of 7.1% and the rate in other regions hover between 7.7%, in the Central Region, and 10.8%, in the Eastern Region.

In respect of the number of employees in each sector, agriculture stands first with 370,000 (35% of total), followed by wholesale and retail trade, 131,300 (12% of total) and education, 86,300 (8% of total). Number of employees in the mining and construction sectors is increasing. In the former, it is 46,700 (4% of total) which increased 4% from the previous year and in the latter it is 59,200 (6% of total) which increased 13% from the previous year. (Refer to Figure 1-2)

5) Wage and Salary

Average wage and salary of workers per month in 2012 was MNT 557,600 (equivalent to USD 410) which increased 24% or MNT 133, 400 from the previous year. Focusing on each sector, financial intermediation sector pays the highest wage which is MNT 1,066,700 (USD 785) per month followed by mining with MNT 814,500 (USD 599) and the public administration and defence with MNT 613,900 (USD 452). The lowest wage, on the other hand, is paid by the agriculture sector which is MNT 244, 500 (USD 180). The disparity in wages among sectors is widening year after year.

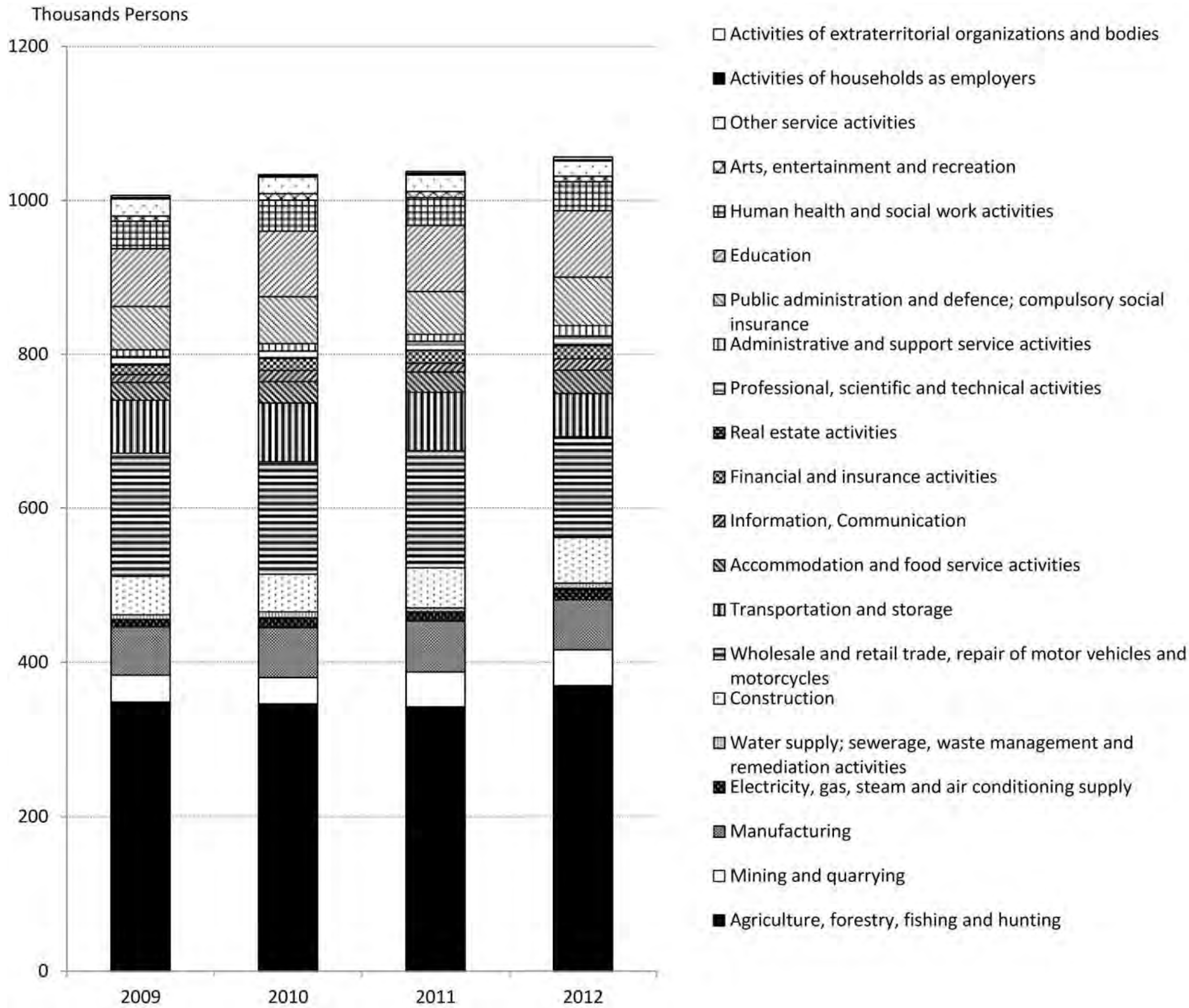
6) Industrial Sector

Major industries in Mongolia are based on rich mineral resources such as coal, copper and iron ore. The Mongolian economy relies on mining and exporting mineral resources.

At present, the government promotes value-added production for industrial development and plans the construction of a heavy industrial park chiefly for coal chemistry, iron and steel and oil refining. Implementing the strategy will allow the mineral resources to be exported with added value and not as unprocessed mineral ore as exported currently.

As dependence on mineral resource industry causes wide fluctuations in national economy by the trend of external demand, the Government also supports light industry for industry diversification. In addition to heavy industry, value-added production is also promoted; textile industry led by the traditional cashmere products, and food and leather goods from domestic, agricultural and livestock products. As a unique example, processed products from a kind of fruit "Chatsargan"[2] are also promoted.

[2] Chartsargan is called sea-buckthorn or seaberry in English. It contains Vitamin C, which is ten times as that of lemon, Vitamin A, E and iron. Extracted oil from the fruit is used to produce high-quality cosmetics.



Source: National Statistical Office of Mongolia

Figure 1-2 Employees by divisions at the end of the year

Population, unemployment and mismatch

According to the National Statistical Office of Mongolia (NSO), the population of Mongolia was 2,754,685 in 2010; and it is estimated to increase to 3,030,000 in 2016, 3,224,000 in 2020, and 3,556,000 in 2030. As for the population structure by age, the composition in 2010 (0-14 age group: 27.3%, 14-64 age group: 68.9%, over 65 age group: 3.8%), is expected to change in 2020 (to 0-14 age group: 23.3%, 14-64 age group: 63.8%, and over 65 age group: 8.0%). It is said that the demographic window that opened in 2011 will close in 2020.

According to the latest labor force statistics by NSO, as of the first quarter of 2012, there are 1,152,800 economically active people in Mongolia and labor force participation rate is 64.9%. Of this, 118,800 people are unemployed, which makes an unemployment rate of 10.3%.

However, according to the Labor Exchange Central Office (LECO), of which the number of registered unemployed people is 53,979 as of May 2012, the breakdown by educational attainment of the registered unemployed people is: MA, PhD (192), Diploma, Bachelor (15,417), Specialized secondary education (3,300), Vocational education (3,974), Completed secondary education (23,878), Completed basic education but not secondary education (8,307), Completed primary education (2,553), and Not educated (538). This indicates that there are many highly educated people who are unemployed, particularly the university graduates.

There is a statistic that represents another aspect thereto. As can be seen in Table 1-3 and 1-4, LECO compared the number of new employment and the number of job openings in each economic division and occupational level, and issued a filled share of each. From these data, it can be seen that the filled share is very low in many areas, despite the presence of a large number of unemployed university graduates mentioned above. As for the economic sector, Information and communications (8.7%), Construction (8.8%), Accommodation and food service activities (11.0%), Water supply, sewerage, waste management and remediation activities (11.7%) are the lowest, followed by Professional, scientific and technical activities (18.2%), Mining and quarrying (23.1%), Electric, gas, steam and air conditioning supply (24.0%) and Manufacturing (30.7%) . In terms of occupational level, fulfilment rate is low in almost all occupations, including professionals (24.6%) and engineers and technicians (20.4%).

From these data, it can be found that there are few applicants with the skills and experience from the employer's point of view, despite a sufficient number of applicants for the job. Since only few (even with a university degree) have the required skills, employers find them unsuitable for employment. There is thus a serious mismatch in skills required by employers and skills obtained by graduates through education. This mismatch is caused by the following:

- Not many students are enrolled in higher education science and engineering courses (only 20% in 2012 were enrolled in science, engineering and agriculture fields), while many go to the social science and business fields.

- Both the quantity and quality of higher education institutes offering science and engineering are insufficient to fulfil the needs of the industry.

Table 1-3 Number of new openings and employed in new workplaces by economic divisions (May 2012)

Economic division	New opening	Number of citizens employed in new workplaces	Difference	Filled share
Construction	16,714	1,469	15,245	8.8%
Manufacturing	5,741	1,762	3,979	30.7%
Other service activities	5,256	1,519	3,737	28.9%
Mining and quarrying	4,734	1,094	3,640	23.1%
Wholesale and retail trade, repairing motor vehicles and motorcycles	3,096	836	2,260	27.0%
Accommodation and food service activities	1,440	156	1,284	10.8%
Transport, and storage	1,431	424	1,007	29.6%
Financial and insurance activities	1,126	152	974	13.5%
Information and communication	972	85	887	8.7%
Education	999	444	555	44.4%
Public administration and defense; compulsory social security	925	649	276	70.2%
Water supply, sewerage, waste management, and remediation activities	300	35	265	11.7%
Agriculture, forestry, fishing and hunting	924	667	257	72.2%
Human health and social work activities	496	265	231	53.4%
Electricity, gas, steam and air conditioning supply	263	63	200	24.0%
Art, entertainment, and recreation	230	58	172	25.2%
Activities of households as employees	180	100	80	55.6%
Activities of extraterritorial organizations and bodies	57	9	48	15.8%
Real estate activities	52	11	41	21.2%
Professional, scientific and technical activities	33	6	27	18.2%
Administrative and support activities	250	552	-302	220.8%
TOTAL	45,219	10,356	34,863	22.9%

Source：LECO (Extract from “Capability Supply Landscape Study – Mongolia, American University of Mongolia, October 2012”)

Table 1-4 Number of new openings and employed in new workplaces by occupations, May 2012

Occupation	New opening	Number of citizens employed in new workplaces	Difference	Filled share
Craft and related trades workers	12,535	2,023	10,512	16.1%
Elementary occupations	8,050	1,842	6,208	22.9%
Professionals	6,383	1,568	4,815	24.6%
Plant and machine operators and assemblers	4,612	1,100	3,512	23.9%
Legislators, senior officials and managers of governmental and non-governmental organizations	3,419	319	3,100	9.3%
Service workers, shop and market sakes workers	4,475	1,375	3,100	30.7%
Engineers and Technicians	2,587	527	2,060	20.4%
Clerks	1,571	721	850	45.9%
Skilled agricultural and fishery workers	1,191	767	424	64.4%
Armed forces	396	117	279	29.5%
TOTAL	45,219	10,359	34,860	22.9%

Source：LECO (Extract from “Capability Supply Landscape Study – Mongolia, American University of Mongolia, October 2012”)

1.1.2 Priority areas in the national plan

The Government of Mongolia, in January 2008, formulated a national comprehensive, long-term policy until 2021 ”The Millennium Development Goals (MDGs)-based Comprehensive National Development Strategy of Mongolia” aiming at development of its people, economy, society, science, technology and culture in the democratic society. Among the wide variety of areas covered in the policy, such as national finance, foreign diplomacy and social development, areas listed below are directly relevant to the need for industrial engineers discussed in “Chapter 5 Economic Growth and Development Policy” of the policy.

- Mining, Heavy Industries
- City Planning and Construction
- Improvement of Transportation Infrastructure
- Energy Development
- Processing Industry (including various industries such as textile, sewing, biotechnology, glass, machinery and copper wire)
- Promotion of Small and Medium Enterprises
- Agriculture and Food
- Information and Communication Technology

Furthermore, in November 2008, the government formulated the “National Action Plan 2008-2012” which also set the goals for promotion of domestic industries, food self-sufficiency, and increase in transparency and accountability of administration process. It also emphasizes on acceleration of mineral resource development including improvement of relevant law, distribution of mineral industry profit to the public, and development of industries.

The "National Action Plan 2008-2012" was followed by the "National Action Plan 2012-2016" published in September 2012 by the new administration. Although the plan focuses mainly on the development of mining and mineral resources, it is more concerned with diversification of industries: (1) Wool, cashmere, raw leather; (2) Traditional livestock, meat and milk production; (3) Tourism; (4) High-tech, Biotech, Nanotech and IT; (5) Production of import substitutes and export commodities; and (6) Service industry.

Based on these national policies, many national level development projects in various sectors, which are currently in the planning stage as discussed below, require a large number of engineering human resources.

- Mining
  - There are many mines being developed, such as Oyu Tolgoi mine and Taval Tolgoi which is one of the largest undeveloped coal mines in the world, in addition to many other small- and medium-sized mines.
  - There is a network of mine-related civil construction industry, structure construction, importation of necessities for mine development such as pipes, construction machinery, trucking, workers' clothing, gloves, accommodation, catering food, drinking water, cafeteria, etc., and these industries are directly relevant to mining.

- Improvement of infrastructure (road, railway, power, water, etc.)
  - Altanbrag - Zamin Uud[3] Highway Project, which is the first high-speed road plan in Mongolia.
  - Plan of new railway linking the southern Mongolia and the central railway system.
  - Plan of building power plants in Oyu Tolgoi mine and Taval Tolgoi mine.
  - Plan of electric line construction between Ulaanbaatar and South Govi.
  - Plan of wind-power plant construction in Govi.

- Development of the heavy industry
  - Project for construction materials such as cement
  - Coke plant
  - Iron and steel pellet plant
  - HBI (Hot Briquette Iron) / DRI (Direct Reduced Iron) plant
  - Coal gasification plant
  - Oil refinery
  - Copper smelter

[3] Altanbrag is a city located near the northern border with Russia. Zamin Uud is located near the southern border with China.

- Power plant
- Iron and steel metallurgy plant, etc.

- Self-sufficiency of energy
  - Coal gasification and CTL (Coal to Liquid) projects using rich coal resources.
  - Use of renewable energy, such as thermal power, wind power and solar power.
  - Development of oil shale, CBM (Coal Bed Methane), and others.

- Light industry
  - Food and beverage, construction material, textile, leather, metal processing, furniture, etc.

- Counteraction to air pollution and environmental problems in Ulaanbaatar
  - Air pollution abatement in gel districts[4]
  - Waste disposal management, water and sewage facilities development, river purification, water resource management, environmental destruction by mine development, countermeasures to desertification, etc.

- 100 thousand housing construction project
  - Construction of 75,000 units in Ulaanbaatar and 25,000 units in other regions.
  - Relocation of gel residents to urban housing such as flat, etc.

- New sum centre[5] project
  - Housing construction by 2X4 method in 96 sums

- New International Airport Construction by the Japanese ODA fund

- Other important projects
  - Artificial satellite launching project
  - Energy production from waste and biomass project
  - Karakorum 13th century project (survey of historical research materials of the Mongolian Empire)
  - High-tech industrial park
  - Student Town Plan
  - Industrial training complex projects for IT in Baganuur, etc.

Based on the national plans mentioned above, the priority areas of engineering human resource needed in Mongolia are as follows. Indicated areas of the human resources are required to reduce the mismatch between university education and labour market needs.

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[4] In Mongolia, large volume of low-income population migrate from rural areas to major cities such as Ulaanbaatar and establish Gel (mobile tent house) villages in the suburbs, for they are not able to afford the high rent of flats. At gels, coal fire is the one and only way of heating, which is a cause of air pollution by generating smoke in a concentrated area of gels.

[5] Sum center is the capital of sum or district and administrative unit between prefecture and village.

- Mining
- Infrastructure construction
- Heavy industry
- Energy industry
- Light industry
- Environmental protection
- High-tech including IT

Additionally, according to a barometer study of the labour market conducted by the Government of Mongolia with the support of Mongol Millennium Challenge Account (MCA-Mongolia) [6]Vocational Education and Training Project, mining and construction and related manufacturing were listed as sectors with the highest demand of human resource. It also points out the importance of skills such as communications, IT, foreign language, management, and team work.[7]

1.1.3 The need for engineers in Mongolian industries

This section describes the need for engineers in Mongolian industries based on questionnaires and interview surveys conducted in target private companies "Data Collection Survey on Higher Education of Engineering in Mongolia" (January 2013, JICA). It is followed by the study of prospective needs of engineers focusing on Sainshand Industrial Park Project, an example of a national development project under consideration.

Method of survey for the need for engineers

The survey targeted companies were to study the current situation for their engineers. Survey items are as follows:

- Need for industrial engineers
- General assessment (shortfalls) of engineers
- Requests to domestic universities

The survey target included 13 industrial sectors covering all Mongolian industries. Random selection from the top 20 ranking companies of each industrial sector was made. Among the 113 companies contacted, 93 companies responded.

Approximately 70% of the respondents are companies that started business in 2000s after the market-oriented economic reform in 1990s, 80% of respondents were Mongolian companies while 20% were foreign investment companies. Figure 1-3 shows the breakdown of the survey respondent companies consisted of Construction (38%), Mining (18%), Light Industry (11%),

[6] One of ODA programs of offered by U.S.A.

[7] Capability Supply Landscape Study-Mongolia (October 2012)

and Information Technology (10%) in order of rank. The construction industry is highly affected by the current mining boom, while Light and Information Technology industries are the most growing and expanding industries at present.

In addition to the questionnaire, about 60 interviews were carried out with individual companies (mainly large companies) and certain experts.

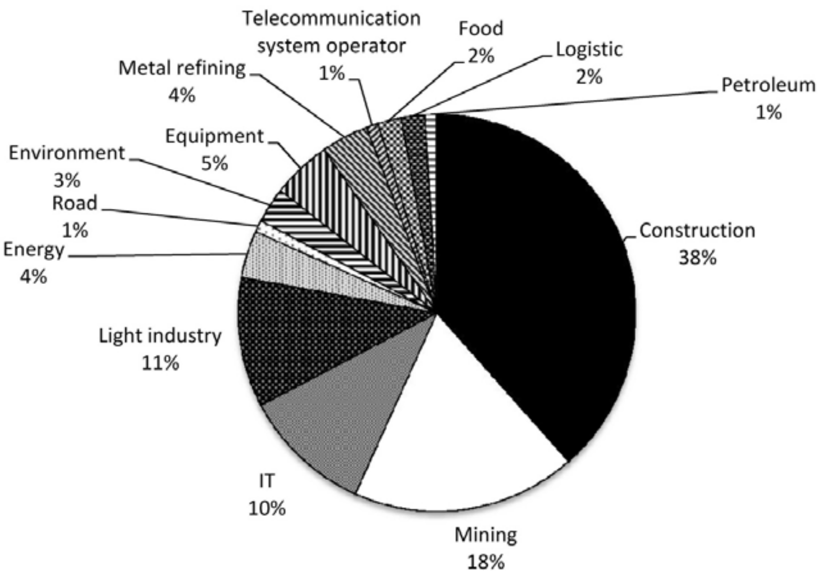

Figure 1-3 Survey participants

Needs for Industrial Engineers who graduated from Higher Education Institutes

The result of the survey from respondents on the specialized fields of engineers currently employed by companies is shown in Fig. 1-4. The Figure shows that their major areas of expertise include Mechanical Engineering, Electrical and electronic engineering, Food Engineering, Architectural Engineering, and Information Technology Engineering in order of rank.

Mechanical engineers as well as electric and electronic engineers are necessary not only in the construction and mining industries but also in various industrial areas. Although many of the survey responses were from construction and mining industries, architectural engineers and civil engineers are also in high demand due to increase in plant construction in the mining industry. Information technology ranks fifth mainly because information technology is required not only by the information-communication technology industry but also by a broad type of companies which apply the technology to internal infrastructure upgrading.

The future need for the engineering field by companies is shown in Fig. 1-5. Top 5 responses are Mechanical engineering, Information Technology engineering, Material Engineering, Electrical and electronic engineering, and Production engineering. High need for Mechanical Engineering, Information technology engineering and Electrical and electronic engineering are expected to continue. It is necessary to specify the type of knowledge, skills and technique of engineers required by companies for effective human resource development at educational institutions.

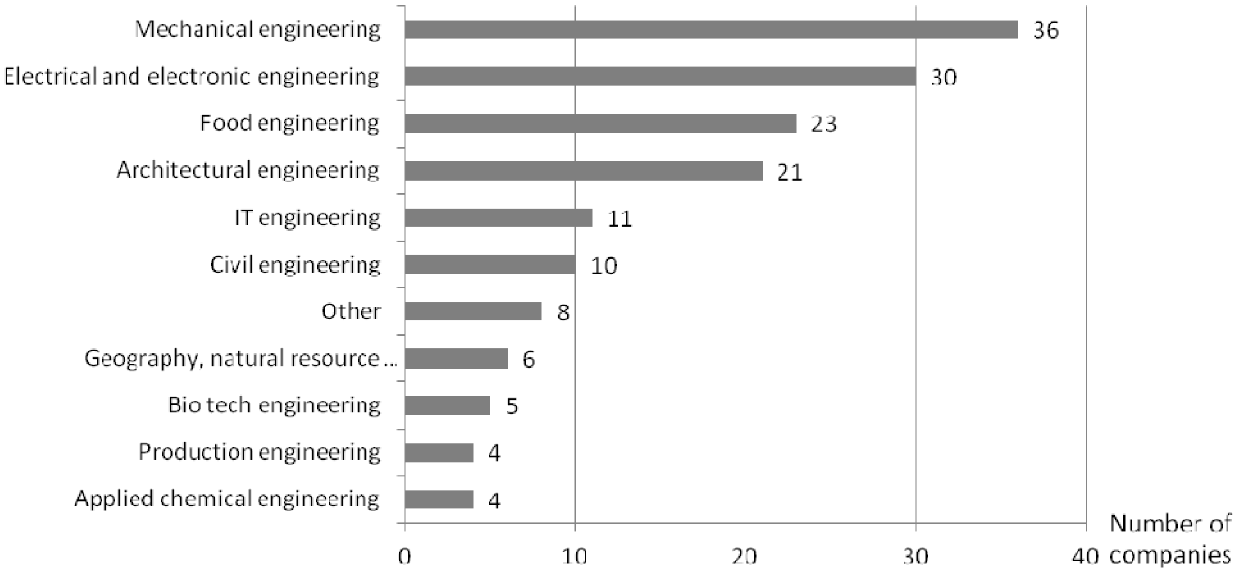

Figure 1-4 Engineer acceptance of the respondent companies (University graduate or higher)

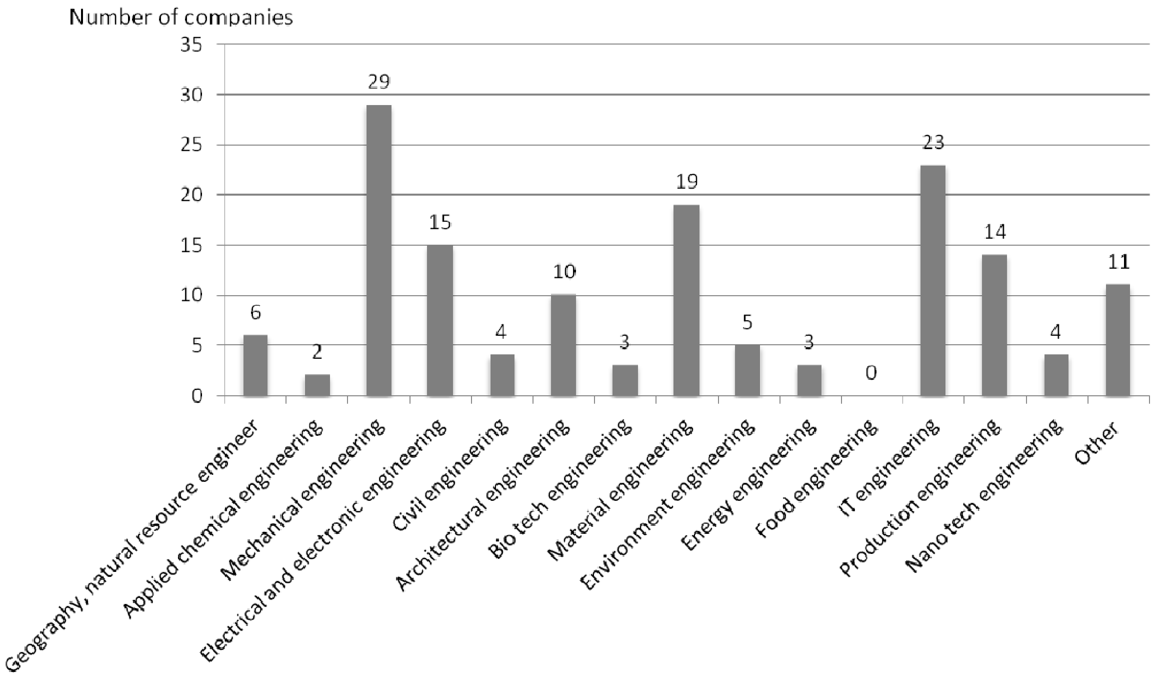

Figure 1-5 Future engineer needs of the respondent companies by technical field

General assessment (shortfalls) of engineers graduated from Higher Education Institutes

A general assessment of currently employed engineers was conducted to identify the knowledge and skills required of them by their employers (Figure 1-6). The top four responses are as follows: Applied technology (34%); Decision making ability (23%); Learning passion (19%); and Basic engineering knowledge (17%). It is notable that respondents recognize their engineers' lack of applied technology and basic engineering knowledge.

In individual interview surveys, respondents pointed out that curriculum in universities are too fractionalized which result in lack of knowledge in basic engineering of engineering graduates. In Mongolia, universities have a policy that emphasizes on specialized and in-depth field study; however there is a shortage of experimental tools and resources to carry out such study. The existing educational method might have led to the lack of practical and decision making abilities. A certain foreign investment company said that educational level of Mongolian engineers is generally 1 year – 1.5 years behind in comparison to that in developed countries.

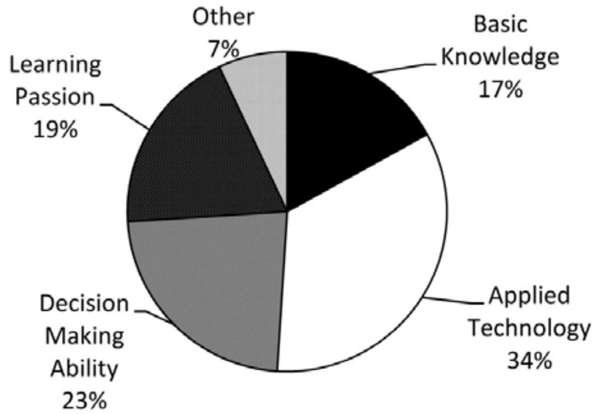

Figure1-6 General assessment (shortfalls) of employed engineers

Industry's requests to universities regarding engineering education

From the result of the survey described above which indicates the lack of applied technology and basic engineering knowledge, the industry's requests to the higher education were reviewed. Among the top requests are introduction of practical training, level up of class concept, global human resource training (e.g. foreign language), installation of advanced facilities and leadership training. These results are closely related to the problems of the currently employed engineers.

Many interviewees also pointed out that new graduates are not ready for practical operation. Most of the companies request universities to conduct practical training. On the other hand, interview survey for universities revealed that they are also aware of the problem of lack of practical trainings at universities.

The following is a description of the requests to universities based on the current situation and problems found by interview surveys:

- **Introduction of practical training**
  - Practical training and experiments should be introduced to current "class room lectures".
  - Learning environment should be improved to fit to practical training.
- **Level up of class concept**
  - Education contents should be upgraded along with technological progress of industries.
  - Training opportunities should be provided to university teaching staff.
  - Cooperation with companies for education should be promoted.
- **Installation of advanced facilities and equipment**
  - Appropriate facilities and equipment should be installed for technology acquisition of

students.

- Improvement of teaching staff to enable self-maintenance and management of advanced facilities and equipment.

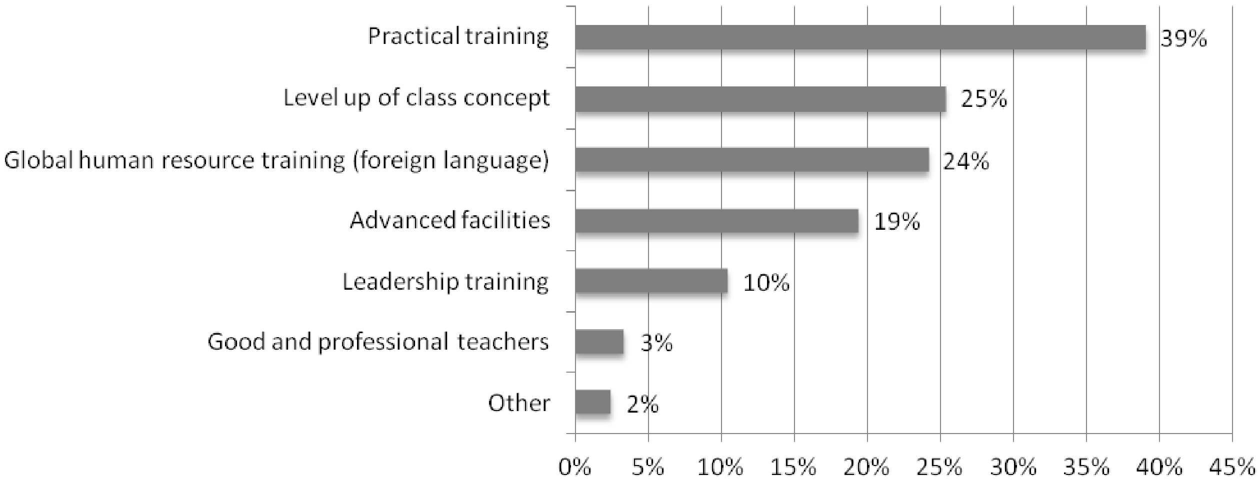

Figure 1-7 Requests to domestic universities

Future needs for industrial engineers

In the following paragraphs, the emerging needs for industrial engineers is discussed based on an example of the Sainshand Industrial park project, which is one of the national development projects under planning.

The Sainshand Industrial park project is a project to construct a heavy industries complex at Sainshand which is located in the south-east of Ulaanbaatar. The project is nominated in the government policy statement of 2012-2016 and is planned to be completed in 2018. It consists of refining plant for minerals, direct-reduced iron (DRI) plant, Coke plant, power plant, cement plant, etc. The manpower demand for construction is calculated as 10,000. After establishment, an estimate of 2,400 people would be employed.

Table 1-5 shows the demand for engineers/technicians at the Sainshand Industrial Park project. According to the project plan, an average of 268 engineers/technicians per 1,000 employees will be necessary. Out of the 268, Mongolian technicians would be 188 while engineers would be 54, and approximately 10% is planned to be filled by foreign resource.

Areas of expertise for the manpower demand by each plant are shown in Table 1-6. Although the demand varies depending on the plant type, electrical engineering and mechanical engineering are commonly needed for both of engineers and technicians. By skill level, engineers with expertise on mining engineering and knowledge of chemistry and physics, and technicians with expertise on mining metallurgical engineering are determined to be necessary.

Under the Sainshand Industrial Park project, four vocational training centers, a college and a

Polytechnical school[8] will develop engineers for the project. Other large-scale infrastructure development projects such as railways, heavy industries, highways and house constructions are under planning and the demand for industrial engineers is expected to increase.

On the other hand, there is a fear that major national projects planned to be implemented in parallel could cause a shortage of industrial engineers. According to the information on the graduates from the engineering fields in higher education institutes, there were only 3,714 graduates from the bachelor's programs and 290 from master's programs in engineering fields in 2012 (Table 1-14) while 2,700 engineering human resource would be required only for the Sainshand Industrial Park project. In the future, a close linkage should be established between the higher education institutes and industrial sector in order to respond to the escalating needs for industrial engineers.

Table1-5 Sainshand industrial park project demand for engineering human resource by plant (Estimation per 1,000 Workers)

Plants	Total	Foreign Workers	Mongolian Workers	
			Engineers	Technicians
Cement Plant	270	27	54	189
Pellet Plant	295	30	59	207
DRI Plant	136	14	27	95
Coke Plant	270	27	54	189
Power Plant	161	16	32	113
Gasification Plant	122	12	24	85
Copper Production Plant	395	40	79	277
Railway Repair Station	100	10	20	70
Average	268	27	54	188

8 Vocational Training Production Center (VTPC) in Nalaikh, Gobi Sumber, Dalanzadgad, Baganuur, Mongolia-Korea College and Karkhan Poly-technical School.

Table 1-6 Sainshand industrial park project demand for Mongolian manpower by skill level and plant (Estimation per 1,000 Workers)

Plants	Level of Workers	No. of Workers	Needed Skills
Cement Plant	Engineers	54	Industrial Engineer, Electrical Engineer, Technicians in Chemistry and Physics
	Technicians	189	Electrical engineering technicians, Mechanical engineering technicians, Mining metallurgical engineer, Plumbers, Welders, Electricians
Pellet Plant	Engineers	59	Mining Engineer, Technicians in Chemistry and Physics, Electrical Engineer
	Technicians	297	Electrical engineering technicians, Mechanical engineering technicians, Mining metallurgical engineer, Plumbers, Welders, Sheet metal worker, Metal machinery worker, Electricians
DRI Plant	Engineers	27	Mining Engineer, Technicians in Chemistry and Physics, Electrical Engineer
	Technicians	95	Electrical engineering technicians, Mechanical engineering technicians, Mining metallurgical engineer, Plumbers, Welders, Sheet metal worker, Metal machinery worker, Electricians
Coke Plant	Engineers	54	Mining Engineer, Technicians in Chemistry and Physics, Electrical Engineer
	Technicians	189	Electrical engineering technicians, Mechanical engineering technicians, Mining metallurgical engineer, Plumbers, Welders, Sheet metal worker, Metal machinery worker,
Power Plant	Engineers	32	Electrical Engineer, Technicians in Chemistry and Physics
	Technicians	113	Electrical engineering technicians, Mechanical engineering technicians, Electricians, Welders, Metal machinery worker
Gasification Plant	Engineers	24	Chemical Engineer, Technicians in Chemistry and Physics
	Technicians	85	Electrical engineering technicians, Mechanical engineering technicians, Electricians, Welders
Copper Production Plant	Engineers	79	Electrical Engineer, Mining Engineer, Technicians in Chemistry and Physics
	Technicians	277	Electrical engineering technicians, Mechanical engineering technicians, Mining metallurgical engineer, Plumbers, Electricians, Welders, Metal machinery worker
Railway Repair Station	Engineers	20	
	Technicians	20	

Source: Calculation by Survey Team from data of "Activities from NDIC to Support the "Sainshand Industrial Park" (Table 1-5, 1-6)

Current situation of industry-university collaboration

One of countermeasures to supplement the shortage of engineering human resources is industry-university collaboration. This is a new concept in Mongolia and there are currently not many known cases of collaborations that have been established. According to the survey of companies, 90% responded that they have not yet implemented an industry-university collaboration to develop new product or any business with any university or research institute. However, an innovation law was established in 2012 which allows universities to start venture businesses. It is expected to promote future industry-university collaborations.

Currently, Mongolian companies do not regard industry-university collaboration in their aim to develop new products or venture into a new field under a two-way collaboration, but simply a one-way relationship where they receive university instructors for technical guidance or students for practical training. On the universities' side, although they hope to implement industry-university collaboration, they have not yet tried to reach companies because of lack of developed matching system, of personnel or organization, between industry and university.

One model case of an existing collaboration is that of a government company UBEDN which provides fund for MUST and carries out business activities along with the research team of the university. It is necessary to expand such activities among industries and academia.

1.1.4 Needs for engineers and research of Japanese investors

Investment trend of the Japanese company to Mongolia

This section's information is based on JICA's previous survey "Data Collection Survey on Higher Education of Engineering in Mongolia" and additional interviews to experts in relevant industries.

Major cases of Japanese direct investments are a mobile phone provider MOBICOM[9] jointly established by Sumitomo/KDDI and a Mongolian company, Khan Bank[10] invested by Sawada Holdings and a construction developer, Suruga Mongol.[11] Major projects which involved Japanese companies include the New Airport Construction Project by Japanese Yen Loan, Darkhan Oil Refinery Project by Mongol Sekiyu Co., Ltd., Ulaanbaatar Subway Project, and No.5 Power Station Project.

In the mining area, Mitsubishi Corp and French Areva are in an uranium mine development project, while other major Japanese trading companies are involved in Tavan Tolgoi Coking Coal Mine Development Project. Sumitomo and Marubeni respectively established a construction machinery distribution, and Kobe Steel, Ltd. is involved in a steel plant project.
In the construction and civil engineering, Dai Nippon Construction, Suruga Mongol, Nippo Corporation, Sakura Construction and other four to five companies are in business in Mongolia. There are also companies that participated in the Public Private Partnership (PPP) bidding for road construction design.

In the manufacturing sector, Sankou Seiki produces office equipment, camera parts and solar panels through a joint venture corporation. Some companies are also considering setting up

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9 Established on November 1995 and became the first mobile phone service provider in Mongolia.
10 As of September 2013, Sawada Holdings own 53 % share of stock of Khan Bank. Refer to https://www.khanbank.com/en/655/Board-of-Directors.html. Kahn Bank is the largest commercial bank in Mongolia on assets base.
11 Suruga Corporation owns 100% shares of stock.

manufacturing plants in Mongolia.

Some Japanese companies invest in textile industry, mainly cashmere factories. Most of the major Mongolian factories have introduced Shima Seiki's automatic weaving machines.

Japanese companies are also interested in renewable energy industry such as solar power and large-scale wind power projects. In the IT sector, Fuji-Infox conducts offshore development by Mongolian engineers. In the infrastructure area, Japanese companies expect opportunities to supply rails, sleepers and signal facilities in railway construction projects.

On May 2013, Japan External Trade Organization (JETRO) held the first "Japan Business Fair in Mongolia 2013" with the Mongolian National Chamber of Commerce and Industry to introduce Japanese products to Mongolia. More than 27 Japanese companies participated in the exhibition and business meeting opportunity and some of them started business in Mongolia. Also, major Japanese banks have started to open branches in Ulaanbaatar aiming at business chances to provide financing to infrastructure development projects.

Future potential industries for Japanese investment

Due to an increase in domestic demand and consumption in Mongolia as a result of rapid continuous GDP growth, potential industries for Japanese companies, particularly SMEs, are domestic demand-oriented industries namely, construction and civil works, construction material manufacturing, food, textile for domestic use, hotels and restaurants, health and medical industry, IT and education etc. The markets in these industries are not yet competitive in Mongolia compared with those in other countries and it will bring rich opportunities of investment to many competitive Japanese SMEs in relevant industries.

Currently, Economic Partnership Agreement (EPA) between Japan and Mongolia is under negotiation in the context of possible mutual complementary relation in economic field. Japan is a narrow land country lacking underground resources with declining birth rate and aging population, but with affluent fund and technology. Mongolia is a vast land country with rich underground resources and rich young labor force, but without enough fund and technology. There would be opportunities for Japanese companies in this mutual complementary relation.

Engineer needs of the Japanese investors

From the movement of Japanese investment and potential industries, Japanese companies are expected to have a demand for engineers related to the following industries:

(1) Construction and civil engineering
(2) Machinery and plant
(3) Power Generation and renewable energy

These three industries are consistent with the priority fields of engineering needs discussed in previous sections. It can be considered that the engineering fields which have the most urgent priority for Japanese assistance are Civil Engineering, Mechanical Engineering, and Electricity and electronics.

High priority areas in engineering human resource needs

Discussion in previous sections on high priority areas engineering human resource needs can be summarized in Table 1-7.

Table1-7 Priority areas in engineering human resources needs

Priority Sectors in National Development Plan	Priority Sectors in Japanese Government's "Country Assistance Policies for Mongolia"	Priority Sectors for Industries	
		Mongolian Industries	Japanese Companies
Mining and relevant sectors	Mineral resource development, processing, utilization and relevant sectors	Mechanical Engineering	Construction and Civil Engineering
Construction of Infrastructure	Construction of infrastructure	Construction and Civil Engineering	Mining
Heavy Industry	Industrial human resource development for diversification of economy	Material Engineering	IT & Communication
Energy Industry	Enhancement of the capacity and function of Ulaanbaatar as urban centre	Electricity and Electronics	Railways and other infrastructure
Light Industry	Environment and relevant sectors	Industrial Engineering	Power production and renewable energy
Environment		IT Engineering	Machinery & plant
High-tech industry including IT, Nano-tech and Bio		(Future needs)	Environment, Food
		Applied Chemistry	Agriculture & livestock, Natural science
		Nano Engineering	
		Environmental Engineering	

As discussed above, there is high demand for industrial human resource in a wide range of sectors in current Mongolia. However, fields listed below can be regarded to have higher priorities from the viewpoint of industries.

- Geology & Mining, Construction & Civil engineering, Mechanical engineering, Electricity and electronics, Material engineering, Food engineering, Industrial engineering, Information engineering

- As future needs, Applied chemistry, Environmental engineering, Nano engineering, and Bio engineering.

It should be noted that three of the most priority fields in those listed above are Construction and Civil engineering, Mechanical engineering, and Electricity and electronics.

1.2 Current situation and challenges in higher education of engineering in Mongolia

1.2.1 Education System in Mongolia

The basis of current education system in Mongolia was developed over 70 years of the Socialist era since the independence from Chinese Qing Dynasty until the 1990s, under the strong influence of the former Soviet Union. In the era, Mongolia successfully developed modern education system due to the support from the former Soviet Union despite the postwar chaos. As a result of the government's ownership of the whole education sector, schools and school dormitories were developed at places where children could commute from any place in the vast land of Mongolia. In addition, education was provided free of charge from primary to higher education. These have very important meaning as a legacy of socialism and have produced a very high literacy rate of 97% in Mongolia.

Higher education in Mongolia has been developed mainly at the National University of Mongolia (NUM). NUM is the oldest in Mongolia and has been the only comprehensive university in the country. The models of this university were the universities in the former Soviet Union. And since its foundation until the 1990s, it was assisted by the former Soviet Union on most of the development aspects. After the foundation of NUM, other major universities at present, including MUST, have been developed as a "branch" of NUM.

At the peak of relations between the two countries in the Socialist era, the Soviet Union subsidized a third of Mongolia's GDP and such huge financial assistance made it possible for the Mongolian Government to invest in public sectors including the education sector. It was reported that the government had spent 17.6% of its budget for education, which was 11.3% of GDP, until the late 1980s.[12]

However, the education system of Mongolia was exposed to a sudden change with the collapse of the former Soviet Union in the early 1990s. Financial assistance from the Soviet Union was suspended and the trade was stopped due to the abolishment of Council for Mutual Economic Assistance (COMECON) which pushed Mongolia down to one of the poorest countries in the world. The expenditure on education in 2003 was reduced down to 3.8% of GDP. As a result, various problems occurred including shortage of teachers, lack of facilities, and increase

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12 Robinson, B (1995). Mongolia in transition: a role for distance education

of dropouts from schools due to poverty. But it is noteworthy that, even in such situation, Mongolia managed to minimize the decrease in literacy and school enrollment rates.

Upon entering the second half of the 1990s, GDP growth had turned positive, and the new government had made educational reforms one after another. Especially after 1996, the government accelerated the educational reform mainly by getting assistance from Asian Development Bank (ADB). The chronology of educational reform since 1990 is summarized in Table 1-8.

Reform of primary and secondary education in Mongolia was launched in the early 1990s. Due to collapse of the centralized administration, it was directed toward more decentralization and strengthening of school autonomy, accompanied by renewal of curriculum and establishment of private schools. The concept of the new Education Law of 1991 was confirmed in the new Constitution of 1992 where human rights, freedom, an open market system, pluralism of political parties, and participation were proclaimed. The first "Education Sector Master Plan (1994)" was developed with the technical assistance of ADB to enhance basic and general education, strengthen the administration of the central government, and provide education for eradication of poverty. In 1995 the Education Law was differentiated into Fundamental Law of Education, Elementary and Secondary Education Law, and the Higher Education Law. In 1996, the "Education Sector Development Program" was formulated with the support of the ADB. Based on this development program, the "Government Basic Instructions" was issued in 1997 and this led to the establishment of goals along the framework of sustainable development and education for all.

In addition, with the "Mongolia Education Sector Strategy (2000-2005)" in 1999, donor countries and international agencies provided assistance for education sector by sector-wide approach, revision of the school curriculum and methodology was focused on shifting from an academic-focused instruction to practical-oriented one, and change to a student-centered teaching. At the same time, the transition to a 12-year school education system was initiated. The actual transition was carried out in stages. Initially, it was shifted to a 5-4-2 or an 11-year system from 2005, and was then shifted to the 12-year system from 2008 (realized in 2006-2015) as defined in the "Millennium Development Goals" for 2005 and Education Development Master Plan of Mongolia in 2006.[13]

Since 1990, the education in Mongolia has been recovering together with the educational cooperation of foreign countries and international organizations including a number of foreign aid agencies, international organizations and NGOs such as ADB, United Nations Educational, Scientific and Cultural Organization (UNESCO), World Bank, United Nations Children's Fund (UNICEF), United Nations Development Program (UNDP), Japan, Korea, America, Germany,

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[13] MIYAMAE, Naomi. Issue of Education Policy and Social Transition in Mongolia, March 2009

Save the Children, World Vision, and others.[14]

[14] Capability Supply Landscape Study – Mongolia, American University of Mongolia, October 2012

Table1-8 Chronology of education reform in Mongolia (1990 - current)

Year	Mongolian History	Chronology of Education Reform	Content, etc.
1990	・Democratic Party formed as the first opposition party ・Mongolian People's Revolutionary Party abandoned one-party dictatorship ・First free multi-party elections ・Enactment of private property		
1991	・Start privatization of state-owned property ・Donor's Conference for Mongolia (in Tokyo)	・Education Law 1991 ・Reorganization of the National University of Mongolia ・The Education Audit Committee established (as an agency reporting to the Minister) ・Introduction of the principal election ・Approval of the establishment of the first private universities	・Introduction of private universities ・4・2・2 System
1992	・New democratic constitution adopted ・Renamed the country "Mongolia" ・Election based on the new democratic constitution (Win People's Revolutionary Party) ・Announced the complete withdrawal of the former Soviet Union	・Ministry of Education to the Ministry of Science and Education	・Explicit right to education ・Guarantee the freedom of the private school established ・Unification of science and technology
1993		・Cabinet Act ・National action plan for the development of the children ・First private ordinary school approved	・Explicit mission of the Minister of Science and Education
1994		・Master Plan for Human Resource Development and Education Reform Project Mongolia (1994-1998)	・Reorganization of the Board of Education Audit Committee ・HRD corresponding to the market economy ・Establishment of the National Education Council ・Installation Management Conference sponsored by the Minister of Education ・Organizational reform of the ministry
1995		・Education Law 1995	・Differentiation to Fundamental Law of Education, Elementary and Secondary Education Act, and the Higher Education Act ・5・3・2 System
1996	・2nd general election (win People's Revolutionary Party)	・Education Sector Development Program ・Ministry of Education and Science changed to Ministry of Education, Culture and Science	・Educational reform aided by ADB ・Integration with Ministry of Culture
1997		Government Basic Instructions for the education sector reform (1997-2005)	・Established administrative measures necessary for the implementation of the Education Act 1995
1998		・Mongolian Action Plan for the 21st Century ・Partially revised Education Act 1995 ・Enactment of the National Standard ・Introduction of accreditation (facilities assessment)	・The key issues in Mongolian society, pointed out the importance of the education sector in particular ・Back to 4・2・2 System ・First National Standard of Primary and Secondary Education ・Natural science, health, foreign language introduced
1999		・Medium-term socio-economic development strategy (1999-2002)	
2000	・3rd general election (Democrat victory)	・Mongolia Education Sector Strategy (2000-2005) ・Education Act Reform	
2002		・Preschool education law, elementary and junior high school law, high school law, education law promulgated	・To 6・3・3 System from 2005 (in fact from 2008)
2003		・Education Act Reform	・Vocational Education Act created
2004	・4th general election (breakthrough of Motherland & Democratic Coalition)		
2005		・Enactment of the National Standard	・5・4・2 System
2006		・Mongolia Education Master Plan (2006-2015)	・12-year System introduced in 2008 (6-year-old enrolment)
2008	・5th general election (win People's Revolutionary Party)	・New Education Law	・12-year 5・4・3 System
2012	・6th general election (Democrat victory) ・Inauguration of Prime minister Arutanhoyagu	・Changed to Ministry of Education and Science	

Source: Issues of transformation of social system and education policy in Mongolia (2009 Naomi Miyamae)

School education system in Mongolia

The Mongolian school education system is under transition from the current 11-year system of 5-4-2 to the 12-year system of 5-4-3 in line with the international standards. In other words, after the transition, five years of elementary school, four years of junior high school, and three years of high school, a total of 12 years of basic education is necessary for students to go on to higher education. Entrance age to primary school is at the age of six. The school system diagram after the transition to the 12 year-system is as shown in Figure 1-8.

Most of the local elementary schools have a dormitory to accommodate the children of nomads. In order to be awarded a certificate of elementary education, it is necessary to pass the standard test for pupils.

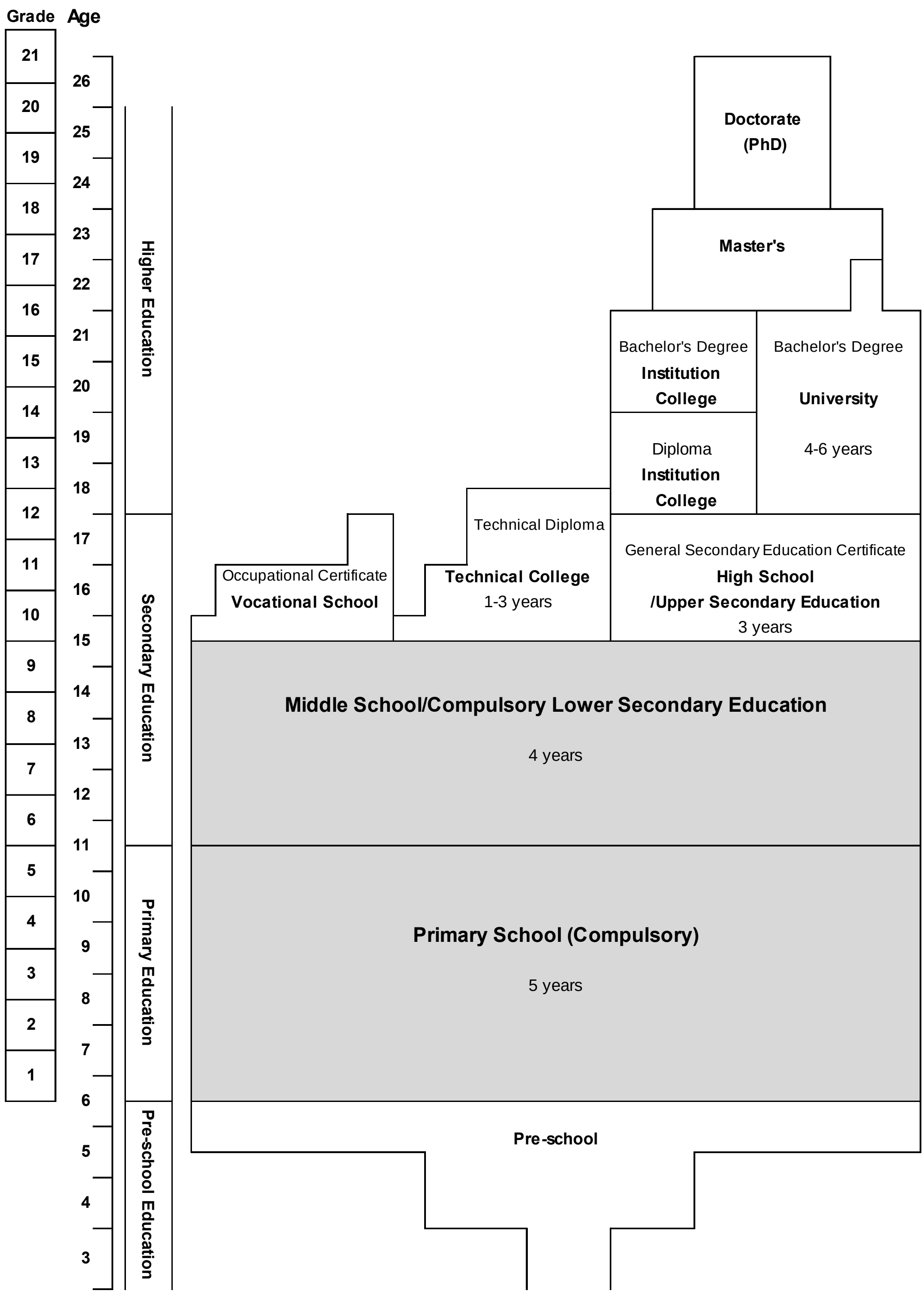
In the past system, the period of compulsory education was up to middle school for four years, and there was a high school education of two years subsequent to it. In the new education system, secondary education is divided into two respective programs of middle school for compulsory education (Compulsory Lower Secondary Education) and high school education (Upper Secondary Education). In order to be awarded a certificate of completion of basic education, students must pass standardized tests at the end of compulsory education of middle school education. Students are also tested at the end of the high school. At the primary and secondary education, the Soviet-style ordinary school where elementary, junior high and high schools have come together is still commonly seen. There are 34, 35 and 36 class weeks per year at elementary school, junior high school, and high school, respectively.

As for vocational education, in general, it is a two-year training program where students can enroll after graduating from middle school. The students can be also enrolled after graduating from high school, in which case it becomes a one-year training program. In order to be enrolled in the professional technical education diploma program, most of which are two-year program, students are required to graduate from high school. However, even if students acquired a Diploma, in the current education system of Mongolia, they are not permitted to transfer to the third year at a university. Short-term vocational training courses are offered in vocational training centers. Many of the programs take 1-3 months and there is no particular entrance qualification for these.

Higher education is being provided at Universities, Institutes and Colleges. The Colleges can offer only bachelor's degree programs and diploma programs of three years. The bachelor's degree programs at universities are four to five years, the master's programs are one to two years, and the doctoral degree programs require three to four years, while medical course requires six years.[15] In Mongolia, the University, Institute and College can offer any of the vocational education programs, professional technology diploma programs and bachelor's

[15] World Data on Education 2010/11, UNESCO

degree programs. Therefore, the name of the school does not represent the level of the program offered.



Source：Capability Supply Landscape Study-Mongolia (October 2012)

Figure 1-8 Mongolian school system diagram after transition to 12-year System

Educational administration system in Mongolia

In Article 16 of the Constitution of Mongolia (1992), the provision of free basic education and the right to education of the public are guaranteed. In addition, it is stated in the Education Law 2002 that the goal of education is to develop the people's ability to learn, work and live on their own by providing proper intellectual, moral and realistic skills based on the principles of humanism. As basis of educational administration, five Education Acts were enacted in 2002 and these are the Education Law, the Higher Education Law, the Elementary and Secondary Education Law, Technical and Vocational Education and Training Law, and Pre-school Education Law.

MECS administers education. Basically, all public education is under the jurisdiction of MECS and its role is defined by laws:

- Ensure to organize the implementation of legal service of the whole country on education
- Develop a comprehensive and appropriate system of education for all (including non-formal education)
- Coordinate activities of organizations in accordance with the provision of training and support for various programs
- Provide training to all personnel of the organization relating to education, and move forward issues related to social benefits of teachers .

Therefore, the guidance and financial support to the public and private educational institutions of the country, related policy formulation, approval of curricula and textbooks, and control of schools and national universities are done by MECS.

However, after the transition to the new government in 2012, administration of technical and vocational education and training (TVET) has been transferred to the Ministry of Labor. In accordance to this change, TVET Agency (A-TVET), an agency formerly under MECS, has also been transferred to the Ministry of Labor together with the personnel in charge (though only one person remained in MECS at the time of the survey). Upon this transition, some questions regarding legal consistency were raised by the people concerned. As examples, the TVET curriculum has been under the jurisdiction of the MECS but can it be really transferred to the Ministry of Labor? Some TVET institutions are now registered as an internal part of the national universities, but how can jurisdiction between the two ministries be divided? For the latter question, a couple of solutions are under discussion; to make TVET institutions in the national universities independent, and to demolish colleges and provide higher education only at universities and institutes. In either case, the technical and vocational education and training Law should be revised for legal consistency and division of TVET administration between two ministries will require further consideration.

Due to a short period since establishment of new administration, not many education policy papers have been issued so far. Nonetheless, the government published action plans as public pledges of the cabinet which discuss a wide range of plans on human resource development. The details of such plans are discussed in section 2-5.

Future trends in education reform

Future trends in education reform are described in the Action Plan of the Government of Mongolia 2012-2016 published by the new administration which took over in 2012. The following are excerpts from the Action Plan indicating the direction of reform:

- Integrate into a single structure the currently separate functions such as employment, professional education and small and medium industries;
- Give priority to improvement of not the quantity but the quality of university education, and improve their quality by bringing into practice new education standards;
- Renew the system to send students to developed countries for education;
- Take measures to establish direct connections between the vocation training centers and the potential employers;
- Integrate activities of vocational training and other education institutions with the labor market demand and supply trends, set criteria to admit students in line with contracts or orders placed by potential employers in order to enable the graduates to have jobs;
- Motivate and support the students of vocational training centers by not decreasing the scholarship amount paid to them;
- Reduce the number of low quality universities, transfer the current education system to a new system where the academic, research and practical trainings are integrated and which prepares only those manpower who are in high demand at the market. Additionally, the state shall provide support to universities that are nurturing a high -tech company and attempting to introduce their creations to the market by establishing a research, production and experimental incubator within their structure;
- Support the idea to establish in Mongolia a less than one branch of the world's leading engineering and technology universities;
- Intensify the processes related to creation of a compromised campus of Mongolian universities;
- Attach special attention to training of teachers and engineers, and provide necessary support to successful students;
- Introduce principles of being community participation based, democratic, independent and open to the governance, organization and management of education and science institutions
- Establish a national fund to support education sector aimed to promote developments, ideas and initiatives related to education technology;
- Implement "A Competitive Mongolian" program. In line with survey results, renew the list of priority professions to lead Mongolia to development, and send 300 students for overseas leading universities;

- Introduce a higher education system that supports advanced technology, increase the number of students taking advanced technology programs and widen the opportunities to exchange teachers/professors with foreign countries;
- Provide financial support from the science and technology fund to the higher education establishments and science organizations through an open bidding processes in order to support creative works of the science and introduce them to the potential markets; and
- Develop cooperation among foreign and domestic higher education establishments in the fields of information, communications, nano and bio technology, and train up to 300 students in leading world universities through student exchange programs.

1.2.2 Higher education in Mongolia

History of higher education policy in Mongolia

Beginning

Higher education in Mongolia started from the foundation of the first higher educational institution NUM in 1942 concurrently with the establishment of the socialist nation. Well into the 20th Century, there was little formal education at any level outside of Buddhist monasteries.

At the stage of foundation, NUM provided professional education at three departments modeled after universities in Russia: pedagogy, medicine, and zoo technology, fields which were prioritized in that period. On the other hand, the State Pedagogical Institute was founded in 1951 as a specialized secondary school in order to meet the country's increasing needs for teachers at the primary school level. It was reorganized into the State Pedagogical College in 1957, becoming an institution where teachers with higher education were trained.

Most of the advanced researches were conducted under the auspices of the National Committee of Science with limited academic fields in the 1950s. Even preceding the 1921 Mongolian revolution, there had been a government agency for overseeing scientific researches and conducting advanced researches. In the mid-1950s, there was a common need by the National Committee of Science and the researchers at NUM to introduce advanced research programs in several areas taught at NUM. It resulted in reforming the policy of the university departments into specialized research institutes to implement advanced research programs which indicates the first major direction of higher education policy. In 1958, the zoological-veterinary medicine department at NUM was the first to be transformed into the Agricultural Institute. It conducted both teaching and researches but emphasized more on researches.

The National Committee of Science was amalgamated with the NUM in 1959. The Medical Institute was formed from the medical school of the State University in 1961. However, since 1961 when the Mongolian Academy of Sciences was founded, there had been a perpetuating pattern of concentrating advanced researches in the Institutes of the Academy of Sciences rather than in the university. The Academy of Sciences also controlled awarding of the highest scientific research title, the Doctor of Science degree. The polytechnic department was established as part of NUM in 1969 and became the Polytechnic Institute in 1982. Higher education was shifted to be designed to meet the needs of a planned economy, with specialized programs leading directly to specific jobs in the government and state-owned enterprises.

The strong Russian influence on Mongolian higher education continued until the collapse of the Soviet Union in 1991. After that year, higher education system underwent a major reform to reorganize higher education institutes which upgraded four research institutes under NUM to independent universities, namely the Mongolian Agricultural University, the Mongolian Medical University, the Mongolian Technical University and the Mongolian Pedagogical University. These universities continued operating into the 21st Century as independent and highly specialized universities.

Higher education during the transition

Following the collapse of the Soviet Union, Mongolia took a different path than its Central Asian neighbors that had been part of the Union. It allowed its currency to float (with accompanying hyper-inflation), established a multi-party democracy and began privatizing state-owned enterprises. Recognizing the importance of building a strong legal foundation for the newly independent republic, a constitution was approved and the Parliament passed the first education law in 1991. This law was amended in 1995, 1998, 2000, and 2002, each time clarifying and defining various dimensions of the tertiary education system (e.g., standards, degree structure, institutional types, assessment and accreditation, governance, finance, etc.).

Enrolment in bachelor’s degree level programs increased dramatically, from 13,825 in 1990 to 59,444 in 1998. Important factors in the rapid expansion of tertiary education in the 1990s were authorization, for the first time, of private higher education institutions, increased demand for advanced education required to find employment in the emerging market economy, and increases in government funding for students. Donor activity also accelerated with funding from multi-lateral (ADB, EU) and bi-lateral (Japan, Korea, USA, Denmark, UK, Germany) agencies.

Current higher education in Mongolia

Basic information

Higher Education sector in Mongolia consists of University, Institute and College. University offers Bachelor’s, Master’s and Doctoral Programs, Institute offers Bachelor’s and Master’s programs, and College can offer only a bachelor’s program. The president of every institute of higher education is assigned by MECS. Although autonomy in university has been discussed in the last 20 years, it has not yet started. Quota of full-time bachelor’s program in every university is also set up by MECS as relic of planned economy system.

Table 1-9, 1-10 and 1-11 show the basic information regarding the higher education sector during the last decade, the current situation, and the distribution of higher education institutes, respectively.

Table 1-9 Main indicators of higher education during the last decade

Indicators	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
Higher Education Institutes (HEIs)	185	183	184	180	170	162	154	146	113	101
State HEIs	42	48	49	49	48	47	48	42	16	15
Pribate HEIs	136	128	129	125	116	109	101	99	92	81
Brabches of foreign univesities	7	7	6	6	6	6	5	5	5	5
Accredited HEIs	58	68	85	88	88	91	86	86	68	67
Total enrollment of HEIs	98,453	108,738	123,824	138,019	142,411	150,326	161,111	164,773	170,126	172,798
State HEIs	66,834	74,134	84,041	91,755	93,478	99,037	106,611	100,581	104,431	104,101
Public HEIs	31,197	34,134	39,405	45,784	48,552	50,878	54,114	63,835	65,306	68,302
Branches of foreign universities	422	470	378	480	381	411	386	357	389	395
Accredited HEIs	79,202	86,599	108,339	110,000	123,609	133,071	140,768	151,049	161,304	164,884
Total staff employed by HEIs	10,674	11,046	11,555	11,676	12,175	12,492	12,555	12,849	12,824	13,021
Full-time faculty members	5,642	5,990	6,337	6,517	6,818	6,892	7,020	7,219	7,183	7,295

Reference: Statistical Year Book Education, Culture, Science and Technology (2011-2012 academic year, 2011 fiscal year)

Table 1-10 Current information regarding the higher education sector in Mongolia

	Universities	Institutes	Colleges	Branches of Foreign Universities	Total
Number of HEIs	14	55	27	5	101
Public HEIs	10	4	1	-	15
Private HEIs	4	51	26	-	81
Branches of Foreign Universities	-	-	-	5	5
Number of Students	118,347	47,243	6,813	395	172,798
Public HEIs	100,763	3,112	226	-	104,101
Private HEIs	17,584	44,131	6,587	-	68,302
Branches of Foreign Universities	-	-	-	395	395
Full-time Faculty	4,867	1,965	424	39	7,295
Public HEIs	4,401	179	66	-	4,646
Private HEIs	466	1,786	358	-	2,610
Branches of Foreign Universities	-	-	-	39	39
Staff	8,730	3,396	772	123	13,021
Public HEIs	7,906	342	105	-	8,353
Private HEIs	824	3,054	667	-	4,545
Branches of Foreign Universities	-	-	-	123	123

Source: Statistical Year Book Education, Culture, Science and Technology (2011-2012 academic year, FY2011)

Table 1-11 Distribution of higher education in Mongolia

	All HEIs	Branches in Rural Areas	All Students	All Full-time Faculties
Western Region	2	5	5,037	289
Khangai Region	3	6	5,831	276
Central Region	3	5	7,449	373
Eastern Region	1	1	993	58
The capital Ulaanbaatar	92	0	153,488	6,299
Total	101	7	172,298	7,295

Reference: Statistical Year Book Education, Culture, Science and Technology (2011-2012 academic year, FY2011)

These tables indicate the following:

Total number of students in higher education institutes (HEIs) had increased from 98,453 of FY 2003 to 172,798 of FY 2012 by booming higher education. Although the number of students in HEIs increased to 75%, the number of the faculties increased by only 29% during the last decade. On the other hand, the government integrated HEIs to assure the educational quality. As a result, the number of HEIs decreased from 185 of FY 2003 to 101 institutes of FY 2012. Referring to Table 1-11, 91% of HEIs and 89% of students concentrate in Ulaanbaatar.

The increase in the number of the students in HEIs was caused by the increase in the population involved in school education and high enrollment ratio at HEIs. Enrollment ratio of higher education in Mongolia is 33.3% and ranks 47 among 151 investigated nations according to the Nation Master.com.

The population may increase from 2.8 million of FY 2012 to 4.0 million by FY 2050; a nearly 50% increase. Hence, the need for HEIs becomes higher and higher. There exists the lack of teaching staff, which will be discussed in following sections.

Quotas for students by Major Fields

The admission quotas of full-time students by major fields are shown in Table 1-12. The quota reflects, to some extent, the government's priority fields in engineering for human resource development.

Table 1-12 Admission quotas for full-time, day students by major fields

Major Category	Quota
Teaching	4,840
Arts	1,200
Psychology, Languages	2,435
Foreign languages	2,000
Economics, Finance. History	2,730
Journalism	663
Management	8,100
Law	1,335
Biology, Biotechnology	285
Physics, Chemistry	970
Geology	265
Mathematics	125
Computer science	2,005
Engineering	**3,745**
Industrial Processing technology	2,370
Metallurgy	45
Machinery	55
Mining	315
Mineral concentration	130
Construction materials	95
Construction and architecture	855
Civil and industrial building	190
Heating, ventilation, sewage	155
Agriculture, animal husbandry	1,125
Land development	375
Veterinary	185
Medicine and health science	2,915
Social work	415
Sports, tourism	995
Transport	125
Railroad	60
Ecology, Environmental science	445
Uniformed services, Military	750
Total	42,298

Engineering Subgroup of possible interest to Mining Industry	Quota
Metal processing	130
Mineral concentration	20
Mining electric equipment	260
Mining deposit assessment	70
Mining exploitation technology	25
Mining machinery	135
Engineering geology	80
Geodesy	80
Hydromechanics	60
Industrial waste processing	60
Water resources	30
Industrial ecology	30
Industrial mechanization	145
Combustion engines	30
Automotive	105
Engineering mechanics	105
Electric works and systems	435
Thermal and heating	155
Renewable energy	110
Information technology and system	630
Telecommunication	190
Railroad communication	20
Engineering mathematics	25
Engineering processing modelling	25
Engineering physics	30
Construction materials production	70
Agricultural mechanics	80
Engineer instructor	140
Total	3,275

Source: Capability Supply Landscape Study-Mongolia (October 2012)

Additionally, State Training Fund, a government agency under MECS, offers scholarship of better conditions to students in the areas of "High Demand Higher Educational Profession" which is listed in the Order #19 (2012). The listed areas are:

- Road Construction
- Primary School Teacher
- Pre-school Teacher
- Teachers for Natural Science
- Geology
- Hydrogeology
- Hydromechanics
- Water Resource Ecology

- Mining
- Mining Machine & Equipment
- Veterinary Science
- Information Technology
- Oil Storage and Transportation
- Civil Engineering, Pipeline
- Renewable Energy
- Nano Engineering
- Bio Technology
- Nuclear Energy
- Diagnosis
- Medical Science

Graduates from higher education institutes by degree

Table 1-13 shows the number of graduates from HEIs by each degree. Key factors indicated in the table are: 63% of the total number of graduates is female, 36% of the total number of graduates was able to land a job within 1 year after graduation, and only 25% of the number of graduates is from full-time bachelor's program.

The high rate of female students in university is caused by the Mongolian traditional custom. According to the custom, the males stay in their hometowns to support their families, and the females go out to be educated. The low rate of employment for the bachelor's program can be attributed to the fact that the number of graduates from the faculties of social science and the law is higher than that of faculties of engineering, as shown in Table 1-14. The number of graduates from the bachelor's program of engineering is 3,714, which is only 11.9% of the total number of graduates, while total number of graduates from diploma, bachelor's, master's and doctoral degree programs of engineering is 4,178 which is only 11.7% of the entire higher education. Although a statistic on employment ratio by major fields does not exist, the number of graduates are small and it can be said that there is an imbalance of demand versus supply in human resource.

Table 1-13 Higher education graduates by degree

	Graduates			Jobfinder	%
	Male	Female	Total		
Public HEIs					
Diploma program	83	761	844	509	60%
Full-time program	83	761	844	509	60%
part-time program	-	-	-	-	-
Remote program	-	-	-	-	-
Bachelor program	6,818	10,569	17,387	5,145	30%
Full-time program	6,032	9,208	15,240	3,828	25%
part-time program	199	343	542	201	37%
Remote program	587	1,018	1,605	1,116	70%
Master program	685	1,299	1,984	1,652	83%
Full-time program	535	836	1,371	1,066	78%
part-time program	-	-	-	-	-
Remote program	150	463	613	586	96%
Doctoral program	35	54	89	87	98%
Full-time program	19	35	54	52	96%
part-time program	-	-	-	-	-
Remote program	16	19	35	35	100%
Total (Public HEIs)	7,621	12,683	20,304	7,393	36%
Private HEIs					
Diploma program	6	89	95	60	63%
Full-time program	6	89	95	60	63%
Part-time program	-	-	-	-	-
Remote program	-	-	-	-	-
Bachelor program	5,012	9,252	14,264	4,518	32%
Full-time program	4,525	7,872	12,397	3,838	31%
part-time program	208	694	902	237	26%
Remote program	279	686	965	443	46%
Master program	317	862	1,179	999	85%
Full-time program	290	810	1,100	920	84%
Part-time program	13	26	39	36	92%
Remote program	14	26	40	40	100%
Doctoral program	3	2	5	5	100%
Full-time program	3	2	5	5	100%
part-time program	-	-	-	-	-
Remote program	-	-	-	-	-
Total (Private HEIs)	5,338	10,205	15,543	5,582	36%
Total	12,959	22,888	35,847	12,975	36%

Source: Statistical Year Book Education, Culture, Science and Technology (2011-2012 academic year, FY 2011)

Table 1-14 Higher education graduates by field of study and degree earned

Field of Study	Diploma	Bachelor's	Master's	Doctoral	Total
Education	133	5,012	623	7	5,775
Arts	8	563	35	3	609
Humanity	38	2,202	310	15	2,565
Social science, Business, Law	43	13,089	1,395	17	14,544
Science	14	1,858	244	10	2,126
Life Science (Biology)	(1)	(167)	(72)	-	(240)
Physics, Chemistry, Geology and Geography	(2)	(543)	(120)	(9)	(674)
Mathematics and statistics	-	(113)	(29)	(1)	(143)
Computer science	(11)	(1,035)	(23)	-	(1,069)
Engineering, Manufacturing and Construction	165	3,714	290	9	4,178
Engineering	(85)	(1,799)	(172)	(3)	(2,059)
Manufacturing and Processing	(61)	(1,342)	(77)	(4)	(1,484)
Architecture and Civil engineering	(19)	(573)	(41)	(2)	(635)
Agriculture	4	687	91	9	791
Health and Welfare	941	2,096	77	21	3,135
Service	41	1,982	98	3	2,124
Total	1,387	31,203	3,163	94	35,847

Source：Statistical Year Book Education, Culture, Science and Technology (2011-2012 academic year, FY2011)

Quality and quantity of faculties

Table 1-15 shows the indicators for the quality of faculty members in public HEIs. From the table, only 24% are Ph. D holders. This is relatively low in comparison with the developed countries including Japan in which approximately 31%[16] of all faculties and almost 100% in science fields hold Ph. D. In addition, most of the faculties with Ph.D. are seniors who earned their degrees from the universities in Russia during the Socialist era.

As for the quantity, as explained in the previous section, the number of faculty members increased by only 29% over the last decade, while the number of students increased by 75% in the same period. Table 1-16 shows the mobility and attrition of HEIs in 2012. In 2012, the newcomers and leavers are 1,360 and 1,248 respectively and the total number of faculty only had a slight increase. The reasons why faculty members left the HEIs are “moved to non-educational entity (6%)”, “became a self-employed (6%)” and “Others (47%)”. It means that more that 50% of leavers moved to the private sectors. This loss of faculty members to the private sector can be attributed to the increase in the pay standard in a booming economic situation.

[16] “Science and Technology Survey”, the Ministry of International Affairs and Communication, 2011

Table 1-15 Higher education administrative staff and faculty

Item	Full-time faculty (FTF)	Composition Ratio
Academic Positon		
Assistant Lecturer	807	11%
Lecturer	2,944	40%
Senior Lecture	1,934	27%
Associate Professor	862	12%
Professor	748	10%
Total	7,295	100%
Years of Experience		
1-5 years	1,868	26%
6-10 years	1,857	25%
11-15 years	1,063	15%
16-20 years	718	10%
21-25 years	610	8%
more than 25 years	1,179	16%
Total	7,295	100%
Age		
up to 30 years	2,109	29%
31-50 years	3,550	49%
51-55 years	761	10%
56-60 years	446	6%
above 60 years	429	6%
Total	7,295	100%
Education		
Doctoral	1,783	24%
Master's	4,890	67%
Bachelor's	601	8%
Diploma	21	0%
Total	7,295	100%

Source: Statistical Year Book Education, Culture, Science and Technology (2011-2012 academic year, 2011 fiscal year)

Table 1-16 Higher education faculty members mobility and attrition

Forms of members reported and attrition		Total	of which female	
Number of faculty members reported previous year		7,183	4,174	
All leavers		1,248	687	100%
of which	to institutions in other aimags or cities	114	72	9%
	to institutions in the same aimag or city	114	57	9%
	changed their position within the institution	147	104	12%
	moved to non-educational entity	76	43	6%
	those who became self-employed	77	44	6%
	retired	79	39	6%
	deceased	26	4	2%
	position was eliminated	23	10	2%
	convicted	-	-	-
	other reasons	592	314	47%
all comers		1,360	800	100%
of which	employed after graduation	265	173	19%
	from institutions in other aimags or cities	127	92	9%
	from institutions in same aimag or city	226	136	17%
	other reasons	742	399	55%
Number of faculty members reported this year		7,295	4,287	

Source : Statistical Year Book Education, Culture, Science and Technology (2011-2012 cademic year, FY2011)

Quality assurance system on Higher Education

Mongolia Council for Education Accreditation (MNCEA) a non-profit organization, is set up for accrediting the HEIs and TVETs. MNCEA is a full member of the International Network for Quality Assurance in Higher Education (INQAAHE) which consists of 173 quality assurance organizations. The Minister of MECS is a chairman of MNCEA. 67 institutes among 101 HEIs are accredited and 95% of the total number of students is studying at accredited HEIs.

Table 1-17 gives a summary of quality assurance in Mongolian higher education which includes accreditation, attestation, licensing, monitoring and ranking systems.

Table1-17 Mongolian higher education quality assurance system

	Accreditation		Attestation	Licensing		Monitoring	Ranking
Purpose	Institutional performance	Program improvement	Compliance check	Permission for operation		Status check	Comparison
Target	HEIs	Academic Program	HEIs	HEIs	Academic Program	HEIs	HEIs
Responsible institution	MNCEA		MECS	MECS		MECS & contracted parties	Interested parties
Method	Self-evaluating, External evaluation	Self-evaluating, External evaluation	Self-evaluating, External evaluation	External evaluation	External evaluation	External evaluation	External ranking
Follow-up /Result	Periodic reaccreditation of HEIs	Periodic reaccreditation of academic program	Periodic renewal of attestation	Renewal of HEIs program license	Renewal of academic program license	Periodic monitoring in HEIs	Periodic ranking

Source：Capability Supply Landscape Study-Mongolia (October 2012)

The standard of curriculum for the higher education in Mongolia is set up by MECS. Subjects are categorized into three contents: General Content, Professional Core Content and Specialization Core Content. "General" and "Professional Core" contents of each major subject are determined by MECS, and "Specialization Core Content" is determined by each HEI. In principle, the curriculum is composed of "General Content" (30%), "Professional Core Content" (40%) and "Specialization Core Content" (30%). The licensing for faculty member is also defined in the program standard. Attestation is to check whether the program adheres to compliance requirements. However, some HEIs cannot observe the program standard.
The ranking of top HEIs in Mongolia is determined by voting by educators and journalists. The result of TOP HEIs ranking in 2012 is shown in Table 1-18.
National University of Mongolia is the clear number one HEIs while Mongolia University of

Science and Technology takes the second place.

Table 1-18 Top higher education institutions in Mongolia

Rank	Name of the Institution	Score	Frequency
1	National University of Mongolia	522	127
2	University of Science and Technology	383	110
3	University of Health Sciences	309	91
4	Institute of Finance and Economics	199	60
5	University of Education	137	49
6	University of Agriculture	105	47
7	Mandakh Burtgel Institute	83	29
8	University of Humanities	66	23
9	Otgontenger University	44	15
10	Academy of Management	32	14
11	University of Art and Culture	38	13
12	Ikh Zasag University	28	12

Source: Capability Supply Landscape Study-Mongolia (October 2012)

1.3 Current situation of major higher education institutes in Mongolia

1.3.1 National University of Mongolia (NUM)

Outline

NUM, the first higher education institution in Mongolia, was established in 1942 with three schools- medicine, zoo technology and pedagogy, and six departments- zoology, biology, mathematics and physics, organic and inorganic chemistry, and anatomy.[17]

In 1947, the School of Social Sciences was established and offered courses on history and economics. The faculties of chemistry and biology were established in 1951. Also in 1951, the faculty of pedagogy became independent from NUM and was reorganized into the Pedagogical Institute. The program of agriculture science and technology was introduced in 1957 followed by the program of geology in 1958. In the same year of 1958, the faculty of Agriculture became independent and was named Institute of Agriculture (presently, the Mongolian University of Agriculture). In 1961, the departments of Geology and Mechanical engineering were established, and the Medical Faculty was separated from NUM and became a medical institute (presently, the Health Science University of Mongolia). In 1962, the departments of metrological engineering and construction and energy engineering were established, and the Nuclear Research Center was founded in 1965. In 1979, the Institute of Russian Language (currently the University of the Humanities) was separated from NUM. The Institute of

17 At NUM and MUST, the term "school" is equivalent to "faculty".

Mathematics was merged into NUM in 1997 while Ulaanbaatar University and the Institute of Commerce and Business were also merged into NUM in 2010.

Currently, NUM is a comprehensive university consisted of 14 Schools, five Institutes and 15 Research centers after undergoing some separations, merging through the several times of organizational restructuring. As the Poly-Technical Institute was separated from the NUM and became the University of Science and technology (Presently, the Mongolia University of Science and Technology) in 1969, NUM has the faculty of science but not the faculty of engineering. It is only recently that it introduced some engineering programs by request of the government.

This survey targets on six schools; Mathematics and Computer, Physics and Electronics, Biology and biotechnology, Chemistry and Chemical Engineering, Geography and Geology, and Information Technology.

Plan of establishing a graduate school of engineering at NUM

At present, NUM is discussing the organizational restructuring. Current graduate courses in NUM are operated by each school. According to the restructuring plan, these graduate courses may be separated from each school, and be relocated under the control of head office of NUM. Then, the head office of NUM will operate the new interdisciplinary graduate courses of; 1) Natural science, 2) Social science, 3) Law and 4) Economy. The Engineering course may be set up under this concept and there are two idea of installation. One is to set up the independent engineering course, and the other is to set up the engineering program in the Natural science course in combination with the natural science and the applied science. The applied science includes renewable energy technology including solar energy, nuclear technology, nanotechnology, bio-technology and information technology.

The concept is still under discussion phase and there are several challenges to realize; to develop the human resources of faculty on engineering field, to develop the curriculum on engineering, and to overhaul the equipment and devices for the education and research on engineering. NUM is investigating the administrative structure of the Universities in Japan, German, Korea, Taiwan and USA to develop the new engineering education system suitable for them.

Education System

NUM provides bachelor degree's program, master's and doctoral degrees programs. The school year from September to June is divided in two semesters which contains 16 weeks each. For bachelor program, the period of education is four years or eight semesters and 120 credits students are required for graduation. The 120 credits include; 24 credits of basic core curriculum, 54 credits of basic core specialty curriculum, 28 credits of core specialty curriculum, eight credits of selective specialty curriculum and six credits of selective curriculum. In addition to obtaining those credits, students are required to more than 60 points of accumulative Grade Point Average (GPA).

Master's degree's program accepts bachelor graduates and education period varies from one and a half year to two years or three to four semesters. 30 credits are required to be obtained for graduation including core curriculum, selective curriculum and master's studies. Doctoral degrees program is for master's degree's program graduates and education period is three years or six semesters. 60 credits are required to be obtained for graduation including lectures and doctor's study. Successful completers are awarded doctoral degree.

Table 1-19 Structure of degree program

Programs	Duration	Credit
Bachelor degree program	4 years or 8 semester	120
Master's degree program	1.5 years to 2 years	30
Doctoral degree program	3 years	60

Composition of faculties at NUM

Faculties consist of professors, associate professors, lecturers (including senior lecturers) and assistant lecturers. Research Assistant (RA) and Teaching Assistant (TA) are assigned to support the faculties. RA and TA are part-time positions newly made to support faculties' research and teaching duties. It is possible for RA and TA to be recruited as full-time faculties if they could obtain masters or doctoral degree at a foreign university.

Table 1-20 shows the number of faculties at schools of science field at NUM. Total number is 188. The number of all teaching and research staff is 252, including 22 RAs and 42 TAs.

Table1-20 Faculties by position and obtained degree at schools of science at NUM

School	Academic Position	Degree			Total
		Doctoral Degree	Master's Degree	Bachelor's Degree	
School of Mathematics and Computers	Professor	7			7
	Associate Prof.	13			13
	Senior Lecturer		10		10
	Lecturer		10		10
	Subtotal of school	20	20	0	40
School of Physics and Electronics	Professor	7			7
	Associate Prof.	8			8
	Senior Lecturer		2		2
	Lecturer		7		7
	Subtotal of school	15	9	0	24

School of Biology and Biotechnology	Professor	10			10
	Associate Prof.	18			18
	Senior Lecturer		5		5
	Lecturer	1	2		3
	Subtotal of school	29	7	0	36
School of Chemistry and Chemical Engineering	Professor	5			5
	Associate Prof.	9			9
	Senior Lecturer	8	2		10
	Lecturer		2		2
	Subtotal of school	22	4	0	26
School of Geography and Geology	Professor	3			3
	Associate Prof.	10			10
	Senior Lecturer	2	7		9
	Lecturer		18		18
	Subtotal of school	15	25	0	40
School of Information Technology	Professor	5			5
	Associate Prof.	5			5
	Senior Lecturer		1		1
	Lecturer		11		11
	Subtotal of school	10	12		22
Total		111	77	0	188

The rate of the faculties that have a doctoral degree in the schools of science field at NUM is shown in Table 1-21. The ratio is lower than that of Japanese universities of almost 100%.

Table 1-22 shows the number of students per a faculties in the higher education institutes. A faculty of NUM has supervised 29.8 students in average. This value is considerably higher than Japan (11.7) and the average of the OECD countries which is 15.7. It indicates a lack of the faculties at NUM.

Table 1-21 Rates of faculties with doctoral degree at schools of science

School	Number of Faculties	Faculty with Ph. D	
		Number	Ratio (%)
School of Mathematics and Computers	40	20	**50.0**
School of Physics and Electronics	24	15	**62.5**
School of Biology and Biotechnology	36	29	**80.6**
School of Chemistry and Chemical Engineering	26	22	**84.6**
School of Geography and Geology	40	15	**37.5**
School of Information Technology	22	10	**45.5**
Total	188	111	**59.0**

Table 1-22 Numbers of students per faculty

Name of country	Number of students / Number of faculties
Australia	14.4
France	15.6
German	11.5
Italy	18.4
Japan	11.5
Average of OECD countries	15.7
NUM	**29.8**
MUST	**27.1**

Source: "International index of education indicators" 2012, MEXT Report

Student Composition

Table 1-23 shows the number of students in the schools of science field in NUMU. As of July 2013, the total number of students studying science subjects at bachelor level is 5,063, master level is 805 and 297 at doctoral level, which accounts for approx. 30% of the whole students of NUM. Number of graduates from undergraduate schools of science fields for last three years is shown at Table 1-24. Except a few cases, number of graduates is inclined to increase year by year especially at the school of mathematics and computers, the school of biology and bio technology and the school of geography and geology.

Table1-23 Number of student in schools of science, NUM (as of September 2013)

School	Bachelor's Program	Master's Program	Doctoral Program
School of Mathematics and Computers	1,004	96	18
School of Physics and Electronics	821	122	43
School of Biology and Biotechnology	789	169	122
School of Chemistry and Chemical Engineering	772	90	35
School of Geography and Geology	1,230	246	67
School of Information Technology	990	82	12
Total	5,606	805	297

Table1-24 Change of number of bachelor program graduates at NUM (NUM total and schools of science)

School	2008-2009	2009-2010	2010-2011	2011-2012
School of Mathematics and Computers	160 (8.0%)	165 (8.4%)	148 (3.7%)	224 (5.5%)
School of Physics and Electronics	147 (7.4%)	162 (8.2%)	149 (3.7%)	149 (3.7%)
School of Biology and Biotechnology	112 (5.6%)	121 (6.2%)	104 (2.6%)	125 (3.1%)
School of Chemistry and Chemical Engineering	89 (4.5%)	77 (3.9%)	170 (4.2%)	142 (3.5%)
School of Geography and Geology	249 (12.5%)	189 (9.6%)	204 (5.1%)	280 (6.9%)
School of Information Technology	75 (3.8%)	64 (3.3%)	81 (2.0%)	89 (2.2%)
NUM Total	1,989	1,965	4,002	4,078

*Numbers shown in parentheses are ratio of each school's graduates to NUM total graduates

Source: Interview at NUM by Study Team

Student employment rate

The detailed state of employment opportunities for the graduates from the engineering programs in NUM is unclear as some programs are new and have not produced graduates. Therefore, Table 1-25 shows the employment situation of only schools that have available relevant data for comparison with the situation of MUST discussed in the following section.

The employment rate of the School of Chemistry and Chemical technology is 70 – 80% and typical employment places are the public and private companies in the mining industries. The employment rate of the School of Physics and Electronics is 50%, which is relatively lower than that of the School of the Chemistry and Chemical Technology, although the employment rate of the graduates from the renewable energy program offered under the School of Physics and Electronics is 100%, according to NUM. The places of employment for graduates from the renewable energy program include renewable energy technology companies.

In comparison with the rate of employment of MUST graduates which is 95 to 100%, the rate of NUM graduates from schools of science fields is low (regarding the data of MUST graduates, refer to the next section). It is estimated that the graduates of the schools of science fields in NUM have received rather scholarly and theoretically-based education and are not regarded as to meet the requirement for engineers by present industrial sectors centered by resource and mineral industries.

Table 1-25 Rate of employment for the students graduated from the schools offering the engineering program

	Employment rate	Typical employment place
School of Chemistry and Chemical Engineering	70 - 80 %	Public and Private mining company
School of Physic of Physic and Electronics	50 %	Mining company etc.
School of Biology and Biotechnology	-	Hospital, pharmaceutical company etc.

Source: Interview at NUM

International collaboration

Schools of science fields in NUM have been conducted various collaboration programs with domestic and international universities, research institutes and governmental agencies. Table1-26 is a list of international joint educational programs of the schools of science fields.

Regarding collaboration with Japanese universities, as of November 2013, the schools of science fields in NUM have conducted joint research programs and exchange of students. On the other hand, there has not been an example of joint educational programs yet.

Table1-26 International exchange programs of schools of science at NUM (June 2013)

Program Title	Program Level	Date of Agreement	Year of Program Beginning	School	No. of Students	No. of Flutiest	Degree Awarding University (s)
Physics – Master Degree Program University of Siegen (Germany)	Master (1+1)	2010	2011-2012		4		NUM and University of Siegen
Environment – Master Degree Program	Master			School of Geography and Geology			
Water Management Joint Program	Master			Joint Program with MUST and College of Daily Farming			
Chemical Engineering	Bachelor (2+2)	2012.10.5	2012-2013	School of Chemistry and Chemical Engineering	25	12	NUM and partner university

Industrial-university collaboration

Although NUM aspires for a research-oriented university based on theoretic, cost for researches is depending on limited budget allocated by the government. Therefore, NUM plans to increase research programs in the fields of applied science and to promote industry-university collaboration changing the past policy focusing on pure science and basic research. NUM is under development of its organization structure to implement the new policy; it established Technical Transfer Office in the industrial-university collaboration department under the vice president in charge of research and innovation. The office will manage NUM's industrial-university collaboration centrally. Currently, the industrial-university collaboration department has two staffs, a specialist of the intellectual property and the other of marketing.

In the past, NUM has few projects for the industrial-university collaboration. There are also some examples of individual-level collaboration managed by each school but the industrial-university collaboration office does not have enough information on the collaboration.

1.3.2 Mongolian University of Science and Technology (MUST)

Outline

Originally established in 1969 as the Mongolia University of Science's Polytechnic Institute, MUST is the nation's only university dedicated to science and engineering, and the only higher education institution specializing in scientific, technological and engineering fields. The main campus is in Ulaanbaatar, with other campuses located in Darkhan, Erdenet, Uburkhangai and Sükhbaatar.

MUST develops educational programs in collaboration with industries in order to respond to the needs of a changing society, and carries out lively exchanges with domestic and international universities and research institutes aimed at raising the educational and academic level of Mongolia to international standards.

MUST is composed of 18 schools, 42 research centers operated by each school, and six research centers under the direct management of the university. Currently, approx. 37,000 students attend the university. Education, research and management of the university are conducted by 1,200 faculties and staff includes 150 professors.

Education system

MUST provides bachelor degree courses, postgraduate courses (master's and doctoral degrees) and occupational training courses. In order to enter the university, candidates need to have graduated from an upper secondary educational institution, vocational training school or special vocational school, while candidates for the master's and doctoral courses have to have obtained a bachelor's and master's degrees, respectively.

Table 1-27 shows the degree composition of MUST. The period of study for the undergraduate courses is for 4.5 years or nine semesters, and 130 credits are required for graduation. The period of study for the master's and doctoral courses are 1.5 years or three semesters and 30 credits, and from four to six semesters and 60 credits. Each school year is composed of two semesters, each of which last for 17.5 weeks. Each semester consists of 16 weeks study and one week of examinations.

Table 1-27 Degree composition of MUST

	Period of study	Credits
Bachelor's degree courses (134 major fields)	4.5 years or 9 semesters	130
Master's degree courses (134 major fields)	1.5 years or 3 semesters	30
Doctoral degree courses (78 major fields)	4 to 6semesters	60

Education programs and curricula are formulated corresponding to each academic degree based on education fields in each course specified by MECS.

The curricula are designed to enable students to make cross-fields selection, thus allowing them to conduct wide-ranging and interdisciplinary research. On the other hand, at most of national universities including MUST, special programs are segmentalized and education emphasizes on theories influenced by Russia in the Socialist era. The table below shows programs of the school of mechanical engineering as an example of program segmentation.

Table 1-28 Programs at the school of mechanical engineering

Program	
Industrial Mechanization	IM
Internal Combustion Engine	CE
Mechanical Equipment of Industry Building Materials	EB
Automobile and Autoservice Engineering	AM
Mechatronics	ME
Aircraft Maintainance Engineer	AH
Technology of Machine Industry	MP
Metal Study and Technology	MS
Metal Processing and Repairs Production	MM
International Transport Management	OU
Transport Management	TU
Logistic Management	LM

Curriculum focusing on theories, in addition to influence of Russia, is caused by old and insufficient experimental equipment and shortage of teaching staff able to offer practical education. For an instance, only five practical classes are provided in four year education of the mechatronics program in the school of mechanical engineering. Compared to faculties of engineering in Japanese universities, the number of classes of practical education is smaller and it indicates the emphasis on theory in education in Mongolia.

- Technical drawing 3 credits 2nd semester, 1st grade
- Practice I 2 credits 1st semester, 3rd grade
- Practice II 2 credits 1st semester, 4th grade
- Workshop practice I 2 credits 2nd semester, 4th grade
- Bachelor graduation thesis 4 credits 2nd semester, 4th grade

In response to the situation, the school of power engineering has recently started curriculum revision introducing new educational programs referred to as CDIO (Conceive, Design, Implement, Operate) which was developed by the Massachusetts Institute of Technology and a Swedish university to offer more opportunities for students to take practical and experimental classes. However, the new program has been installed only partly due to lack of sufficient equipment and teaching staff.

The fulltime program is for students who have completed upper secondary education and passed the entrance examination, while the in-service training program is aimed at working people who passed the entrance examination. Most of the in-service training programs run in the evening. There are no differences between the entrance requirements for the fulltime and in-service training programs. The undergraduate courses provide over 3,500 programs in 134 major fields across 18 schools.

Master's courses are provided across all 18 schools, with over 100 major fields; doctoral courses are available only in a restricted number of schools, and around 70 major fields are catered for and administered by the Office of Graduate Studies.

The students graduating from the Mongolian University of Science and Technology are able to acquire the degrees indicated in Table 1-29.

Table 1-29 Types of degrees awarded by MUST

Doctoral Degree (1)	Master's Degree (8)	Bachelor's Degree (8)
Doctor of Philosophy	Master of Arts Master of Science Master of Engineering Master of Computer Science Master of Public Administration Master of Business Administration Master of Industrial Management Master of Information Technology	Bachelor of Arts Bachelor of Science Bachelor of Engineering Bachelor of Computer Science Bachelor of Public Administration Bachelor of Business Administration Bachelor of Industrial Management Bachelor of Information Technology

Composition of faculty at MUST

Faculties are Professors, Associate Professors, Lecturers including Senior Lecturers and

Assistant Lecturers. Table 1-30 shows composition and rates of doctoral degree holders of faculties.

A master's or superior degree is required to become a faculty of MUST. On the other hand, only 38% of members hold doctoral degree which is comparatively lower than that of Japanese, South Korean and European universities of engineering fields. There is also an age group bias in members holding doctoral degrees, the majority of whom are over the age of 50, and the remainder of which are comparatively younger people under around 35 years. Those aged over 50 acquired their degrees at universities in the former Soviet Union, and those who acquired degrees after the collapse of the Soviet Union had theirs at universities in Russia, Germany, U.S.A., Japan, South Korea, China and elsewhere. On the other hand, those in their 30s and 40s who have acquired a doctoral degree are extremely small in number.

Table1-30 Number and rates of doctoral degree holders among faculties in each school of MUST (Teaching Staff only)

School	Number of Staff (*)	Professor	Assoc. Prof.	Lecturer	Rate of Doctoral Degree Holders (%)
Civil Engineering and Architecture	114	7	15	92	33.3
Geology and Petroleum Engineering	59	9	7	43	54.2
Computer Science and Management School	103	6	16	81	29.1
Mathematics	83	9	7	67	28.9
Materials Science	55	7	10	38	52.7
Mechanical Engineering	90	7	10	73	28.9
Information and Communication Technology	86	4	10	72	24.4
Social Technology	58	2	7	49	32.8
Mining Engineering	68	9	12	47	39.7
Industrial Technology and Design	81	10	14	57	42.0
Food Engineering and Biotechnology	46	8	14	24	65.2
Language Education	87	2	9	76	25.3
Power Engineering	108	14	21	73	40.7
Total	1,038	94	152	792	38.0

Recently MUST launched a new recruitment system to employ high-achieving students at master's degree courses as RA and TA. Recruited RAs and TAs assist professors, associate professors and lecturers in their educational and research activities. If they hope, after acquisition of master's degree in future, they will be employed as full-time faculties. Currently, 96 RAs are on-duty for there are 96 leading professor teams (the team is equivalent to laboratory in Japanese universities) in MUST.

One concern is the fact that there is no adequate number of faculties to cope with the burgeoning amount of students. Table 1-22 shows the number of students per faculty at universities and degree programs in OECD countries. Referring to the Table, it indicates that the average of the students/faculty for the OECD countries is 15.7, while 11.5 in Japan and 14.4 in Australia. Although the situation is improving year by year, the ratio at MUST is 27.1 and clearly indicates a severe lack of faculties at the university and shows that this is a serious issue for science and technology in Mongolia's higher education.

Student Composition

MUST provides undergraduate and postgraduate (master's and doctoral) courses and in-service (or vocational) training program. In 1992-1993 there were 3,083 students at the university and in 2011-2012 there were 37,776 students, an increase of roughly twelve times over a period of around 20 years.

MECS determines the university's student quota according to the study on personnel needs it conducts each year. As can be seen in Table 1-30, the need for personnel in the fields of science and technology is rising dramatically throughout Mongolia, though the quotas for each school fluctuate from year to year.

Table 1-31 below shows changes in the number of students in each program at MUST from 1992 to 2012.

Table 1-31 Changes in the number of students by year

Year	Number of students
1992-1993	3,083
1995-1996	5,091
2000-2001	15,156
2005-2006	21,572
2009-2010	26,312
2010-2011	36,331
2011-2012	37,766

Table 1-32 Number of students (March 2012)

School	Bachelor's	Master's	Doctoral	Lyceum	Vocational Training	Total
Civil Engineering and Architecture	3,389	234	89			3,712
Geology and Petroleum Engineering	1,781	227	68			2,076
Technology School in Darkhan	3,302	107	8			3,417
Computer Science and Management	2,363	504	109			2,976
Mathematics	460	26	25	179		690
Materials Science	791	55	48			894
Mechanical Engineering	2,039	91	69		581	2,760
Information and Communication Technology	2,265	239	73			2,577
Social Technology	491	36	24			551
Mining Engineering	2,881	597	111			3,589
Industrial Technology and Design	2,313	105	71	105	125	2,719
Food Engineering and Biotechnology	1,384	120	45			1,549
Language Education	543	27	28	253		851
Power Engineering	2,508	252	15			2,775
International Higher Education Research Center						40
Technology School in Erdenet	927				138	1,065
Technology School in Uvurkhangai	455				1,487	1,942
Technology School in Sukhbaataar	192				593	785
College of Polytechnics in Ulaanbaatar					1833	1,833
College of Polytechnics in Darkhan					632	632
Training and Vocational Education Center in Bor-Undur					333	333
Total	28,084	2,647	796	557	5,682	37,766

Student employment rate

MUST has built a support system to help students find work: an employment support center was established in its head offices while each school explores potential places of employment based on their own studies on the personnel needs of industrial sectors. In addition, MUST invites personnel managers of companies to bachelor's and master's theses presentation meetings to offer students opportunities to present themselves. As a result of such effort, 95 to 100% of the students in each school have currently been employed, and 85 to 87% of those are working in sectors related to the fields they majored at MUST.

High-achieving students at each school have been employed in the mineral resources-related companies forming the today's backbone of the Mongolian economy. This is mainly because these companies are successfully performing and are able to offer better working conditions to their employees than companies in other sectors. Conversely, according to some reports, there occur difficulties for companies in other sectors to recruit prospective students.

Table 1-33 Employment rate of graduates by School

Schools	Employment rate（%）	Types of Industry
Civil Engineering and Architecture	100	Construction, Mineral resource-related
Geology and Petroleum Engineering	97	Mineral resource-related
Computer Science and Management School	95	Internet, Telecommunication, Software development
Mathematics	100	Internet, Power plant, Light industry
Material's science	96	Mineral resource-related, Steel, Light industry
Mechanical Engineering	100	Mineral resource-related, Construction, Railway
Information and Communication Technology	100	Telecommunication, Railway, Airline etc.
Mining Engineering	100	Mineral resource-related
Industrial Technology and Design	97	Light industry （Textile , Outfitting, etc.）
Food Engineering and Biotechnology	95	Food-related, Light industry
Power Engineering	97	Power, Energy-related

Research and technical development

MUST conducts its research activities with emphasis on technical development corresponding to the social needs of Mongolia. For this principle, they are preparing industry-university collaboration that encourages mutually beneficial research activities.

Scholars at MUST are also eager to promote the industry-university collaboration by participating in governmental projects or joint research activities with private companies as a part of their academic activities. Approximately 60 % of MUST faculties are member of these projects. As of 2009, MUST maintains around 40 research centers and six laboratories, with 96 professors leading approximately 150 frontier research efforts. In 2010, an incubation center was established in order to make the 'seeds' of the technologies developed at the university commercially viable, and an environment for industry-university cooperation has been improving.

Though only a few examples have been identified in a few schools, one example of industry-university collaboration identified in this survey is a project by the School of Information and Communication Technology to develop high-speed communications technologies with a Mongolian telecoms company. In parallel, as mentioned at 1.1.4, a governmental company UBEDN started to provide fund for MUST and carry out business activity along the research theme of the university. However, other industry-university collaborations such as dispatching students on internship or specialists to support companies are being implemented even though the cases are still limited.

International collaboration

MUST is implementing various international collaborations aiming at bringing its level of education and research up to international standards. MUST internationalization process consists of the following measures:

- Bilateral cooperation agreements with foreign universities
- Participation in international university networks
- Participation in international education and research programs and projects
- Academic exchange at student and departmental levels
- International exchange at school, research lab, department and individual levels
- Dual degree program

As programs for its scholars, MUST promotes programs for participation in meetings, seminar and symposiums held by international academic associations, partner universities and other academic institutions, short-term overseas programs for teaching staff, and joint research. As international programs for students, MUST promotes twinning programs with collaborating universities, exchange stay programs, summer training programs and internship programs.

The following Table 1-34 is a list of the international educational programs planned and implemented by MUST. They conduct student exchange, dual degree program and training programs for faculties. Among them, dual degree program is conducted at the most at both of the bachelor's degree courses and postgraduate courses. The dual degree program follows the same format as twinning program; students study at MUST for the first few years and take the following few years of the course at the partner universities. In the case of the bachelor's course, the initial two or two and a half years are spent studying at MUST, with the subsequent one and a half or two years being spent at one of the partner universities. Students who completed the dual degree program are awarded a diploma attested by both MUST and the partner university. Regarding language, both of Mongolian and that of the partner universities' national languages are used at the dual degree program: classes are given in the language of the country of the partner universities, although Mongolian is used for the explanation of specialist terms in parallel. Mongolian lecturers who acquired a degree at the partner university or at another university at that country teach these classes. Also, there are a few cases where Korean lecturers stay and teach at MUST for a short time.

As of November 2013, no degree level joint programs are being implemented between MUST and any Japanese universities. However, joint research, short-term training and exchange programs are underway on individual faculties and department. MUST School of Geology and Petroleum Engineering has accepted the establishment of the Nagoya University Field Research

Center on its premises, where joint research and exchange of faculties are currently active. Nagoya University also accepts prospective faculties and students of MUST to its doctoral degree courses to contribute to the improvement of MUST's teaching and research ability.

Akita University also has opened a Mongolian office on MUST campus and is preparing for distance learning, research meetings and other academic exchanges in the future. Since 2010, four students and seven faculties of MUST have visited Akita University by student exchange and short term training program for faculties.

Although not mentioned at the Table 1-34, Nagaoka University of Technology has also established its branch office at the School of Mechanical Engineering of MUST and is planning for future collaboration projects (as of September 2013). The School of Civil Engineering and Architecture is conducting joint research that will contribute to improving Mongolia's regional infrastructure with Ashikaga Institute of Technology, and Miyakonojo National College of Technology has for over ten years been conducting joint research with the university into monitoring the environment in Mongolia. The School of Mining Engineering has implemented an exchange stay student program with Kyushu University, in which students from both universities stayed in each other's country as interns. Other schools also have such experiences based on faculties' individual relationship with Japanese universities.

MUST hopes to enthusiastically develop and seriously implement international educational programs regarding international educational programs as effective methods to improve the quality of both education and research at their university. It considers that by enhancing the skills of its faculties the quality of the university will be improved, that by providing better education it will be possible to nurture higher quality students, and that through fostering human resources the needs of Mongolian business will be responded to and a contribution to the development of society will be enabled.

At current state, MUST believes it is imperative that international programs for faculties to be enriched and improved. There were ardent requests for joint research in fields that would be of mutual benefit to both MUST and partner organizations – specifically research areas covering Mongolia's rich natural environment such as those related to mining engineering, geology and biodiversity – and in fields contributing to Mongolia's infrastructure.

There were also requests to promote programs for students. Mongolian students are keen to study abroad. Though MUST is conducting twinning programs with consideration for the financial burden of students, in the future they hope to implement double degree programs able to award degrees to students.

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Table 1-34 International exchange programs of schools at MUST

Program Title	Type of Program	Date of Agreement	Year of Program Beginning	School	Program level	Number of Students and Faculties	Number of Graduates	Degree Awarding University (s)
Field Research, Field Research Center, Nagoya University (Japan)	Student Exchange Joint Field Survey	2011.6.16		Geology and Petroleum Engineering	Doctor	2		
Akita University (Japan)	Student Exchange Short Term Survey by Staff Joint Field Survey	2009.9.28	2010	Geology and Petroleum Engineering Material's Science, Mining Engineering		Student Exchange(1) Short Term Survey by Staff(7)		
Niigata Institute of Technology (Japan)				Mechanical Engineering	Doctor			
North of China Electric Power University (China)	Joint Education Program(2+2)	2012,5.17		Power Engineering				
Shanghai Medical Instrument College (China)	Joint Education Program (3+1、2+2)			Power Engineering	Doctor	1	1	Diploma of Both Universities
Taiwan University of Technology (Taiwan)	Dual Degree Program(2+2)	2008.6.27	2008	Industrial Technology and Design	Bachelor	6	5	Diploma of Both Universities
National University of Technology (Taiwan)	Dual Degree Program(1+1)	2011	2011	Industrial Technology and Design	Master	16	16	Diploma of Both Universities
Shandong University of Science (China)	Dual Degree Program(1.5+2.5)	2013.1		Mining Engineering	Master	8		Diploma of Both Universities
Limkokwing University of Creative Technology (Malaysia)	Student Exchange (2+2) Staff training	2006.12.20		All Schools		Staff Training(120)		
Soonchunhyang University (South Korea)	Dual Degree Program Student Exchange	2007.6.7	2007	Language Education	Bachelor	2, 15(Student Exchange)		Soonchunhyang University
Dankook University (South Korea)	Student Exchange	2011.7.7	2011	All Schools	Bachelor			
University of Pavia (Italy)				All Schools				
Freiberg Technical University (Germany)	Dual Degree Program(3+2.5)	2011.11.16		Geology and Petroleum Engineering	Bachelor	1		Diploma of Both Universities
Technical University Darmshadt (Germany)	Joint Degree Program (2+3)	2013.1		Geology and Petroleum Engineering Mathematics	Bachelor			Diploma of Both Universities
University of Arizona (U.S.A.)	Dual Degree Program(2+2)			Mining Engineering	Bachelor	15		Diploma of Both Universities
University of Alaska, Fairbanks (U.S.A.)	Dual Degree Program(2+3)			Mining Engineering	Bachelor	15		Diploma of Both Universities
IEC Group of Institute (India)	Joint Degree Program (2+3)	2012.5.7		Computer Science and Management School	Bachelor			Diploma of Both Universities
Mancosa Management college of Southern Africa (South Africa)	Joint Degree Program(online)			Computer Science and Management School				

1.3.3 Present condition of facilities at NUM and MUST

Both of NUM and MUST have convenient access for students and staff. Main campuses are located at Sukhbaatar district, Ulaanbaatar city; less than one kilometer from the center of the city and other campuses are within three- kilometer range. Although the location of the school of mechanical engineering of MUST is relatively far compared with the others, it is only ten to thirty minute-drive from the city center. Each campus has students' dormitories as well.

Most of university facilities were built around 1946, in the era of the former Soviet Union. Aged facilities have many problems including lack of capacity to accommodate increasing students. Details of survey result on the present condition of facilities are described in attachment 22.

1.3.4 Current situation, issues and needs for assistance in the fields and schools of priority

Current industries in Mongolia have strong demand for engineering human resource. In Table 1-7, all of the mining industry, national projects center on infrastructure development and other prospective industries will need more human resource in almost all engineering fields. However, human resource is insufficient both in quantity and quality of all levels of specialists, engineers and technicians, particularly the specialists and engineers with high expert knowledge, applied skill and problem-solving ability.

The fields of civil engineering, mechanical engineering and electricity and electronics engineering were selected to be assisted by this project based on the needs of industries and urgency of growing sufficient human resources in quantity and quality. In this section, situation of relevant schools of MUST are described, namely the school of civil engineering and architecture, the school of mechanical engineering, the school of power engineering.

- The school of civil engineering and architecture

The school of civil engineering and architecture, MUST consists of four departments and laboratories listed in the table below. The numbers of faculties are 114, consisted of seven professors, 15 associate professors and 92 lecturers, and 33.3% of them are doctoral degree holders. Enrolled students are 3,389 in the bachelor's degree courses, 234 in the master's degrees courses and 89 in the doctoral degree courses. The school offers 11 undergraduate programs.

Table 1-35 Laboratories and major fields, School of civil engineering and architecture, MUST

Department	Laboratory	Major Field
Structure Engineering	➢ Building Structure ➢ Structural Diagnosis & Testing ➢ Structural Analysis・CAD	・ Civil Engineering ・ Rain Construction Engineering
	➢ Geotechnical Engineering ➢ Soil Mechanics	
Road and Construction Technology	➢ Road Construction	・ Road and Bridge Construction
	➢ Construction Technology and Material	・ Construction Material and Techniques ・ Construction Material Industrial Technique
	➢ Construction Technology and Management	・ Estimation of Construction Cost
	➢ Road Materials	・ Road Materials
Architecture and Engineering Drawing	➢ Architecture and Urban Planning	・ Architecture ・ Architecture and Urban Planning
	➢ Engineering Drawing	・ Engineering Drawing
Environment Engineering	➢ Hydraulic Engineering and Water Use Facilities	・ Water Use Facilities ・ Water Management ・ Water Resource and Ecological System
	➢ Water Supply and Sewerage Systems, Heat Supply and Air Ventilation	・ Water Supply and Sewerage System ・ Heating System and Air Ventilation ・ Sanitary Engineering ・ Waste Disposal Technique

*There is also laboratory of hydraulic and pump station which does not belong to any departments.

➢ The school of mechanical engineering

The school of mechanical engineering consists of three departments. There are 90 faculties of seven professors, 10 associate professors and 73 lecturers with 28.9% of them being doctoral degree holders. There are 2,760 students with 2,039 in the bachelor's degree courses, 91 in the master's degree courses and 69 in the doctoral degree courses.

Besides undergraduate and graduate courses, the department of mechanics provides training and vocational programs which enroll 581 students. The school offers 12 undergraduate programs.

Table 1-36 Laboratories of the school of mechanical engineering, MUST

Department	Laboratory	
Transportation	➢ Automobile Component and Theory ➢ Automobile Examination ➢ Automobile Repair and Maintenance ➢ Engine Examination and Maintenance ➢ Internal combustion engine ➢ Transportation system	➢ Engine Examination ➢ Fuel System ➢ Electric System ➢ Fluid Mechanics ➢ Mechatoronics ➢ Metallic Element
Logistics	➢ International Logistics Management ➢ Foreign Language	
Machine building	➢ Metal Materials ➢ Mold Materials ➢ Metallic Chemistry ➢ Meltage and Molding ➢ Mechanic Experiment ➢ CAD・CAM ➢ Aerodynamics	➢ Computerized Machine ➢ Mechanization of Industry ➢ Restoration of Wear Component ➢ Development of Uninhabited Vehicle ➢ Aircraft Structure and Element

➢ The school of power engineering

The school of power engineering consists of two departments and seven laboratories. There are 14 professors, 21 associate professors and 73 lecturers with 33.3% of them being doctoral degree holders. The number of students is 3,389 in the bachelor's degree courses, 234 in the master's degree courses and 89 in the doctoral degree courses. The school offers 13 undergraduate programs

Table 1-37 Laboratories of the school of power engineering, MUST

Department	Laboratory	
Thermal Energy	➢ Heat Transfer, Thermal Mechanics ➢ Heat Supply and Automatization	➢ Industrial Ecology and Renewal Energy
Electric Energy	➢ Electric System and Energy Management ➢ Distribution of Electricity, High-pressure Engineering	➢ Electric System Automation ➢ Electronic System

1.3.5 Needs of target universities for Japanese assistance

As discussed in the outlines of two target universities in the previous sections, the following items are common issues for NUM and MUST.

- ➢ Improvement of the faculties with higher education and research ability
- ➢ Improvement of the equipment for education and research
- ➢ Development of practical education system
- ➢ Renovation and construction of facilities

Improvement of the faculties with higher education and research ability

This survey revealed that NUM and MUST have a common issue of lacking research ability from lack of human resources. Both universities hope to grow present and future faculties including RAs and TAs to obtain high level of technology and knowledge through joint research projects with Japanese universities.

The lack of research ability is indicated by the low ratio of doctoral degree holders among faculties. The ratio at schools of science fields of NUM is around 59% and at MUST is 38%. Three out of six schools of science fields of NUM and only three out of 13 schools of MUST have the ratio over 50%. Merely the school of Biology and Biotechnology and the school of Chemistry and Chemical Engineering have the ratio over 80%. Compared with the ratio in developed countries including Japan, South Korea and U.S.A. which is almost 100%, the ratio at schools of science fields at NUM and MUST are low. Just for reference, the ratio of whole Mongolian higher education institutions including schools of humanities and social sciences is 22.4%, according to the statistic information for the Higher Education Institutes in Mongolia 2012 – 2013.

One of the causes of low ratio of doctoral degree holders among faculties is imbalance of number of students and faculties. As shown in Table 1-22, the number of students per faculty at NUM is 29.8 and at is MUST 27.1 which is much higher than 5.17 at the University of Tokyo. As a result, faculties of NUM and MUST spend long time for educational activities and thus have difficulties to have enough time for research activities which prevent them from improving their research abilities and acquiring doctoral degree to improve their carrier.

To reduce the difficulty, both of NUM and MUST recently established RA and TA as discussed in previous sections. Although there are some differences of employment conditions between two universities, prospective students at postgraduate courses and high-achieving engineers working at industries are recruited as RAs and TAs. They assist faculties for research and educational duties and reduce their burden. Introduction of this system enables faculties to spare time for their own research activities, as well as offering RAs and TAs opportunities to become faculties by obtaining master’s or doctoral degree.

Improvement of the equipment for education and research

Improvement of the equipment for education and research is another common issue of two universities. It is also closely related with the former issue of cultivation of faculties.

Most of the equipment installed at NUM and MUST are very old, made in Russia and China in the 1960s and 1970s. Even if not yet broken-down, current equipment are not sufficient for research as well as for education and the situation is shared by almost all schools at both universities. A few departments have made efforts to improve their equipment by their own, but these were rare cases. The equipment have not been renovated sufficiently as allocated government budget was not enough for research innovation and universities need to be supported by foreign organizations or secure their own fund.

Decrepit equipment narrow the activities of faculties and prevent them from conducting advanced research which may result in the loss of prospective researchers as they transfer to industries or go to other countries. The lack of equipment also prevents students, who are the future industrial human resource, from receiving practical training. Also, education at universities becomes consisted mainly of classroom lecture. Trained with outdated equipment, students are not able to make substantial use of advanced equipment at companies. Graduates from these universities then have to undergo practical training at each place of employment. Therefore, this situation results in additional expenses and loss of time.

Improvement of equipment for educational and advanced and practical research is absolutely necessary considering the contribution it could give to the present Mongolian industries and academics and for the cultivation of practically trained industrial engineers and researchers to innovate research and technologies.

Development of practical education system

During this survey, MUST pointed out the necessity of development of practical education system especially at bachelor’s degree courses to satisfy the needs of Mongolian industries for engineering human resource.

Current education system at MUST is mainly classroom lecture which was influenced by Russia in the Socialist era. In addition, decrepit and insufficient educational equipment make it difficult for students to perform experiments and receive practical training. As a result, it brings a gap between the ability of MUST graduates and engineering human resource with practical technical capability needed by industries.

For Mongolian industries today, ensuring sufficient engineering human resource is an urgent issue to be tackled in a large number of planned national projects. To respond to this urgent need, universities must hasten the growing of engineering human resource with practical technical capability. It is difficult to grow such engineers only by curriculum development, but cultivation of faculties and improvement of equipment have to be carried out concurrently. As these efforts require investment of time at MUST, it is necessary to implement educational programs through international collaboration with Japanese universities.

MUST is active in international exchanges with foreign universities including Japanese and implements dual degree programs of bachelor’s degree level with Chinese and South Korean universities. In this proposed project, MUST expects to start a twinning project at bachelor’s degree courses with two year education each in Mongolia and in Japan, aiming at bringing the level of undergraduate education up to international standard while achieving cost effectiveness.

Renovation and construction of facilities

As described in the section on facilities of NUM and MUST, facilities of these universities are decrepit and not large enough to contain the growing number of students and to install new equipment for research and education. Both universities are keen to construct and renovate their facilities. However, as shown in the Attachment 20, the Mongolian government has a long-term plan to relocate universities and it makes the MECS pessimistic about new large scale construction at present campuses. For this reason, renovation will be limited only to facilities necessary to accommodate and utilize new equipment for research.

1.4 Assistance policy of Japanese government toward Mongolia and trend of other donors' cooperation

Assistance policy of Japanese government toward Mongolia

Since the Mongolian transition from socialism to democracy and market economy in 1990s, Mongolia and Japan have strengthened close bilateral relationship through Japanese ODA in various areas. In 2010, two countries reached a consensus to develop a relationship aiming at establishing "strategic partnership" by promoting economic activities, followed by an agreement to start negotiation on execution of "Japan-Mongolia Economic Partnership Agreement" at a bilateral summit in March 2012.

The basic policy of assistance (overall goal) of the Japanese government is "Supporting the effort toward poverty reduction through sustainable economic growth" and the priority areas of assistance (mid-term goal) are:

1) Sustainable development of the mining sector and enhancement of governance;
2) Assistance for inclusive growth; and
3) Enhancement of the capacity and function of Ulaanbaatar as an urban center.

Upon visit of Japanese Prime Minister Shinzo Abe to Mongolia in March 2013, the two countries concurred to strengthen the politics and security, the economy, and the human and cultural exchange to deepen "strategic partnership". In the area of economy, Mr. Abe's proposal named "Erch Initiative" which consists of 1) Development of investment / business environment and 2) Cooperation for Mongolia's sustainable economic development was approved by Mongolian Prime Minister Norov ALTANKHUYAG to promote economic relationship. In relation with the development of higher education, "2) Cooperation for Mongolia's sustainable economic development" includes three cooperation areas, which include the environment, the human resource, and the improvement of infrastructure, as basis for development. As for the human resource, it was mentioned that it will "launch preliminary survey to foster human resources for Mongol's industry through reinforcement of functions of higher engineering education institutions and acceptance of students for study in Japan (loan assistance)".

Thus, it can be considered that this project is consistent with the Japanese government's assistance policy for Mongolia.

Trend of other donors' cooperation for higher education development

Regarding international official assistance for higher education in Mongolia other than Japan, ADB and German Agency for International Cooperation (Deutsche Gesellschaft fur Inter-nationale Zusammenarbeit or GIZ) are two major donors.

Although ADB has assisted the education sector in Mongolia since the early period, it was just recently in September 2011 that it started to cooperate for higher education through the "Higher Education Reform Project", a loan project of 20 million USD. The project components are: 1) improvement of quality and relevance of higher education program; 2) improvement of governance, management and financing of higher education institutions and the entire subsector; and 3) promotion of equitable access to higher education. The project mainly focuses on relevant survey, advices and training. Improvement of equipment and scholarship programs are not included.

In the fall of 2013, GIZ started a project to establish Mongolia-German University of Technology (GMIT) under their assistance program for higher education "Cooperative Vocational Training in the Mineral Resource Sector in Mongolia". GMIT project is a technical cooperation project of four million Euro for the first four years. It aims at establishing a science and technology university of European standard. At the first stage, GMIT was simulated to start as a school of either NUM or MUST and then become independent as a new national university several years later. However, with the Mongolian government's strong will to establish an independent university since its first stage, it was opened as an independent public university in September 2013. GMIT campus is planned to be placed at a vocational training school in Naraiha, in the suburb of Ulaanbaatar, to be constructed by OT LLC and to be donated to MECS in November 2013. It is simulated to run undergraduate courses for the first five years and open master's and doctoral degree courses afterward. In September 2013, prospective 39 students were selected and entered the first grade of Basic Engineering Program, and the number of student is expected to increase up to 550 by the year 2017. At its beginning, there are five teaching staff, which will be increased to 25 in the future and teach in the fields of Mineral Resource Engineering, Mechanical Engineering and Environmental Engineering. It emphasizes practical training based from German system and will introduce collaboration programs with private companies. It has planned to invite short-term teaching staff from partner universities in Germany. The teaching language will be Mongolian and English, but students who wish to study in Germany are also able to receive classes in German. The tuition is 3.5 million MNT and there are scholarship programs sponsored by private companies.

1.5 Necessity of the project for higher education of engineering

Survey results describe above can be summarized as below:

- Due to rapid economic growth supported by the development of mineral resources in Mongolia, the demand for human resource among industries is increasing together with the expansion of higher education.
- However, the rapid quantitative expansion of education is not followed by qualitative improvement. For instance, the ratio of faculties with doctoral degree in science fields are 59% at NUM and 38% at MUST which are low compared to the ratio in developing countries including Japan.
- In addition, many students in higher education major in social sciences including business while only 23% of students choose engineering courses which have limited enrollment capacity in spite of the high demand of Mongolian industry. Development of personnel in the field of science and technology is regarded as an urgent task to sustain continuous economic growth of Mongolian economy.
- “2012-2016 National Action Plan” published by the new administration in 2012 advocates diversification of economics and industry and expresses that the government would promote: 1) Industrialization of mining, manufacturing, livestock, tourism, etc.; 2) High technology, biotechnology, nanotechnology and IT; and 3) Production of import substitute goods and exports, and mentions the necessity of human resource development to assume that goal.
- Both of Mongolian industries and Japanese investors have high needs for human resources in almost all fields of engineering, particularly in civil engineering, mechanical engineering and electric engineering. They also request the conversion of education system from classroom-centered to practice-based.
- NUM and MUST are the centers of higher education of engineering in Mongolia. However, they face challenges such as improvement of faculties with high research and education ability, development of education and research equipment, development of practical education system, and renovation and construction of school buildings.
- Although foreign assistance for Mongolian education had been concentrated in primary education and vocational training, ADB and GIZ recently began giving assistance for higher education which is expected to be followed by other donors.
- “ERCH Initiative” published by Japanese Prime Minister Mr. Abe on his visit to Mongolia mentions about the development of human resource of engineering through strengthening higher education institutions and dispatch of students to Japan.

The survey results shows the necessity and importance of the Yen Loan project at NUM and MUST proposed in the following chapters which include the improvement of undergraduate engineering education programs, the improvement of education and research abilities of faculties, and the development of relevant equipment.

Chapter 2 Project Master Plan

2.1 The objectives of the project

The objective of this project is to cultivate the engineering human resources necessary for Mongolian industry through improvement of quality and quantity of engineering education and research at two major universities in Mongolia, MUST and NUM.

This project is to respond to the high demand of the market for engineering human resources and to the problem that higher education in Mongolia is not sufficient to supply enough quantity with quality human resources, particularly in providing the practical technique and level of education equivalent with international standards. The improvement of MUST and NUM, which are the major universities in the engineering education field, will decrease the mismatch between university education and the needs of labour market. Furthermore, it aims to cultivate the industry-ready engineers at the field.

2.2 The basic approach

In order to achieve the above objectives, this project will adopt the following approach. Figure 2-1 below shows the conceptual diagram of the project.

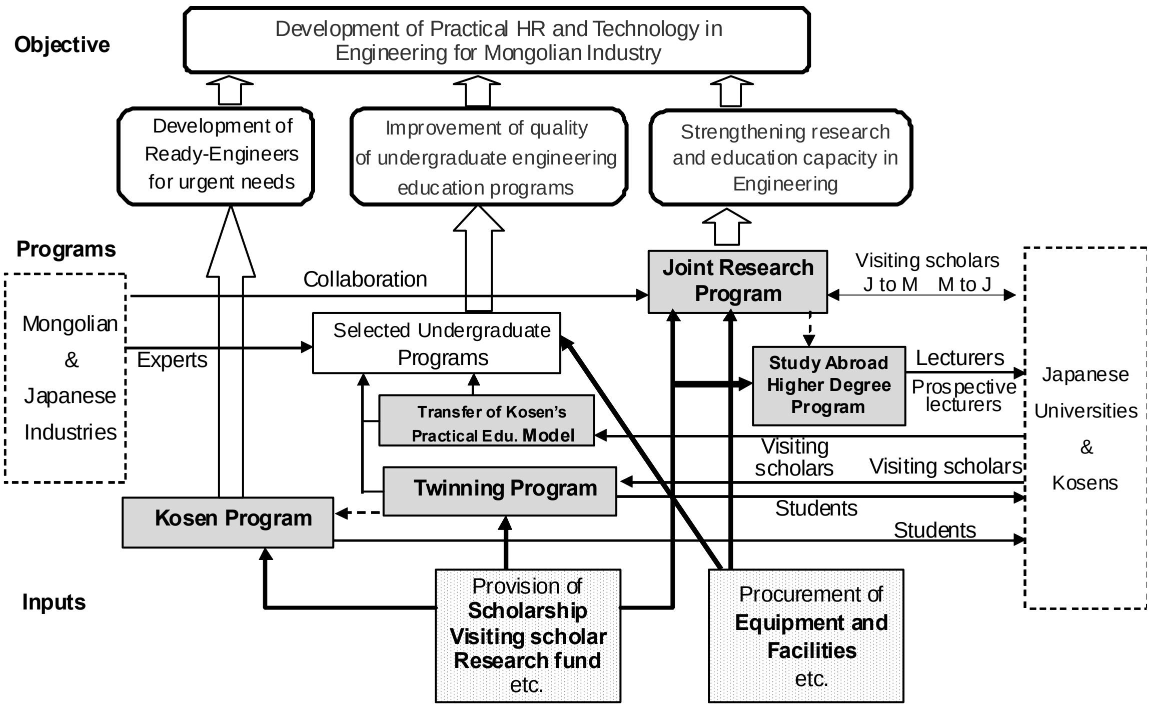


Figure 2-1 Project conceptual diagram

The improvement of quality of the undergraduate education

- Twinning program, the international collaborative education program with Japanese universities, will be established and conducted in order to improve the quality of undergraduate education which is the foundation of human resource development at the university.
- Through its process, the theory based curriculum which is common in Mongolia will be improved to the curriculum which focuses more on practical experiments.
- The necessary educational equipment for the new practical curriculum will be procured.
- The above activities will be concentrated on the fields of high industrial demand. The spread effect of the successful achievement will be expected.

Strengthening of education and research capacity of faculties

- Opportunities for studying in Japan to obtain master's or doctoral degree for faculties of NUM and MUST will be provided to strengthen their education and research ability.
- Mutual exchange between Mongolian and Japanese faculty members will be promoted through joint researches.
- The necessary research equipment for selected joint researches will be procured.
- Studying in Japan for faculties will be linked effectively with the improvement of faculties who are able to educate using new undergraduate curriculum and equipment, and conduct collaborative research.

Kosen program

- A certain time frame will be necessary to provide the human resources requested by the industry through the above approaches for improvement of universities. However, the rapid economic growth of Mongolia requires industry-ready engineers. In order to respond to the needs, the opportunity to study at Kosen in Japan will be provided.

Three phases of the project

The project will be conducted in three phases as shown below for effective implementation.

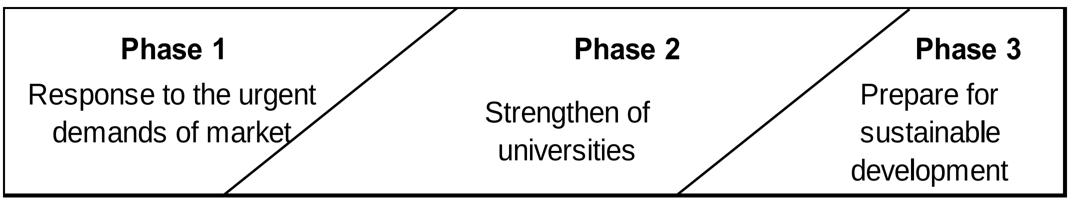


Figure 2-2 Three phases of project implementation

- During Phase 1, the industry-ready engineers required urgently by rapid economic growth will be provided by giving them the opportunity to study in Japan, because the establishment of human resource development will take time. In order to make an impact on the economy, the aim of "sending a thousand students to Japan" will be set and at the same time, the strengthening of universities such as bidding for materials and machinery as well as placing order for them, and curriculum improvement will be arranged.[18]
- Phase 2 is the core part of this project. During this period, ordered equipment are expected to be delivered, faculties who studied in Japan will begin to return, and interaction between faculty members through joint research and twinning program will be actively conducted. Bases of international and practical engineering education and research will also be established in Mongolian universities.
- In Phase 3, faculties and students who studied in Japan will continue to return, and the project will be prepared for sustainability after the completion of the Yen-Loan project.

2.3 Summary of the project

Based on the objectives and basic approaches stated above, the project summary is as described below.

Project Name (tentative) The Project for Higher Education of Engineering in Mongolia
Objective of the project The cultivation of engineering human resources required by Mongolian industry through the improvement of the quality and quantity of engineering education and research of two major universities in Mongolia, MUST and NUM.
Components of the project Component 1: The quality improvement of the undergraduate education (Curriculum development and twinning program) 1-1 Dispatch of faculty members for curriculum development and forming and conducting of twinning program 1-2 Scholarship for twinning program Component 2: Strengthening of education and research capacity of faculties (Study in Japan for the degree program and joint research) 2-1 Study in Japan for the faculties – Master's degree program in Japan – Doctoral degree program in Japan – Non-degree study in Japan 2-2 Joint research program

[18] For the entire project schedule, refer to Attachments 1 and 2.

Component 3: Kosen program 3-1 Scholarship for study at Kosen in Japan 3-2 Dispatch of lecturers for the preparation education for Kosen Component 4: Facilities and equipment procurement 4-1 Procurement of educational equipment 4-2 Procurement of research equipment 4-3 Renovation of facilities
Main target Twinning program: 320 Study in Japan for faculties Master: 100, PhD: 60, Non-degree (Long-term, Short-term): 320 personnel/time Study at Kosen in Japan: 200 Total number to study in Japan under the programs : 1,000 personnel Visiting scholars from Japan (Long-term, Short-term): 377 personnel/time Collaborative research: 20
Period of the project Nine years, from June 2014 to May 2023
Implementation structure Implementing agencies Executing Agency: Ministry of Education, Culture and Science (MECS) Implementing Body: Mongolian University of Science and Technology (MUST) National University of Mongolia (NUM)

Cost

Overview (million yen)

Component	Foreign currency	Domestic Currency	Total
1. Improvement of undergraduate education	1,756	0	1,756
2. Strengthening of capacity of faculties	1,496	0	1,496
3. Kosen program	1,250	0	1,250
4. Facilities and equipment procurement	1,600	108	1,708
Base Cost	6,102	108	6,210
Price escalation	389	0	389
Contingency fund (5%)	323	6	328
Total of base cost	6,814	114	6,928
5. Administrative cost	0	380	380
Price escalation	0	6	6
Contingency fund (5%)	0	6	6
6. Program development support service	641	0	641
Price escalation	41	0	41
Contingency fund (5%)	34	0	34
Total of project cost	7,529	506	8,035
VAT, Front-end fee, Interest during construction		153	153
Grand total	7,529	1,368	8,177

Although this project consists of various components, NUM will not participate in some activities as shown in Table 2-1.

Table 2-1 Implementation of each project component at MUST and NUM

Project component	MUST	NUM
Component 1: Improvement of undergraduate education		
1-1: Teacher dispatch for curriculum development and forming and conducting of twinning program	✔	
1-2: Scholarship for twinning program	✔	
Component 2: Strengthening of capacity of faculties		
2-1: Scholarship for faculties to study in Japan for the degree		
- Master's degree in Japan	✔	✔
- PhD degree in Japan	✔	✔
- Non-degree study in Japan	✔	✔
2-2: Exchange of researchers for collaborative research	✔	✔
Component 3: Kosen program		
3-1: Scholarship for study at Kosen in Japan	✔	
3-2: Dispatch of teachers for the preparation education for Kosen	✔	
Component 4: Upgrading of equipment		
4-1: Upgrading of educational equipment	✔	
4-2: Upgrading of research equipment	✔	✔
4-3: Renovation of facilities	✔	✔

2.4 Component 1: Improvement of undergraduate education

Target universities and schools

Although the target universities of this project are MUST and NUM, component 1, improvement of undergraduate education targets only MUST since NUM does not have undergraduate courses of engineering.

The target schools are the School of Civil Engineering and Architecture, the School of Mechanical Engineering, and the School of Power Engineering which are in the fields of urgent need by industries as discussed in Chapter 1. However, as described in a later section, the implementation of twinning program will be only in two schools namely, the School of Civil Engineering and Architecture and the School of Mechanical Engineering.

Contents of the component

Contents of the component for improvement of undergraduate education for the above mentioned three schools will be as below:

1-1: Dispatch of faculty members for curriculum development and forming and conducting of twinning program

1-2: Provision of scholarship for twinning program

In the activity of 1-1, scholars of Japanese universities are dispatched to MUST. Improvement of undergraduate education, strengthening of faculties and procurement of educational equipments are necessary and are discussed in the Component 2 and Component 3. Providing scholarship for twinning program is closely related with Kosen program in the Component 3, for prompt cultivation of industry-ready engineers.

2.4.1 Curriculum and syllabus development

As stated in the previous chapter, the universities in Mongolia have been influenced by Russian educational system of segmentalization and theory oriented method. Such educational system is considered as one of the reasons for the increasing need for practical and applied education at universities to meet the demands of industries.

As mentioned in the Chapter 1.3.2, the segmentalized education system has adverse effects. Therefore, MUST has the intention to change the system and be able to produce a Bachelor of Engineering degree curriculum similar to those at Japanese universities where they can cultivate students to have a wider range of capability and produce flexible graduates with better job opportunities.

On the other hand, the theory oriented curriculum, coupled with a shortage in experimental equipment, influenced the basic engineering experiments which are very much emphasized in the universities in Japan. When the project starts, detailed analysis of curriculum and syllabus will be done by the scholars from Japanese universities and the objectives will be the implementation of practical and applied undergraduate education which responds to the needs of the industry.

The above situation will also be the problem upon introduction of the twinning program. The improvement of curriculum and syllabus should be paralleled with the planning and implementing of twinning program by scholars dispatched from Japan in terms of the contents and efficiency.

2.4.2 Introduction of an international education program（Twinning program)

This project has the plan to introduce an international education program as part of the improvement of undergraduate education; the twinning program, a double degree program between MUST and universities in Japan.

Twinning program has started between universities in Western countries and Asian countries in early 1980s. Before its introduction, students had to study in the Western countries for the whole duration to receive education there. With this program, the cost and the duration of studying abroad are reduced by taking the credits of first half in the universities of home country and then transfer the credits to the destination university. The implementation of twinning program, especially that of a double degree system, needs adjustment in curriculum and syllabus and exchange of lecturers and lectures between universities. It will be one means of improvement of undergraduate education of universities in Mongolia. Furthermore, the opportunity to study in Japan with lesser cost and shorter period for students is, of course, valuable for the cultivation of industry-ready engineers which will be explained in Component 3.

Challenges to be faced for the implementation of twinning program are as follows:

1) Selection of target schools
2) Determination of Japanese partner universities
3) Problem with 12- year school education system in Mongolia
4) Establishment of program outline (e.g. Duration of education in each university)
5) Selection of students and number of students
6) Establishment of scholarship system
7) Japanese language education
8) Lectures of engineering in Japanese language
9) Mutual credits accreditation and the system for quality assurance between partner universities

1) Target schools

As mentioned previously, the target of the improvement of quality of undergraduate education will be the School of Civil Engineering and Architecture, the School of Mechanical Engineering, and the School of Power Engineering of MUST. Nagaoka University of Technology, Japan, targets to implement twinning program in the first two schools mentioned and has started preparation for the program. This is because the implementation of the program requires much effort and introducing it in three schools at the same time will impose much strain on Japanese universities. Besides, twinning program is already implemented in the School of Power Engineering with North China Electric Power University and Shanghai Medical Instrumentation College. However, the School of Civil Engineering and Architecture and the School of Mechanical Engineering do not have any experience of twinning program and the urgency of human resources from the industry is quite high in those schools. The School of Power Engineering has already agreed to be excluded from the twinning program of this project.

2) Japanese Partner Universities

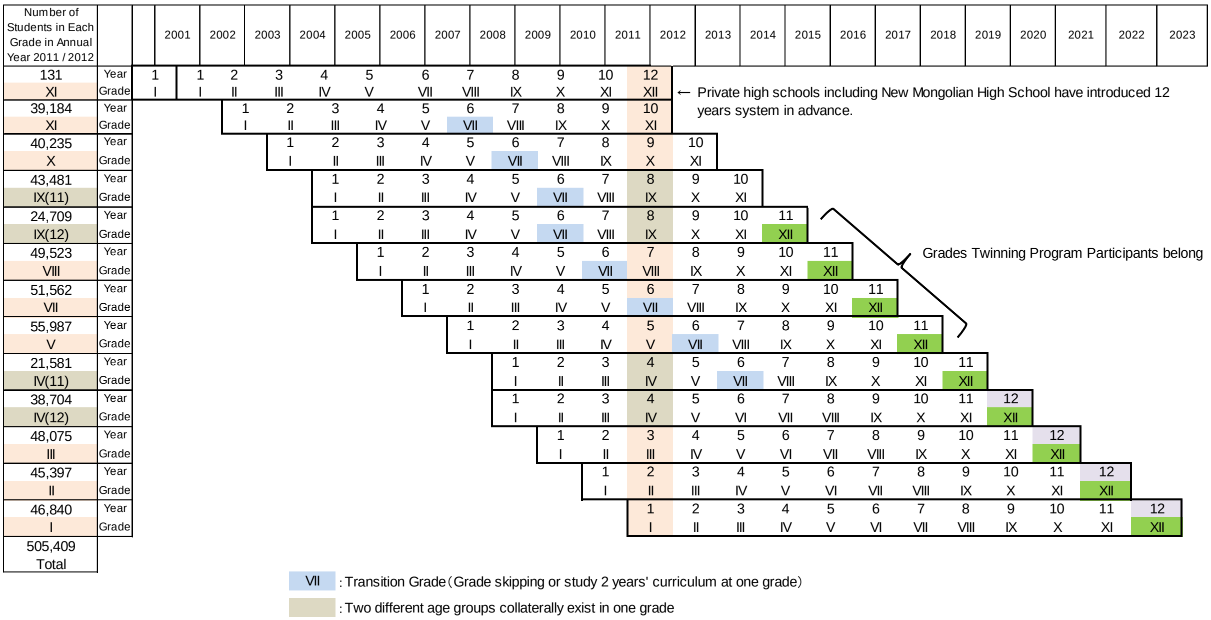
Nagaoka University of Technology has started consultation with MUST to establish Twinning Program since the time this survey started. The President of Nagaoka University of Technology has visited Mongolia and showed an intense interest. Therefore, it is appropriate to make Nagaoka University of Technology as the main partner in cooperation with other universities in accepting students. Because of the cost issue, the partner universities will be limited to national universities. Among national universities, The School of Engineering, Nagoya University already showed their interest. It is expected that there will be no barrier in finding more national university partners.

3) Problem with 12-year educational system

The education system in Mongolia is presently under conversion from 10-year to 12-year education through a stage of 11-year education. In Japan, one of the criteria to be accepted to universities is that students must have received a minimum of 12 years of education. Japanese universities express their concern that whether the Mongolian education can fulfil this entrance requirement.

Mongolia had tried to change from 11-year education system to 12-year education system by accepting students of age 7 together with students of age 8 (however, actual education period is still 11 years) in 2004. The students of this 12-year education system will enter the university after 2015. Furthermore, schools started to accept students of age six together with the students of age seven in 2008 and they will enter the university in 2020. At that time, 12 year education system which adopts the 12-year curriculum will reach completion. The students who will enter the university in 2014 will be under the 11-year education system (actual education period is 10 years), and the students who will enter university in September 2015 are still under the 12-year education system (however, the actual education period is still 11 years). Figure 2-3 shows the outline of the process of change using the statistics of the number of students published by the Ministry of Education.

In regard to this problem, Nagaoka University of Technology expressed their opinion that if the two and half year education in Mongolia can be considered as 12-year curriculum, the acceptance of students by Twinning Program will be possible. In that case, the acceptance of the first batch of students should start in September 2015 even though the Yen Loan will be available in the early 2014.



Source: Statistical Year Book Education, Culture, Science and Technology (2011-2012) and Website of Mongolian Ministry of Education and Science. Diagram by Study Team

Figure 2-3 Transformation process to 12-year education system (Number of students in each grade in fiscal year 2011 / 2012)

4) Program Outline

As shown in Figure 2-4, the first semester starts in September and ends in December and the second semester starts in March and ends June at universities in Mongolia.

Based on the differences of academic year in both countries, it is reasonable that education period in Mongolia is two years and seven months and in Japan is two years, and the whole schedule of Twinning Program will be four years and seven months. It means that the students will end the first semester of 3rd year education in Mongolia and will transfer to Japanese universities in April.

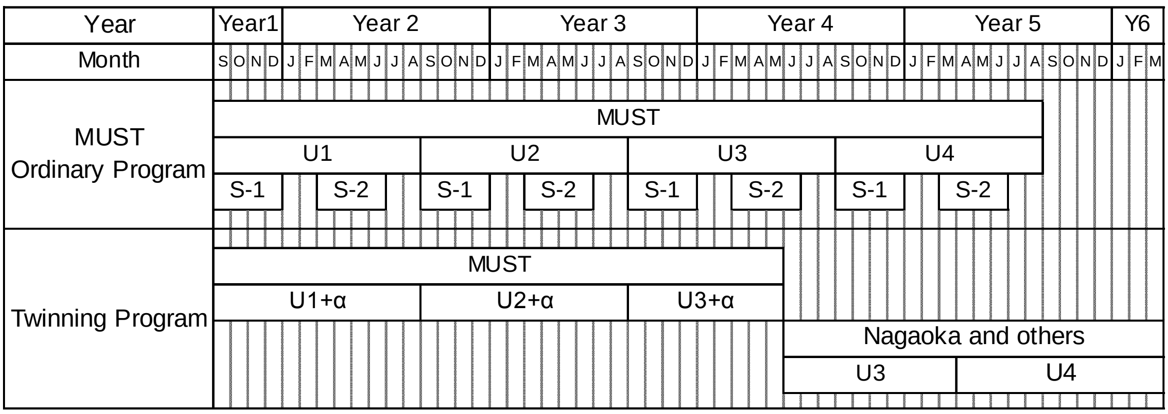


Figure 2-4 Semesters at MUST and Twinning Program schedule

5) The selection of students and number of students

There are two options for selection of students for Twinning Program.

- Select from students who are already enrolled in MUST
- Recruit new students for Twinning Program at the time of entrance to MUST

All other Twinning Program conducted by MUST adopts the latter option. It is considered appropriate to adopt the latter option for Japanese Twinning Program because it is necessary to take additional subjects such as Japanese language and subjects required by Japanese universities.

According to the university system in Mongolia, students send the result of high school unified graduation examination to the university of their choice. If the result satisfies the minimum requirement, the student then chooses the school and each school judges the acceptance. The Twinning Program of this project is expected to follow the same process.

The number of student acceptance will be decided by the Mongolian Government according to the budget. To achieve the objective of "dispatch 1,000 students to Japan", this survey targets to accept 40 students each from the School of Civil Engineering and Architecture and the School of Mechanical Engineering, a total of 80 students each year, for four batches, and 320 students throughout the project period.

6) Scholarship

The Mongolian Government and students sign a contract called Conditional Loan for the scholarship under the program of study abroad at the top 100 universities by the government for undergraduate students. However, the specific conditions of reimbursement are not determined yet. The plan under consideration is that 70 to 80% of the cost will be changed to grant from loan if the student's mark is greater than GPA 3.0 at the graduation. The contract does not force students to work at universities or government in Mongolia after graduation.

The scholarship condition for Japanese Twinning Program which is under deliberation in the cabinet council is stipulated to be the same.

As a reference from other country, Malaysia, which is conducting Japanese Twinning Program under the same Yen Loan project, adopts a 100% grant scholarship. Conditional Loan for studying at other countries applies the condition that 80 to 95% of loan will be changed to grant if the students achieve a certain grade at graduation and 100% will be granted in case the student works at universities or governmental organizations specified by the government for more than three years after graduation.

In terms of the amount of scholarship, it includes the examination fee, entrance fee, tuition fee for two years, a return air ticket, and living allowance for two years. The amount of living allowance is estimated to be 117,000 yen per month which is the same as the scholarship by Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT).

Table 2-2 Cost estimation of twinning program scholarship (per student)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Total
				FC	FC	FC	FC
Entrance Examination Fee	Once	30,000	1	30,000			30,000
Admission Fee	Once	282,000	1	282,000			282,000
Tuition Fee	Year	535,800	2	535,800	535,800		1,071,600
Air Fare to & from Japan	One way	100,000	2	100,000		100,000	200,000
Living Allowance	Monthly	117,000	24	1,053,000	1,404,000	351,000	2,808,000
				2,000,800	1,939,800	451,000	4,391,600

7) Japanese language education

One of the barriers of Twinning Program with Japanese universities is the Japanese language. Most of the lectures at Japanese universities, especially the undergraduate level, are given in Japanese. Therefore, it is necessary to introduce the Japanese language education in the program at Mongolia.

MUST has the Japanese language major in the School of Language Education and currently eight students are studying with Mongolian Japanese language lecturer. They have, not only the normal Japanese language course, but also the Japanese technical translation course and the level of Japanese language education is relatively higher than in other countries. As the number students of Japanese language course are not many, dispatch of Japanese language lecturer to the Japanese language education for Twinning Program will be possible upon introduction of the program.

The objective of Japanese language education by Twining Program is not the success in N1 or N2 level of Japanese Language Proficiency Test (JLPT), but the acquisition of Japanese ability to catch up with the lectures of engineering at Japanese universities.[19] Therefore, Japanese language education specialized for engineering is necessary as well as the normal Japanese language education. In this regard, the Japanese language department with Japanese technical translation course at MUST has certain advantages.

About 1,000 hours of Japanese language education will be required during the two and half year of education in Mongolia in order to achieve the objective. For reference, Twinning Program in Malaysia conducts 1,200 hours of Japanese language program. However, Mongolian students generally acquire Japanese very quickly due to its similarity with their language.

[19] The test has five levels: N1, N2, N3, N4 and N5. The easiest level is N5 and the most difficult level is N1. Linguistic competence required for N1 is "The ability to understand Japanese used in a variety of circumstances" and for N2 is "The ability to understand Japanese used in everyday situations, and in a variety of circumstances to a certain degree"

1,000 hours is calculated based on such ability of Mongolian students and advise of Japanese language lecturers. Each Japanese language lecture is 90 minutes, hence, 1,000 hours equals 677 lectures.

On the other hand, in Figure 2-5, two and half years of education at Mongolia consists of five semesters of 16 weeks each and a total of 80 weeks of school. Between each semester will be an examination and two months of vacation. If one month of the interim period can be changed as intensive course, five intensive courses and 20 weeks in total can be added. During the intensive course, not only Japanese language classes but also engineering lectures by lecturers from Japanese universities will be conducted.

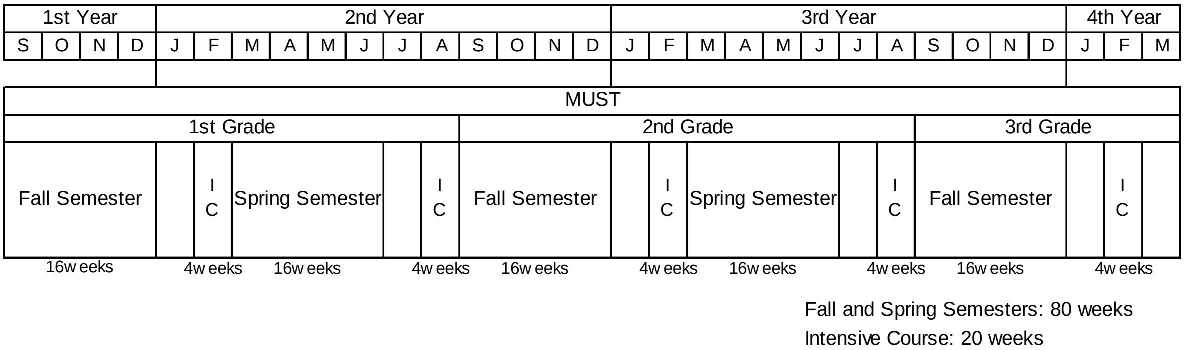


Figure 2-5 Schedule of the first twenty-seven months of twinning program in Mongolia

Base on this assumption, the apportionment of each lecture at each semester will be as below.

Table 2-3 Hours of Japanese language course in each semester

Semester		Weeks	Hours per Week	Total Hours	No. of Lessons per Week	Total No. of Lessons
1st Grade	Fall Semester	16	10.5	168.0	7	112
	Intensive Course	4	21.0	84.0	14	56
	Spring Semester	16	10.5	168.0	7	112
	Intensive Course	4	15.0	60.0	10	40
2nd Grade	Fall Semester	16	10.5	168.0	7	112
	Intensive Course	4	10.5	42.0	7	28
	Spring Semester	16	10.5	168.0	7	112
	Intensive Course	4	3.0	12.0	2	8
3rd Grade	Fall Semester	16	7.5	120.0	5	80
	Intensive Course	4	3.0	12.0	2	8
Total		100		1,002.0		668

Supposing the number of students for Twinning Program will be 40 students for each school of

Civil Engineering and Architecture and Mechanical Engineering and intake of some extra students for drop outs, each school requires three classes and a total of six classes each year. As the average of the number of classes for Japanese language lecturers per week will be 10 (15 hours), the required number of Japanese language lecturers is estimated as described in Table 2-4.

The details will be decided at the consultation between specialists of Japanese language education from Japanese partner universities and MUST. According to the estimation of this survey, three Japanese language lecturers from Japan (the last year will be two) will basically reside in Mongolia and the rest of the required teachers will be covered by teachers dispatched by the School of Language Education of MUST. The number of classes for Japanese language lecturers dispatched by the School of Language Education will vary between 12 and 108 per week. The employment of temporary lecturers of the School for this project may be necessary in some cases. However, it is still preferable that the lecturers dispatched by the School be fixed to the same personnel to acquire experience from this project.

Table 2-4 Number of Japanese language lecturers required

Year		2015	2016				2017				2018				2019				2020				2021
Fiscal Year		2015/2016				2016/2017				2017/2018				2018/2019				2019/2020				2020/2021	
Semester/ Intensive Course		Fall	IC	Spr.	IC	Fall	IC	Spr.	IC	Fall	IC	Spr.	IC	Fall	IC	Spr.	IC	Fall	IC	Spr.	IC	Fall	IC
Number of Students																							
Batch 1	80	80	80	80	80	80	80	80	80	80	80												
Batch 2	80					80	80	80	80	80	80	80	80	80	80								
Batch 3	80									80	80	80	80	80	80	80	80	80	80				
Batch 4	80													80	80	80	80	80	80	80	80	80	80
Total	320	80	80	80	80	160	160	160	160	240	240	160	160	240	240	160	160	160	160	80	80	80	80
Number of Students' Classes																							
Batch 1	6	6	6	6	6	6	6	6	6	6	6												
Batch 2	6					6	6	6	6	6	6	6	6	6	6								
Batch 3	6									6	6	6	6	6	6	6	6	6	6				
Batch 4	6													6	6	6	6	6	6	6	6	6	6
Total	24	6	6	6	6	12	12	12	12	18	18	12	12	18	18	12	12	12	12	6	6	6	6
Lesson Hours/ Week/ Student																							
Batch 1		7	14	7	10	7	7	7	2	5	2												
Batch 2						7	14	7	10	7	7	7	2	5	2								
Batch 3										7	14	7	10	7	7	7	2	5	2				
Batch 4														7	14	7	10	7	7	7	2	5	2
Work lord /Week /Lectures																							
Batch 1		42	84	42	60	42	42	42	12	30	12												
Batch 2						42	84	42	60	42	42	42	12	30	12								
Batch 3										42	84	42	60	42	42	42	12	30	12				
Batch 4														42	84	42	60	42	42	42	12	30	12
Total		42	84	42	60	84	126	84	72	114	138	84	72	114	138	84	72	72	54	42	12	30	12
Total Number of Lecturers Required		4.2	8.4	4.2	6	8.4	13	8.4	7.2	11	14	8.4	7.2	11	14	8.4	7.2	7.2	5.4	4.2	1.2	3	1.2
(Breakdown)																							
Lecturers from Japan		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
Lecturers from Faculty of Language (including External Part-timers)		1.2	5.4	1.2	3	5.4	9.6	5.4	4.2	8.4	10.8	5.4	4.2	8.4	10.8	5.4	4.2	4.2	2.4	1.2	0	1	0
Conversion to Lesson Hours		12	54	12	30	54	96	54	42	84	108	54	42	84	108	54	42	42	24	12	0	10	0

8) Lectures of engineering in Japanese language

For Twinning Program, it is necessary to give engineering lectures in Japanese language as well as Japanese language education. Otherwise, students will not be able to catch up with the lectures after they transfer to 3rd year at Japanese universities.

There are three ways of holding engineering lectures in Japanese language.

- Dispatch of Japanese lecturers for a long period of time
- Intensive lectures by lecturers from Japanese universities
- Distance learning using TV conference system

Details will depend on the consultation between partner universities. However this project plan intends to adopt all of the three methods.

One lecturer each for the School of Civil Engineering and Architecture and the School of Mechanical Engineering, a total of two lecturers, will be dispatched for long term and give lectures, and at the same time will coordinate the inputs to local education from the Japanese side. Secondly, a lecturer or a technical staff (with background in industries is preferred) who can instruct and teach engineering experiment and engineering practice will be dispatched to each schools and the School of Power Engineering, a total of three.

The number of lecturers to be dispatched for intensive courses cannot be confirmed at this moment. However, the plan is to dispatch two lecturers for each intensive course for five times. The insufficient lectures will be covered by distance learning using TV conference system.

9) Mutual credits accreditation and the system for quality assurance

Twinning Program through this project is basically credits transfer program. Ongoing consultation between Nagaoka University of Technology and MUST has the intention to make it a double degree program to mutually accredit the credits.

The calculation of credits in Mongolia is that a 45-minute class for 16 times per year become one credit, and it is the half of an experimental subject where a 45-minute class for 32 times per year become one credit. Japanese universities count a 90- minute class for 15 times per semester as two credits for lecture subjects and a 90-minute class for 15 times per semester as one credit for experimental subjects. Therefore, the number of hours for one credit is slightly more in Mongolian universities but it will not be a problem for mutual credit accreditation. The required number of credits for graduation in Mongolia ranges from 125 to 135, and the minimum required credits in Japan is 124 or more than 130 depending on the department and faculty. There will be no problem in this regard. However, some subjects which are not offered in Mongolia are the compulsory subjects in Japanese universities and this will be an issue. In case of Nagaoka University of Technology, it adopts the total accreditation system and does not accredit the credits per subject when students transfer either from Kosen or from foreign universities. Therefore, the compulsory subject problem does not apply to Nagaoka

University of Technology. However, it can be a barrier for other universities. The insufficient subjects must be covered through lectures by teachers dispatched from Japan and through distance learning using TV conference system.

Most of the twinning programs generally apply the evaluation of examination questions and grading conditions at each periodic exam. The consultation for this matter has not been done yet for this project.

2.5 Component 2: Strengthening education and research capacity of faculties

The plan for strengthening education and research capacity of faculties of NUM and MUST under this project consists of two programs: the scholarship program to obtain the degree (Master's and Doctoral) from Japanese universities and the joint research program with Japanese universities.

The joint research program consists of three programs: the program to dispatch scholars from Japanese universities to NUM and MUST, the non-degree program where faculties of NUM and MUST conduct researches in Japanese universities, and the research fund program.

It is necessary to strengthen human resources and improve the environment at the same time in order to strengthen education and research capacity of faculties, and the strengthening process is important. Considering the process of this project, there is a possibility to take a substantial amount of time from the start of project to the improvement of research environment such as procurement of research equipment. Therefore, in the beginning stage of improving the research environment of NUM and MUST, it is planned to emphasize the implementation of capacity building of human resources through the scholarship program and the non-degree program. In the second stage, the faculties who returned from Japanese universities will proceed with joint research with Japanese universities by using the research equipment installed in NUM and MUST. In the third stage, in order to establish the structure for NUM and MUST to sustain and proceed with research and education programs on their own, activities to obtain external funds such as business-university collaborations in cooperation with Mongolian or overseas industries will be promoted, based on the outputs from the joint research program with Japanese universities.

2.5.1 Study in Japan at postgraduate level for capacity building of faculties

Program Overview

The study in Japan postgraduate level to improve the education and research capacity of faculties consists of two programs: the degree program to study at Master's and Doctoral courses in Japanese universities, and the non-degree (post-doctoral) program to study in Japan for short and long term researches and education of faculties without obtaining degrees.

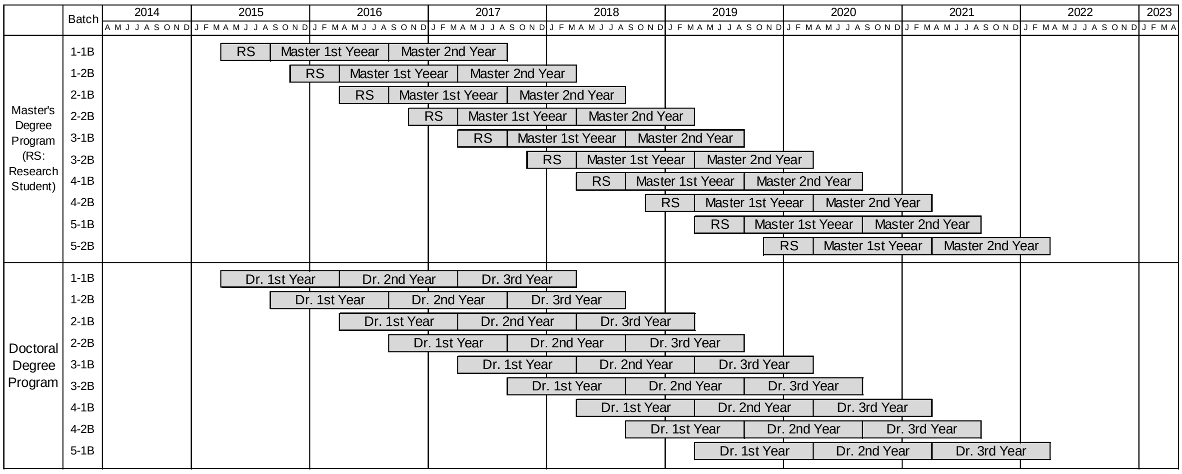


Figure 2-6 Degree program schedule

The standard program is three years for Doctoral degree course and two years for Master's degree course. However, there may be case to accept research students from six months before the entrance examination as a result of pre-consultation with supervisory professors of Japanese universities. Since the enrolment for the Japanese postgraduate schools are twice a year in spring and fall, the departure time may be decided based on the convenience of faculties.

Selection of faculties and selection measures

- Degree program:
  This program basically targets the present faculties, RAs and TAs who will join the faculties of engineering of either universities in the future and who do not possess Master's or Doctoral degree at the moment.

- Non-degree program:
  This program targets the faculties who are engaged in implementation of joint researches, improvement of curriculum and syllabus, formulation and implementation of twinning programs, etc.

These programs will accept candidates from various fields of engineering and is not only limited to the priority support fields (civil engineering, mechanical engineering, power engineering) of the two universities. The overseas study program will also be implemented targeting teachers, research assistants and teaching assistants under the collaborative research program with Japanese universities. Concerning the selection measures, Project Implementation Unit (PIU) will prepare the necessary documents and the Steering Committee will eventually select from the candidates recommended from each department. Details of PIU and steering committee are explained in following sections.

Number of participants

The target number of participants for the degree programs are:

- Master’s degree program: 100 participants
- Doctoral degree program: 60 participants

It is ideal that participants of both degree programs depart in the early period of the project and return within the project period, and then participate in the joint research and joint education programs.

For the non-degree program, considering the budget, it is planned to have 30 participants for the one-year overseas study, 50 participants for the six-month overseas study, and 230 participants for the visits (for about one-week short visit). The length of period may be flexible. Details of the yearly target number of participants are shown in Table 2-8.

Scholarship

The scholarship for degree program covers entrance exams fee, entrance fee, tuition (two years for Master's course and three years for Doctoral course), return airfare, and living expenses during the study period including the period as research students. The monthly amount of living expenses is assumed to be 144,000 yen per month which is same as the scholarship of Japanese MEXT. The unit costs for each program are estimated in Table 2-9.

The faculties who participate in the program will sign the contract with the university before the departure, and they will be exempted from the repayment obligation of scholarship on the basis that they work for the university for a certain period of time (for example, five years) after their return. However, if they do not fulfil this condition, they will be obliged to repay the incurred costs as loans.

Japanese host universities

The candidates from the research laboratory which conducts the joint research are to be hosted primarily by the partner university. In case of some difficulties at the partner university, they will look for another host university. For the faculties who want to study at Master’s course, the Japanese university where their choice of supervisory professor belongs to will be the first priority. If there is no specific choice of a supervisory professor, the national universities with international postgraduate programs and with special selection methods for overseas applicants will be prioritized. For the faculties who want to take a Doctoral course, all the universities will be considered regardless of whether there is a choice of the supervisory professor or not.

Preparatory education on Japanese and English languages

The host Japanese universities set a certain level of English ability as the condition of acceptance and usually, it is judged in the interview exams. Japanese ability is not necessary as the condition of acceptance but it is expected that the participants have the Japanese ability required for their daily lives. However, in this program, such preparation will be dependent on the participants’ own initiatives, and it will not provide the special preparatory education.

Table 2-5 Number of program participants (Offer Basis)

Unit: Persons

Program	Total	Number of New Offer								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
1 Master degree program										
Batch 1-1 (April)	30	30								
Batch 1-2 (September)	20		20							
Batch 2-1 (April)	15		15							
Batch 2-2 (September)	20			20						
Batch 3-1 (April)	10			10						
Batch 3-2 (September)	1				1					
Batch 4-1 (April)	1				1					
Batch 4-2 (September)	1					1				
Batch 5-1 (April)	1					1				
Batch 5-2 (September)	1						1			
Sub-Total	100	30	35	30	2	2	1	0	0	0
2 PhD degree program										
Batch 1-1 (April)	15	15								
Batch 1-2 (September)	10		10							
Batch 2-1 (April)	10		10							
Batch 2-2 (September)	10			10						
Batch 3-1 (April)	10			10						
Batch 3-2 (September)	3				3					
Batch 4-1 (April)	2				2					
Sub-Total	60	15	20	20	5	0	0	0	0	0
3 Non-Degree Program										
2015 (1 year)	2		2							
2016 (1 year)	2			2						
2017 (1 year)	0				0					
2018 (1 year)	1					1				
2019 (1 year)	0						0			
2020 (1 year)	0							0		
2021 (1 year)	1								1	
2022 (1 year)	0									0
2014 (6 months)	15	15								
2015 (6 months)	15		15							
2016 (6 months)	15			15						
2017 (6 months)	1				1					
2018 (6 months)	1					1				
2019 (6 months)	1						1			
2020 (6 months)	1							1		
2021 (6 months)	1								1	
2022 (6 months)	1									1
2014 (1 week)	70	70								
2015 (1 week)	80		80							
2016 (1 week)	80			80						
2017 (1 week)	10				10					
2018 (1 week)	10					10				
2019 (1 week)	7						7			
2020 (1 week)	2							2		
2021 (1 week)	2								2	
2022 (1 week)	2									2
Sub-Total	320	85	97	97	11	12	8	3	4	3
Total	480	130	152	147	18	14	9	3	4	3

Table 2-6 Unit cost estimation

Master Degree Program (Starting from April)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Total
				FC	FC	FC	FC
Entrance Examination Fee	Once	30,000	1	9,800	30,000		39,800
Admission Fee	Once	282,000	1	84,600	282,000		366,600
Tuition Fee	Year	535,800	2	173,400	535,800	535,800	1,245,000
Air Fare to & from Japan	One way	100,000	2	100,000		100,000	200,000
Living Allowance	Monthly	144,400	24	1,299,600	1,732,800	1,299,600	4,332,000
				1,667,400	2,580,600	1,935,400	6,183,400

Master Degree Program (Starting from October)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Year 4	Total
				FC	FC	FC	FC	FC
Entrance Examination Fee	Once	30,000	1	9,800	30,000			39,800
Admission Fee	Once	282,000	1	84,600	282,000			366,600
Tuition Fee	Year	535,800	2	173,400	535,800	535,800		1,245,000
Air Fare to & from Japan	One way	100,000	2	100,000			100,000	200,000
Living Allowance	Monthly	144,400	24	433,200	1,732,800	1,732,800	433,200	4,332,000
				801,000	2,580,600	2,268,600	533,200	6,183,400

Ph.D. Degree Program (Starting from April)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Year 4	Total
				FC	LC	LC	LC	FC
Entrance Examination Fee	Once	30,000	1	30,000				30,000
Admission Fee	Once	282,000	1	282,000				282,000
Tuition Fee	Year	535,800	2	535,800				535,800
Air Fare to & from Japan	One way	100,000	2	100,000			100,000	200,000
Living Allowance	Monthly	145,000	36	1,305,000	1,740,000	1,740,000	435,000	5,220,000
				2,252,800	1,740,000	1,740,000	535,000	6,267,800

Ph.D. Degree Program (Starting from September)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Year 4	Total
				FC	LC	LC	LC	FC
Entrance Examination Fee	Once	30,000	1	30,000				30,000
Admission Fee	Once	282,000	1	282,000				282,000
Tuition Fee	Year	535,800	2	535,800				535,800
Air Fare to & from Japan	One way	100,000	2	100,000			100,000	200,000
Living Allowance	Monthly	145,000	36	580,000	1,740,000	1,740,000	1,160,000	5,220,000
				1,527,800	1,740,000	1,740,000	1,260,000	6,267,800

Non-Degree Program (1 year)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	1 yar
				FC
Air Fare to & from Japan	Return	150,000	1	150,000
Accommodation*1	Monthly	50,000	12	600,000
Living Allowance	Monthly	100,000	12	1,200,000
				1,950,000

*1: Unit Cost ofr Accommodation is a ceiling amount and actual expenses will be reimbursed.

Non-Degree Program (6 months)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	6 months
				FC
Air Fare to & from Japan	Return	150,000	1	150,000
Accommodation*1	Monthly	120,000	6	720,000
Living Allowance	Monthly	100,000	6	600,000
				1,470,000

*1: Unit Cost ofr Accommodation is a ceiling amount and actual expenses will be reimbursed.

Non-Degree Program (1 week)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	1 week
				FC
Air Fare to & from Japan	Return	150,000	1	150,000
Accommodation*1	dayly	10,000	6	60,000
Living Allowance	dayly	5,000	6	30,000
				240,000

*1: Unit Cost ofr Accommodation is a ceiling amount and actual expenses will be reimbursed.

2.5.2 Joint research program with Japanese universities

The joint research program is the plan to strengthen the research and education capacity through the implementation of joint research between Japanese universities and NUM and MUST.

The joint research program consists of three programs: The Visiting Scholar Program where scholars of Japanese universities visit the two Mongolian universities, the Non-Degree Program where scholars of the two Mongolian universities visit Japanese universities, and the Research Fund Program.

For this project, a needs survey was conducted on the basis of Research Profile proposed by each school of NUM and MUST. A total of 72 themes of joint researches were proposed by NUM and MUST as shown in Table 2-7. Among them, 35 themes were from NUM and 37 were from MUST.

Table 2-7 Number of Joint Researches Proposed by NUM and MUST

MUST		NUM	
School of Mechanical Engineering	18	School of Biology and Biotechnology	4
School of Civil Engineering and Architecture	9	School of Chemistry and Chemical Engineering	12
School of Power Engineering	5	School of Geography and Geology	4
School of Food Engineering and Biotechnology	2	School of Information Technology	6
School of Geology and Petroleum Engineering	3	School of Physics and Electronics	8
		School of Mathematics and Computers	1
MUST Total	37	NUM Total	35
Total for both Universities			72

Source: Survey Result by the Study Team

In NUM, a large number of researches related to “Applied Technology” were started by each school in addition to the researches related to “Pure Science” in order to meet the need for engineering human resources by the industries in Mongolia. Research themes which apply nanotechnology and researches to handle the rich mineral resources in Mongolia were proposed by the School of Chemistry and Chemical Engineering. Research themes related to recyclable energy and satellites (space technology) were proposed by the School of Physics and Electronics, while research themes related to drug discovery utilizing the biological resources unique to Mongolia were proposed by the School of Biology and Biotechnology.

In MUST, a large number of researches based on the current issues in Mongolian industries and society were proposed. The development of fundamental technology needed by all industries was proposed by the School of Mechanical Engineering. The development of infrastructure technology suited to the environment of Mongolia such as the development of building materials suited to cold weather regions was proposed by the School of Civil Engineering and Architecture. The research to improve the electric power system was proposed by the School of

Power Engineering, while the research theme related to mineral resources which are currently booming in Mongolia was proposed by the School of Geology and Petroleum Engineering.

The selection of joint research themes (candidates) conducted in this project was done using the following procedure.

First, in both NUM and MUST, the prioritization was done by the dean of each school and the associate dean in charge of researches. Next, in NUM, the vice president in charge of researches prioritized the researches as a whole in accordance with the university's research promotion policy. In MUST, the chief of research department and the vice president in charge of researches prioritized the research themes based on the priority of each school. Table 2-8 and 2-9 show the top 10 priority research themes selected by NUM and MUST and their details are described in Attachment 3 and 4. However, these research themes are not yet finalized for the joint research program. The finalized themes for joint researches will be decided by the Project Steering Committee consisting of NUM, MUST, MECS of Mongolia, Ministry of Economics and Development of Mongolia, the Embassy of Japan in Mongolia, JICA, and the groups representing the industries in Mongolia after the project starts.

For reference, Table 2-8 and 2-9 shows the number of scholars dispatched from Japanese universities to NUM and MUST (person/year), the number of participants of short-term overseas study from NUM and MUST to Japanese universities (person/year), and the number of person who obtained the degrees (Master and Doctor) in the joint research program.

Table 2-8 Joint research themes in order of priority in NUM

	Joint Research Title	Department	Degree Program		Visiting Program		Japanese Counterpart Univ. (Candidate)
			Msc	PhD	M->J	J ->M	
1	Know ledge and technology based sustainable use of Mongolian biological resources	Biology and Biotechnology, Microbiology	15	5	5	3	Yokohama National Univ., Riken, Tohoku Pharmaceutical Univ., Nagoya Univ.
2	Research and development of genetically engineered antibacterial peptides from Mongolian genetic resources	Biology and Biotechnology, Genetic Engineering	6	0	2	2	
3	Study on Organic Photovoltaic and Organic Light Emitting Devices	Chemistry and Chemical Engineering, Center for Nanoscience &Nanotechnology	2	1	2	2	Yokohama National Univ.
4	Environmental microbiology for engineering	Biology and Biotechnology, Microbiology	3	2	6	3	Ehime Univ.
5	Clean energy technology and carbon resource conversion	Chemistry and Chemical Engineering, Organic Chemistry	10	3	3	3	Kyusyu Univ.
6	Study on the Photovoltaic system and Solar Resource in Mongolia	Physics and Electronics, Application Physics					
7	Development of functional materials based on Mongolian natural minerals for environmental remediation	Chemistry and Chemical Engineering, Inorganic Chemistry	4	2	3	3	Miyazaki Univ.
8	Floating point arithmetic processor	Information Technology, Electronics	-	-	-	-	
9	Studies on Mine Optimization and Simulation	Mathematics and Computer Science, Applied Mathematics	6	4	3	3	
10	Study on Machine translation among agglutinative languages: Mongolian and Japanese	Information Technology, Electronics	2	1	2	2	Nagoya Univ., Toyohashi Univ. of Tech., NICT

Table 2-9 Joint research themes in order of priority in MUST

	Joint Research Title	Department	Degree Program		Visiting Program		Japanese Counterpart Univ. (Candidate)
			Msc	PhD	M->J	J ->M	
1	Sky-Infra project in Mongolia: Logistics, Environmental monitoring and Aero-space-Mechanical Engineering Education	Mechanical Engineering, Aero-mechanics	10	10	10	20	JICA Senior Volunteer, Nagaoka Univ. of Sci. & Tech.
2	Research on Material w hich based on Pow der metallurgy and Nano technology by renew able energy	Mechanical Engineering, Industrial Mechanization	2	2	4	2	
3	Study of Binder and Asphalt Designs for the Cold Region	Civil Engeering and Architecture, Civil engineering	2	2	3	4	Nagaoka Univ. of Sci. & Tech.
4	Utilization of Mongolian Fly Ash in Construction Industry for Greener Future	Civil Engeering and Architecture, Construction materials	1	1	6	3	Tohhoku Univ., Nihon Univ. Kyoritsu Women's Univ. Toin Univ. of Yokohama
5	The Research for Electromagnetic Influence in the Energy System	Pow er Engineering,	0	0	0	0	
6	New Laboratory for Electrical Supply and High Voltage Testing and Fault Detecting	Pow er Engineering, Electric energy	2	2	2	2	
7	Rheology laboratory of Food Products /Mongolian traditional food, (meat and dairy products)	Food Engineering and Biotechnology, Food Engineering	10	5	3	3	
8	Comparative study of drying methods for some traditional Mongolian food	Food Engineering and Biotechnology, Food preparation and Nutrition	3	2	2	3	
9	Geoenvironmental study in the Tuul and the Kharaa Rivers Basins, Central Mongolia for sustainable development	Geology and Petroleum Engineering, Mineral exploration	10	10	20	10	Nagoya Univ.
10	Understanding and Developing Mineral Resources of Mongolia	Geology and Petroleum Engineering, Mineral exploration	7	5	8	8	Kyusyu Univ.

Inputs for joint researches

Inputs for the joint research program are planned as follows.

- Visiting Scholar Program: where scholars of Japanese universities visit the partners of joint research in NUM and MUST:
- Non-Degree Program: where scholars of NUM and MUST visit Japanese universities;
  The main participants of non-degree program explained earlier will visit for these joint researches.
- Research Fund Program:

In addition to these programs, the procurement of research equipment and facilities will be done for the joint researches, but it will be explained in Component 4.

Visiting Scholar Program

The Visiting Scholar Program of Japanese universities is for the scholars of Japanese universities to have meetings on joint researches and give guidance to Mongolian faculties for the implementation of joint researches. As a result of this preparatory study, 69 scholars are requested by NUM while 117 scholars are requested by MUST. Most research themes request two to three visiting scholars per year. However, in the cases of joint researches in which Mongolia takes the leading role, such as the researches in the field of geography and geology, a large number of scholars were invited from Japanese universities.

Based on the results of this needs survey, two different visiting periods will be set for short-term (two weeks) visiting scholars and long-term (one year) visiting scholars. It is planned to have 180 short-term and 20 long-term visiting scholars during the project implementation period.

Non-Degree Program

The Non-Degree Program is for the scholars of NUM and MUST to exchange information on new knowledge and technologies, to conduct the researches which can be done only at Japanese universities, and to learn the operation and maintenance methods of the research equipment which will be introduced to NUM and MUST. Concerning the need for non-degree program, 77 persons are requested by NUM while 108 persons are requested by MUST. This is influenced by the fact that it has been difficult to conduct researches at NUM and MUST due to their degrading research facilities.

Based on the results of this needs survey, due to the wide range of visiting purposes, long-term (one year in Japan) visiting scholars, medium-term (six months in Japan) visiting scholars, and short-term (three months in Japan) visiting scholars will be set in the project. It is planned to have 27 long-term, 67 medium-term, and 270 short-term visiting scholars during the project implementation period.

Research fund program

For the selected joint researches, an estimated total of 70,000,000 yen for 20 researches for seven years (an average budget of 500,000 yen per research) is required to cover the costs of research reagents, research materials and other consumable research products.

2.6 Component 3: Kosen Program

It requires a considerable period of time to supply the human resources requested by industries through the strengthening of universities by the approaches explained in this Chapter. However, the rapid economic growth in Mongolia urgently needs work-ready engineers and technicians. In this project, the opportunity to study at Japanese Kosen is provided in order to meet such need. Studying in Japan under the twinning program explained in 2.4.2 also takes some time for preparation, but the program is also aimed at meeting the urgent need for human resources in Mongolia.

The National Technical Colleges (Kosen)

The National Technical Colleges in Japan (so-called Kosen) is different from the university education system. Kosen accepts graduates of junior high school and serves as the higher education institute to provide comprehensive education for five years (five and a half years for the Maritime Technology Department) in order to cultivate engineers needed by the society. At present, there are 51 national schools, three public schools and three private schools. The graduates are recognized as associate degree holders.

The characteristics of education in Kosen are summarized as follows.

- Comprehensive specialized education for five to five and a half years for the young students who graduated junior high school.[20]
- Practical technical education emphasizing on the experiments, practices, and skills building upon the theoretical bases.
- Small-size classes with detailed educational instructions given by educational staff such as professors and associate professors.
- Job opening-to-application ratio for the graduates is 10-20 and nearly 100% employment rate for the job seekers.
- About 40% of graduates go to the advanced course level of Kosen or transfer to the 3rd year of universities.

The features of Kosen to support the above characteristics are as follows.

[20] After completion of regular education for five to five and a half years, students are able to receive further specialized education at advanced course for two years which enable them to obtain bachelor’s degree.

- Curriculum which starts from making the students like the manufacturing.
- Education emphasizing practices and experiments.
- Many technical staff and lecturers with background in industries.
- Facilities and equipment enabling quality practices and experiments.
- Graduation researches with levels equivalent to university researches.
- Fully equipped student dormitories.

Other feature is the low-level of its costs. The tuition for a student of Kosen is 234,000 yen per year, and admission fee is 84,600 yen, which are about half of that of Japanese national universities.[21] Tuition for the 3rd year students is further reduced to half of it. In addition, dormitories are fully-equipped and the living costs are quite cheap since they are mostly located in the rural areas.

Recently, they are promoting the acceptance of foreign students, and in most cases these students are accepted from the 3rd year as transfer students.

Kosen Program

Japanese government categorizes Mongolian students at Japanese Kosen as Foreign Government Sponsored Students who are admitted to be transferred to the 3rd grade of Kosen and receive the succeeding three years of education, in the same manner as Japanese Government Scholarship Students. In exceptional cases, students can be transferred to the 4th grade of Kosen depending on the Kosen and the student's academic performance, and in such cases students can graduate in two years. However, exceptional cases are not frequent. Therefore, the plan under this project is based on the transfer to the 3rd grade and the study at Kosen for three years.

To be transferred to Kosen, there is a high possibility that the students have to take the Examination for Japanese University Admission for International Students (EJU) which is generally held in November each year. There is a similar government-sponsored program to study in Japanese Kosen in Malaysia, and they also conduct the examination by MEXT wherein contents are almost same as EJU. Required subjects to be taken are Japanese language, Science (two choices from Physics, Chemistry and Biology) and Mathematics. Each Kosen or Institute of National Colleges of Technology for National Kosen will screen candidate students based on the EJU results. Therefore, students are required to have a certain level of Japanese language skills (although there is no defined standard, they are supposed to have Japanese language skills equivalent to the middle of N3 and N2 levels of JLPT[22]) and the academic

[21] As of fiscal year 2013, annual tuition of Japanese national universities is 535,800 yen and admission fee is 282,000 yen.
[22] Linguistic competence required for N3 of JLPT is "The ability to understand Japanese, to

abilities to achieve a certain level of results in taking the exams of Science and Mathematics in Japanese language.

Therefore, in the proposed Kosen Program under this project, two tracks for students shall be designed: Track 1 for those who already have certain standard of Japanese language skills and Track 2 for those who have no Japanese language skills as shown in Figure 2-7.

Track 1 program is for students who have studied Japanese language at high school or university and have skills equivalent to the level of middle of N3 and N2 of JLPT. In the annual program schedule, open recruitment should be in June, first screening in August, and EJU in November. Successful candidates selected based on EJU would be transferred to Japanese Kosen and granted three years scholarship. Possible enrolees of Track 1 are graduates of high schools with advanced education of Japanese language, Mathematics and Science.

Track 2 program is for students who are beginners of Japanese language or with the Japanese language skills below the required level. In the annual schedule, open recruitment should be in June and first screening is in August. Successful passers of the first screening will take 18 months preparatory education course of Japanese language, Science and Mathematics in Japanese language and prepare for EJU in November in the second year. Those who passed the screening by each Kosen based on EJU will be granted three years scholarship.

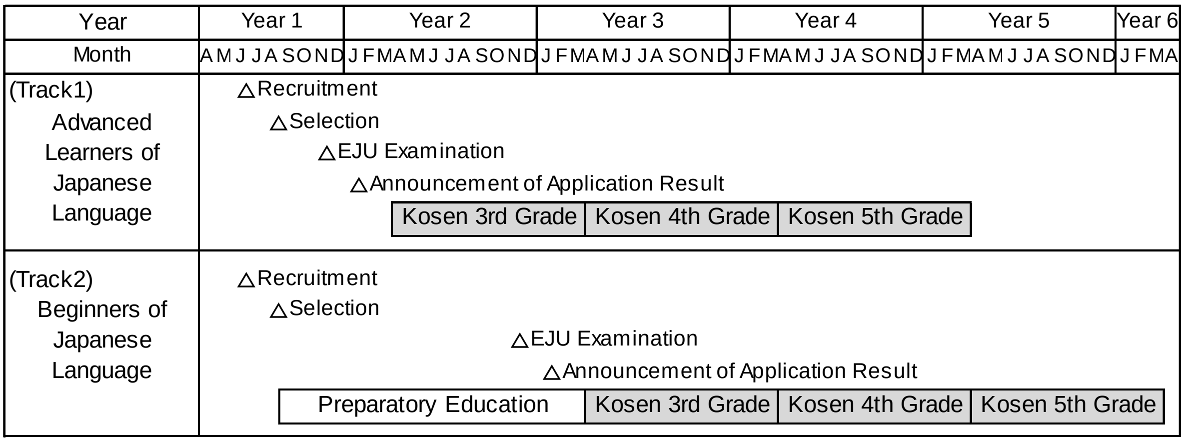


Figure 2-7 Kosen program schedule

Promotion of application for the program

The proposed Kosen program has the advantage of growing field engineers in a short period at low cost to meet the urgent demand of Mongolian industry. However, it has some points of concern.

- Japanese degree "Associate Degree" which Kosen offer to its graduates does not exactly match with any Mongolian degree. The similar "Diploma" degree receivers in Mongolia

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a certain degree, for use in everyday life" are not admitted to be transferred to the 3rd grade of university. (MECS is currently revising relevant regulations.)

- If the scholarship program obligates students to work as field engineers in Mongolia right after graduation from Japanese universities, high-achieving students might avoid participating in the program.
- For Japanese language beginners, both of twinning program which confers Bachelor's Degree and Kosen program which confers Associate Degree will take four years and seven months to complete. There is a concern if Kosen program can attract high-achieving students in comparison with twinning program.

To overcome such concerns, the following points will be considered in the planning of this project.

- To increase the number of Kosen program applicants, age limitation should be raised (e.g. allow candidates up to 25 years old to apply) and promote the number of enrolment into high schools with advanced education of Japanese language, Mathematics and Science.
- To examine the measures such as securing employment of graduates after the program, job placement before studying in Japan, or dispatch of their workers by companies.
- Kosen program students should receive privileges to be granted the scholarship under some conditions such as working for at least five years at Mongolian companies. In case the scholarship is provided by loan base, terms of loan repayment should be eased such as raising the percentage of grant given a certain condition possibly by achievement of high academic performance.

Scholarship

Scholarship for studying in Japan by Kosen program includes entrance exam fee, admission fee, tuition for three years, return airfare, and living expenses in Japan for three years as shown in Table 2-10. Living expenses are estimated to be 117,000 yen per month in accordance with the Japanese MEXT Scholarship. As explained earlier, the amount of Kosen's tuition is approximately half of national universities'. By the supportive fund granted for the 3rd-grade students (the first year in Japan on Kosen program of this project), actual cost in the year will be half of the original tuition. The student dormitory is fully equipped and the living costs are quite cheap since most of Kosen are located in the rural areas. However, the amount of scholarship is estimated to be the same as the Japanese MEXT Scholarship. This is suggested concerning the reduction of incentives for application.

Table 2-10 Unit cost estimation of Kosen program scholarship

Unit: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Year 4	Total
				FC	FC	FC	FC	FC
Entrance Examination Fee	Once	16,500	1	16,500				16,500
Admission Fee	Once	84,600	1	84,600				84,600
Tuition Fee	Year	234,600	3	234,600	234,600	234,600		703,800
School Support Fund	Once	-118,800	1	-118,800				-118,800
Air Fare to & from Japan	One way	100,000	2	100,000			100,000	200,000
Living Allowance	Monthly	117,000	36	1,053,000	1,404,000	1,404,000	351,000	4,212,000
				1,369,900	1,638,600	1,638,600	451,000	5,098,100

Number of students

Kosen program is added to this project in order to respond to the immediate demand for field engineers to serve for Mongolia's rapid economic growth, and because it takes a considerable period of time to supply the human resources needed by the industries through the strengthening of universities. For this purpose, a large number of students should be dispatched promptly. It is proposed to send 200 students in three years (three batches of 66-67 students per year).

Regarding the receiving capacity of Japanese Kosen, according to the center for international student exchange, Institute of National College of Technology, Japan, the limited capacity of students' dormitory is a concern. However, to accommodate 66-67 students for three years is still possible though there are some problems to be solved in advance. On the other hand, 20-30 students in each year are easy to be accommodated.

Fields of study

The following specialized divisions are set up in Japanese Kosen.

> Department of Mechanical Engineering, Department of Material Engineering, Department of Electric Engineering, Department of Architecture, Department of Electronic Control, Department of Environmental Urban Engineering, Department of Information Engineering, Department of Maritime Technology

In Kosen Program of this project, students can enter any of the above-mentioned divisions. However, considering the characteristics of Mongolia, maritime technology will be excluded from the target fields of study.

Preparatory education for Kosen Program

Students in the preparatory education for Kosen program must complete the education on Japanese language, Mathematics, Physics, Chemistry and so on within 18 months.

Regarding Japanese language, the estimated study hours necessary to obtain JLPT N2 level is approximately 900. Assuming that the program is conducted at MUST and the 18-month course can contain 60 class weeks as calculated in the paragraph of twinning program, 15 hours of Japanese language classes per week will be required. This is just equivalent to the workload of one teacher.

If we assume that six out of 66 students per grade already have enough Japanese skills to skip the preparatory education, the appropriate number of classes and teachers are four for the other 60 students who will take the preparatory education program. It is proposed to appoint two language lecturers each from Japan and the department of foreign language, MUST. Two grades will collaterally run for six months in the fall semester of the second and third years of the program, and eight language lecturers will be required only during this period. The required number of lecturers coming from the department of foreign language will therefore be six. The costs for Japanese lecturers dispatched from Japan and the department of foreign language are the same as explained in the paragraph about twinning program.

In the preparatory education program, Mathematics, Physics and Chemistry classes will be provided to prepare for EJU. Three Japanese and Mongolian lecturers who graduated from Japanese universities will be required.

2.7 Component 4: Facilities and equipment procurement

2.7.1 Procurement of equipment and facilities

Current status of existing equipment and facilities

<u>The School of Mechanical Engineering, MUST</u>

In recent years, equipment had been procured for some departments, such as the Department of Information and Communication Technology, through financial assistance from donors. However, in other departments, practical training cannot be performed fully and efficiently because many equipment, manufactured in the 1970s, are already obsolete. The present condition of equipment in each department is described as follows.

- Department of Machine Building

  Industrial mechanization: This department has practical training equipment such as a jaw crusher and a concrete pump. Of the 29 items, most are superannuated, Russian-made and were manufactured between the 70s to 80s, except for two Japanese-made items. Since 14 items are not working and not repairable, they should be replaced with new ones.

  Laboratory of Aerodynamics: This laboratory has 10 items of training equipment such as pneumatics trainer and electro hydraulics trainer, which are all made in Korea in 2011.

- Department of Transportation

Laboratory of mechatronics: This laboratory has training equipment such as basic electricity training equipment and electronic demonstration system. All of 29 items are made in Korea in 2011. This laboratory also has training equipment such as sensor trainer and inverter motor trainer. All of 14 items are made in China in 2011.

- Laboratory of Internal combustion engine: This department has 13 items of training equipment such as engine test bench, diesel pump stand and oil pump stand. Most of the items are Russian-made, and only a few items are Korean or Japanese-made. Most of Russian-made items are not working. In addition to obsolete equipment manufactured between the 70s and 80s, some items manufactured in 2000s are also not working.

The School of Civil Engineering and Architecture, MUST

Most of the existing equipment are working in general, and defective equipment are estimated at only around 10%. Though most of the items were manufactured after 2007, there exist a small number of items made between 1968 and 1970 and some of them are still working. Among the out-of-order equipment, many items are manufactured in early 2000s. Most of the equipment originated from Russia and China, while few are from Korean and Europe.

- Laboratory of hydraulic and pump station: This department has 5 items of training equipment such as hydraulic bench and venturi meter. All items are manufactured in 2009 and are working.

- Department of Architecture and Engineering drawing

  Laboratory of engineering drawing: This department has 30 personal computers and projectors for students' training. All of them are manufactured in 2010 and are working properly.

- Department of Environmental Engineering

  Laboratory of Building physics and air study: This laboratory has basic measurement devices such as thermal resistance meter, heat flux meter and voltage sensor, etc. The equipment are manufactured between 2005 and 2010 and are all working except for 3 of the total 16 items. 2 items are partially defective caused by lack of spare parts. Most of the items are European-made.

- Department of Road, Construction Technology and Management

  Laboratory of Road materials: This laboratory has standard testing equipment for road construction materials. Most are working except for 5 of the total 37 items. Most are manufactured in 2007 and are Chinese-made.

- Department of Structure engineering

  Laboratory of Geotechnical Engineering: All of 17 items are basic experimental equipment and 3 of them which were manufactured in 1970 or 1989 are obsolete and condemned. Most are Korean-made or Russian-made and a few are from China.

The School of Power Engineering, MUST

- Department of Thermal energy

  Laboratory of Heating supply and automation: Years of manufacture range from late 70s to 2013. Countries of origins are Russia, China and Mongolia. At the moment, 6 of the total 34 items are not working.

  Laboratory of Heat exchange and thermodynamic: Most are Russian or Chinese-made and 70% of all the items are working. Most of the equipment are manufactured before early 2000s and are obsolete and condemned, and thus should be renewed.

- Department of Electric energy

  Laboratory of Electrical system automation: 1 among the total of 4 items which were manufactured in the 90s in Japanese but is not working. Since the manufacturer of the item has no agent locally and that the contact in Japan is unknown, it is impossible to procure the spare-parts.

  Laboratory of Electrical supply and high voltage engineering: All of 100 items are working and manufactured between 2007 and 2009. Most of them are Chinese-made.

  Laboratory of Electronics system: All of 70 items are working. They are manufactured between 1980s and early 2000s, and are Chinese-made.

Outline of newly-procured equipment

(1) MUST

The training equipment plan of MUST is formulated in order to develop a more practical training function against the conventional lecture-centered education. Aside from the renewal of existing obsolete equipment, the equipment plan should be devised to adopt equipment that are actually operated in the factories of Mongolian industries so that MUST can meet the demand for prospective human resources. The equipment plan aims to procure new training equipment deemed necessary to properly carry out the syllabus stipulated in the curriculum of MUST.

The outline of equipment for three schools of MUST, Mechanical Engineering, Civil Engineering & Architecture and Power Engineering and the justifications for their procurement are shown as follows.

School of Mechanical engineering, MUST

Equipment plan by laboratory/school and its justification
Lab. of Mechatronics, Dept. of Transportation
It is planned to equip this department with testing, analytical & measurement machines for application in levels from year 2 through year 4, but mainly for year 4. Major items which include an electronic system laboratory for Automobile, a digital oscilloscope and a movement controller for robot technology are aimed for the improvement of practical training and experiment function.
Lab. of Internal combustion engine, Dept. of Transportation
This department plans to procure equipment necessary for experiments and training subjects in the curriculum of year 4. The plan aims to enhance practical training function by procurement of fuel consumption tester, an engine stand, an exhaust gas analyzer, and some analyzers. It is intended to make students learn various inspection procedures of the internal combustion engine through training. This department devised an equipment plan required for the advanced level experiments stipulated in the curriculum of year 4 and intended to improve training and experiment function by introducing testing devices and analytical machines which are actually used for research and development in the real industry. The equipment plan aims to replace the existing analytical devices with instruments of better precision and the major items are X-ray fluorescence sulfur analyzer and a portable magnetic memory tester. Through training and experiments with these equipment, it is intended to improve students' ability for research and development in the internal combustion engine, which meets the objective of this project.
Lab. of Automobile, Dept. of Transportation
This department aims to procure equipment needed for experiments and training for automotive engineering based upon the curriculum for year 2 through year 4 in this project, to replace the existing inspection and testing equipment of automobile with latest models, and to improve training function through the vehicle check. Major items of equipment include Vehicle Emissions Test System, a dynamometer for brake, and a fuel consumption measurement system. This department also plans to procure the latest models of inspection equipment for experiments and training and to improve the practical education function.
Lab. of Road Traffic, Dept. of Transportation
This department aims to carry out a joint project on efficiency of the transportation plan to cope with

increasing traffic by development of a transportation means in future and also to push forward the master and doctorate students' researches. The study needs to procure a transportation plan software, that is, simulation software for traffic control.

Lab. of Aerodynamics, Dept. of Machine Building

This department plans to procure equipment required for students' training, i.e. training for aerodynamics study experiment to perform the subjects in the curriculum from year 2 to year 4. The equipment to be procured is comprised of training, experiment equipment such as a high-speed camera, a heat camera, and a machine center. In this department as well, it is intended to strengthen the training function by procurement of highly precise measuring equipment and a machine tool to add to the existing aerodynamics experiment training equipment.

Dept. of Machine building

This department plans to procure new equipment necessary for training in the basic mechanical engineering subject in the curriculum from years 2 to 4.The equipment plan is comprised of machine tool to perform materials measurement, metalwork, welding and major items of the plan are CNC lathe, a welder, and a molten induction furnace. This department also aims to improve practical training function and fill the shortage in number by replacement of obsolete equipment with the latest model used in real industry.

Lab. of Industrial mechanization, Dept. of Machine Building

This department intends to update obsolete equipment and to procure training and experimental equipment of latest industrial mechanization technology and to fill shortage in number. Such equipment are required to perform experiments which are stipulated in the curriculum from year 2 to year 4so that students can learn the mechanism of the industrial machine through assembling of various simulators. Major items are crane simulator, simulators truck crane and others.

Lab. of International Transportation management, Dept. of Machine Building

This department plans to introduce training of the computer programming about logistics and transport management in this project. The major equipment is logic programming and its procurement will enable the improvement of training and research functions for logic programming stipulated in the curriculum of year 4.

School of Civil engineering and architecture, MUST

Equipment plan by laboratory/school and its justification
Lab. of Hydraulic and pump station
The equipment is procured for student experiments such as the simulation equipment of oil pressure and

the pumping station newly and also for improvement of the practical training function. In the equipment plan it updates existing obsolete experiment equipment to a training device such as the latest model of hydraulic pump and the major items are a centrifugal pump module and a pressure center. The equipment plan meets the objective of this project, and thus is judged as proper.
Lab. of Architecture, Dept. of Architecture and Engineering drawing
The equipment plan of this department aims to improve the students training function for dual degree program by procurement of new education and training equipment. The major equipment items listed include a multi-function meter and a high-performance PC for data handling. The equipment plan meets the project objective and is thus judged to be proper.
Lab. of Engineering drawing, Dept. of Architecture and Engineering drawing
The equipment plan is intended to improve the training function by procurement of equipment for engineering drawing. Major equipment items include a high-performance PC and a plotter. It is judged that the said plan is proper since it supplements the number of existing equipment, and will be needed with the increase in number of students, and for updating of obsolete items.
Lab. of Building Physics and Air study, Dept. of Environmental Engineering
The equipment plan of this laboratory is intended to improve the practical education function by the procurement of new training and experimental equipment in conjunction with building facilities. In this plan, procurement of training equipment such as a flue gas dust meter and blower tester is planned, and thus, the plan is judged to be proper.
Lab. of Construction Materials, Dept. of Road, Construction Technology and Management
Because it is necessary to improve the training experiment function of the students for dual degree program by introducing a basic experiment program in this testing room, this laboratory plans to procure new training and experiment equipment. The equipment plan is devised to procure equipment necessary for construction materials examination such as a steam curing chamber and a compression testing machine. The said plan meets the objective of this project and is thus judged to be proper.
Lab. of Geotechnical Engineering, Dept. of Structural Engineering
Equipment plan for this laboratory aims to add new training and experiment functions by procurement of the latest physical property testing equipment and measurement device. Major equipment items are the latest direct shear testing machine and automatic tri-axial compression apparatus for soil. The plan meets the project objective, and is judged to be proper.
Lab. of Structural Engineering, Dept. of Structural Engineering
In this laboratory, studies are carried out to investigate on the influence of earthquakes on buildings. The equipment plan intends to start new training and experiment program by procurement of the latest

physical properties testing equipment and measurement device. The equipment plan includes a high speed digital dynamic strain-meter, a shaking table, and a reaction wall. The plan meets the project objective, and is thus judged to be proper.
Lab. of Structural Analysis and CAD, Dept. of Structural Engineering
This laboratory plans to procure training equipment such as analysis software and high performance PC to improve training experiment function for the students of the dual degree program by introducing a new training program necessary for structure analysis in this laboratory.

School of Power engineering, MUST

Equipment plan by laboratory/school and its justification
Lab. of Heating Supply and Automation, Dept. of Thermal Energy
This laboratory intends to update obsolete training and experiment equipment, and to improve the training experiment function of students. The laboratory also plans to procure training equipment such as measuring equipment specifically equipment for determining thermo physical characteristics of solid and fluid materials.
Lab. of Electrical system automation, Dept of Electric energy
Since training and experiment equipment of latest models are lacking in this laboratory and the existing equipment has become obsolete, and it is therefore necessary to update the equipment and supplement the number of equipment. In this department, it is intended to procure an electronic circuit and a training device for programming to improve training and experiment function of students. Major items include a microprocessor trainer kit and a device for measurement of electromagnetic fields.
Lab. of Electrical Supply and High Voltage engineering, Dept. of Electric energy
In this department, training and experiment has been performed with the training and experiment equipment procured from 2007 through 2009. This department plans to procure new equipment to introduce the new program in this project. The major items are test equipment for industrial electrical supply and test equipment for city's electrical supply. Equipment plan aims to procure equipment used in real power supply for training and experiments.
Lab. of Electronics System, Dept. of Electric Energy
Training and experiment equipment procured from 1980 through 2000 are used in this department, but many items are deteriorated. In this project it is intended to procure equipment such as necessary software to introduce a new program. Major items include the Software for Electrical System of Mongolia. The equipment plan intends to introduce equipment used in the real power supply spot for

training and experiments.
Lab. of Heat Exchange and Thermodynamic, Dept. of Thermal Energy
In this department, training and experiment equipment procured in early 2000 are still used, but 1/3 of the existing equipment are broken down due to deterioration. In this project it is intended to procure necessary training and experiment equipment for introducing a new program in addition to the updating of the said equipment. Major items include a gas analyzer and a Dif-manometer. This plan aims to introduce equipment used in real grounds for training and experiments.

2.7.2 Procurement plan for research equipment

(1) MUST

Regarding the procurement plan for the research equipment of MUST, the following 10 themes are under consideration based on the priority. The outline of the equipment for each research plan is shown as follows.

School of Mechanical Engineering, MUST

Outline of research plans and justification
Sky Infra Project in Mongolia (Aircraft Maintenance Engineering Laboratory)
The laboratory has one aero-engine made in Russia, but it has become obsolete and is insufficient for learning the modern aviation maintenance technology. The aircraft maintenance engineering is required widely and is the most rapidly growing field of engineering in Mongolia. Metalwork equipment, a turbojet engine, a wind tunnel, and a turbo-shaft engine are included in the procurement plan under this project. Students can gain practical experience through the equipment to be procured in this project and receive practical training with an aero-engine from the stage of processing of materials to the assembling. It is expected that students can acquire ability and confidence to contribute to development of the aviation in the future by these training and experiments. In addition, this research plan contributes to support graduate courses, i.e., master's and a doctoral, in addition to the training of the non-degree graduate program.
Research on material which based on Powder metallurgy and Nanotechnology
The nanotechnology is studied at only a few research institutes and Powder metallurgy is not studied at all in Mongolia. In addition, parts prepared by Powder metallurgy and nanotechnology are imported by large amount in the industry of Mongolia. In this research work, procurement of new equipment such as Scanning Electron Microscope (SEM), the automatic carbon nanotube CVD growth system is planned. The research plan aims to enable parts production based on Powder metallurgy and nanotechnology by joint research between Mongolia and Japan and to develop the technology of Mongolia. The equipment

plan is expected to contribute to human resources training demand of the Mongolian industry.

School of Civil Engineering and Architecture, MUST

Outline of research plans and justification
Study of Binder and Asphalt Designs for the Cold Region
Since the pavement rate of road in Mongolia is only 7.6%, need of pavement, quality improvement and repair of the road are extremely important. In addition, the harsh climate of Mongolia and the extreme temperature change have a serious influence on mixed composition of the asphalt pavement. With these, a design of asphalt mixture and the study on the reforming binder are required. It is intended in this research plan to establish a laboratory of road materials to promote the above-mentioned research, and to enhance the knowledge and technique of lecturers. The equipment plan aims to procure equipment for preparations of the asphalt mixture, testing equipment of asphalt materials, and field testing equipment. Major items of equipment include an automatic laboratory mixer and breaking point apparatus. This equipment plan contributes to achieve purpose of the research plan and training for the students of master's and doctoral courses, in addition to the training of non-degree graduate program.
Utilization of Mongolian Fly Ash in Construction Industry for Greener Future
This research plan aims to achieve the 1) Use of fly ash for concrete, 2) Recycling of old, demolished concrete as aggregate for new concrete, and 3) Use of recycled glass to obtain foam glass as light-weight aggregate for concrete. The equipment plan intends to introduce testing equipment of cement, analysis equipment for the chemical structure composition of materials, and testing equipment of the concrete. An X-ray powder diffractometer and a TGA analyzer are major equipment items. The research plan is expected to contribute to training of master's and doctoral course students, in addition to training of non-degree graduate program students.

School of Power Engineering, MUST

Outline of research plans and justification
Research for Electromagnetic Influence in the Energy System
This faculty intends to establish a new laboratory to study the electromagnetic influence in the energy system. It is planned to procure research equipment such as measurement equipment for an experiment in the water, power equipment, data processing equipment, and major items are an electromagnetic current meter, a centrifugal pump, and a software package. Procurement of new items of the said devices will enable students receive training and perform experiments using them and allow students of master's and doctoral courses to perform applied researches.

New Laboratory for Electrical Supply and High Voltage Testing and Fault Detecting
This faculty trains 200 students every year, but the laboratory for the study of power supply and training does not exist. There exists only a training panel for laboratory in the electric machine laboratory. In such situation, it is difficult to perform testing and to detect fault in a high voltage laboratory. Therefore, the faculty planned to establish a new laboratory of power supply and high-voltage in pushing forward with this study. In this plan, the research work will be performed jointly by Japanese and Mongolian researchers. Major items are a printed circuit board prototyping and the electric power experiment panels.

School of Food Engineering and Biotechnology

Outline of research plans and justification
Rheology of Food Products /Mongolian traditional food
Rheology is a new field for the research of the traditional food of Mongolia. The said traditional food can be classified into dairy products and processed meat. The Mongolian traditional food is produced only in a local family without being made by the food industry. It is impossible to elucidate a correct manufacturing method of this traditional food, and that is why it is necessary to define a physical and mechanical characteristic of this traditional food. The rheology laboratory is expected to be utilized fully in farm products and other fields as well as food. In the equipment plan, it is intended to procure measurement devices to determine various physical and mechanical characteristics, such as a capillary rheometer, and a MCR rheometer, a penetrometer, and a viscometer. This research plan is a trial in the industrialization of the food industry in Mongolia. The planned equipment is essential to push forward the joint research with Japanese university in food processing technology.
Comparative study of drying methods for some traditional Mongolian food
In this research, the major objective is to compare and define some methods about effective dry methods for traditional dairy products and fruits. Thus, this research purposes are 1) to define an effective dry method of the food, 2) to learn engineering methods about freezing, spraying and drying, and 3) to perform joint research with a team of professors. It is planned to procure equipment for experiments such as a spray dryer, and a hybrid dryer. This research plan is also a trial in the industrialization of the food industry in Mongolia and the contents are required to perform the joint research with a Japanese university in food processing technology.

School of Geology and Petroleum Engineering

Outline of research plans and justification
Geo-environmental study in the Tuul and the Kharaa Rivers Basins, Central Mongolia for sustainable development
The study purpose aims to conduct petro-physical research on rocks distributed all over the territory of Mongolia and create Geo-Database. It is necessary to procure the latest models of measurement equipment to perform a laboratory experiment to realize the said purpose. In this study, it is intended to procure precision measurement equipment such as a Schonstedt magnetometer measuring residual magnetization and a Gamma ray spectrometer, which is used to measure radioactive characteristics. Procurement of these equipment is necessary to perform this study, and is thus judged as proper.
Understanding and Developing Mineral Resources of Mongolia
In the laboratory, there are few opportunities to touch the applied technology necessary for the research and development of natural resources at the moment since highly precise analysis equipment are not fully equipped. Analytical study is extremely important to understand and develop the mineral resources engineering. 80% of exploration companies send samples to three foreign firms analyzing mineral resources in the country under the present condition, and a large amount of foreign currency flows out. In addition, these companies do not carry out scientific and investigative activities. In this study it is planned to perform research work in cooperation with the Japanese researchers with an advanced technology, and also to procure Elemental Analyzer for CHN analysis of soil and water, and X-ray diffraction system for qualitative analysis of soil as major items. These precision equipment are essential to carry out and achieve the purpose of this study.

(2) National University of Mongolia, (NUM)

The outline of equipment for each research plan of NUM is shown as follows.

Equipment plan by laboratory/school and its justification
Knowledge and technology based sustainable use of Mongolian biological resources
This research introduces the latest technology including genetic engineering, biotechnology, and bioengineering for sustainable use of biological resources of Mongolia. In addition, this research will promote biological resource business of Mongolia and enhance cooperation for joint research between Japan and Mongolia. This research will be carried out by the cultivation of transgenic plants, the processing preparation of samples, and various microscopic observations. In the equipment plan, cultivation device of plants, liquid chromatograph/mass spectrometer (LC-MS), an immunity electron microscope, and the confocal microscope will be procured to achieve the study goal.

Research and development of genetically engineered antibacterial peptides from Mongolian genetic resources
The study themes of this laboratory are: 1) Ecology of a microbe and the environmental research: to detect soil, water, atmospheric pollutants and their monitoring, 2) Microbial biotechnology: The application of the microbe which can live under extreme environment, and 3) Application to food biology. (mating of the yeast) The equipment plan is comprised of a bacteriologic culture device, and precision analyzers to perform the above-mentioned molecular biology experiment. The major equipment are a fluorescence upright microscope, a liquid nitrogen generator, and a high-performance liquid chromatograph (HPLC), which are duly required to perform this study.
Study on Organic Photovoltaic and Organic Light Emitting Devices
Indium tin oxide (ITO) has properties of high conductivity and transparency in the visible spectral region and it is widely used for applications in photovoltaic (PV) and Organic Light Emitting Devices (OLEDs).In this study, it is intended to further develop the performance of organic PV cells and OLEDs. The equipment plan is devised to procure experiment equipment such as solar simulator, sputtering apparatus and measurement devices such as oscilloscopes, Infra-red spectrometer, and UV-Vis spectrophotometer.
Study for environmental microbiology for engineering
This study aims to push forward 1) Structural and functional diversity of microbial communities, 2) Ecology of contaminated environments, 3) Experimental biodiversity research, 4) Microbe-plant interactions, and 5) Development of biotechnologies for the restoration and prevention of environmental damage. In the equipment plan, it is intended to introduce equipment necessary for sterilization of microbe, culture, cryopreservation, analysis, and identification, which are required to push forward a microbiological study and thus their procurement is justified. Major items are a freeze dryer, Phase-contrast microscope, and a micro-plate reader.
Clean energy technology and carbon resource conversion
This study aims to develop an applied technology of the clean energy technology in Mongolia to make conversion to synthetic clean fuel of natural carbon resources of Mongolia. In the equipment plan, it is intended to procure experimental equipment necessary for preparation of samples, conversion reaction, analysis of the catalyst, analysis of the fossil fuel, and analysis of the gas product on an experiment scale, which are essential to push this research work forward. The major equipment include an X-ray diffraction device (XRD) and highly precise analyzers such as a micro gas chromatograph and a high pressure autoclave reactor.
Study on the Photovoltaic system and Solar Resource in Mongolia
In addition to the study of photovoltaic (PV) panel performed conventionally, in this study, it is intended to evaluate and develop performance of PV panels prevailing in Mongolia. In the equipment plan, it is intended to procure basic and essential equipment such as a PV module selector, a pyranometer, a Sun

Tracker, and an I-V Curve Tracer to push forward this study.
Development of functional materials based on Mongolian natural minerals for environmental remediation
This study is comprised of the following 5 packages: 1) Synthesis or preparation of functional materials based on natural minerals in this study or preparation, 2) Physical and Chemical characterization of prepared materials, 3) Evaluation, parameterization and optimization of experiment for removal of heavy metals and organic pollutants, 4) Remediation of wastewater and soil by adsorption of heavy metals and organic pollutants, and 5) Scale up applications and theoretical modelling. The equipment plan aims to introduce highly precise reaction device and analysis equipment such as an adsorption chemical reaction device, an X-ray diffractometer, and an X-ray fluorescence spectrometer to perform the adsorption experiment on the experiment scale, mineral analysis, element and chemical analysis to accomplish this study.
Floating point arithmetic processor
It is possible to devise more proper evacuation plan taking into consideration movement of the estimated individual in the simulation of the evacuation prediction based on damage predictions such as earthquakes with a high-performance computer so that evacuation is performed smoothly at the time of disaster outbreak. This study plans to introduce a high-performance computer to develop the city planning by inspecting various software of building plan, and to develop an original one. The equipment plan is comprised of high-performance PCs and building softwares.
Studies on Mine Optimization and Simulation
The purpose of this research is to optimize the management of mine production and mine site rehabilitation processes. In this study the logistics management and the rehabilitation plans of a certain mine will be inspected and evaluated from the perspective of optimization theory and geo-statistics, and formulate these as mathematical problems and solve them. In addition, development of computer algorithm to solve a problem will provide means to develop software used by mining industry. This research will require the basic and essential equipment such as a desk top PC for software development, UPS, printers, LAN-related equipment for data collection as the equipment plan.
Study on machine translation among agglutinative languages: Mongolian and Japanese
This joint research focuses on machine translation of an agglutinating language particularly between Japanese and Mongolian. The Nagoya University team developed a method of morphological analysis and Japanese - Uighur translation. This research applies the said development method to Japanese - Mongolian translation to be performed in cooperation with these researchers. Major equipment include high-performance PCs to perform training of language model and calculating, and a high quality speech recording studio for performing recording of speech.

The equipment list and its estimated cost by department/laboratory are attached in Attachment 6-1, 6-2, 6-3, 6-4 and 6-5.

Procurement of training equipment

Procurement of training equipment corresponds to the Component 2 of improvement of quality on undergraduate education. Target faculties for improving the training equipment are the School of Mechanical Engineering, School of Civil Engineering and Architecture, and School of Power Engineering.

Procurement cost for training equipment was calculated by the equipment lists submitted from three schools. The price shown below includes miscellaneous expenses.

School of Mechanical Engineering	468,000,000	Yen
School of Civil Engineering and Architecture	302,000,000	Yen
School of Power Engineering	64,000,000	Yen
Total	834,000,000	Yen

Price of the equipment of School of Mechanical Engineering is relatively higher compared with the other two schools. However, it is reasonable because the School of Mechanical Engineering offers a lot of educational programs and needs large-scale equipment.

As for the equipment for training program, it is important to spend on discussing the practical education in the undergraduate course among MUST and Japanese counterpart universities. Therefore, after implementation of the project, the equipment list for training program should be revised.

Procurement of equipment for research

Collaborative researches between MUST and Japanese universities involve the procurement of equipment. In case the 20 research themes shown in Table 2-8 and 2-9 are adopted, the procurement cost of the equipment for research is as follows:

National University of Mongolia	10 Themes	288,000,000	Yen
Mongolian University of Science and Technology	10 Themes	478,000,000	Yen
Total		766,000,000	Yen

As for the research equipment, it is necessary to discuss adequately the validity of equipment for research with Japanese counterpart universities.
Total price of the equipment for training and research is 1.6 billion Japanese Yen.

2.7.3 Facility renovation

Confirmation of the scope of work

The construction of the new buildings in NUM and MUST has been excluded from the scope of the project assisted by ODA loan because it has been decided that construction is to be carried out by the Mongolian side. Therefore, the survey team present here recommendations relating to the outline of the renovation of the existing facilities where installation work is to be implemented, coupled with the equipment installation work, so that the installed equipment can be operated appropriately.

1) Summary of the conditions for renovation

The buildings to be renovated in this project were constructed almost 70 years ago. After long years of use, they have developed structural problems such as the leaning framework of the 2nd Building of MUST. They also have functional problems such as the size and/or height of rooms that are too small for the installation of equipment, and infrastructure services that offer insufficient capacity. Because of these problems, the renovation may not achieve all expected outcomes.

Most of the rooms currently being used as laboratories were originally constructed as lecture rooms (classrooms). Therefore, many of them are not equipped with the water supply, sewerage or ventilation facilities appropriate for conducting experiments and research. When the installation of equipment in those laboratories necessitates the installation of water supply and sewerage facilities and/or the upgrading of electrical facilities, work such as the installation of piping and waterproofing will have to be carried out in the rest of the buildings.

A study of the structure of the existing facilities has not been carried out as part of this survey. Therefore, a study of the structures will have to be carried out to clarify the load conditions of the existing facilities and to decide whether or not they have adequate earthquake resistance. The results of the study will be used to decide whether the facilities are worth renovating and what kinds of work should be included in the renovation.

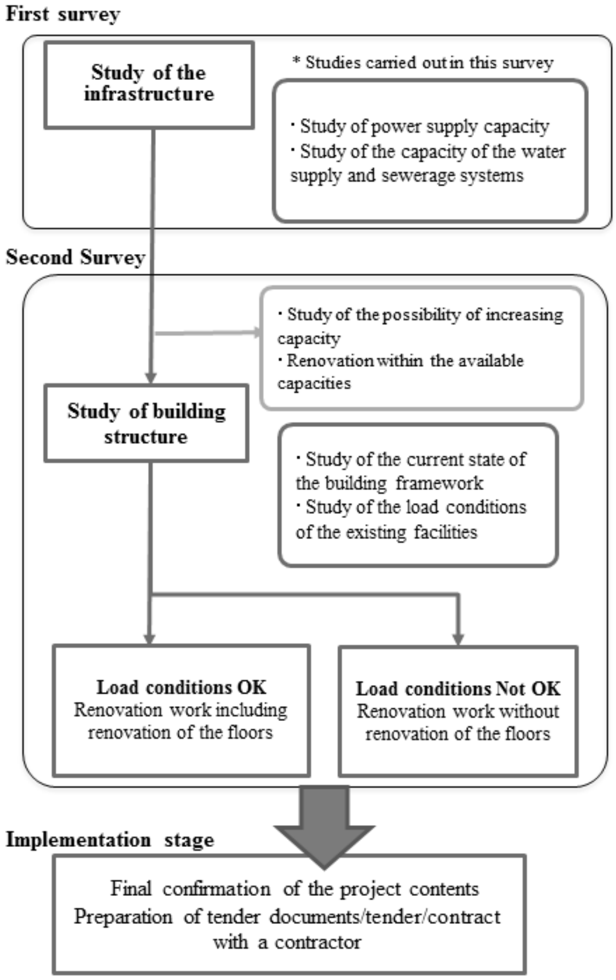
A renovation design that will be applicable to the majority of the rooms will need to be developed based on a hypothetical standard model room, so as to minimize the impact of the renovation on the facilities overall.

2) Flow of the renovation work

This survey has revealed the current state of the infrastructure on the campuses. However, a new study of the capacity of the infrastructure in the facilities concerned will need to be carried out after the equipment to be installed has been selected, in order to determine whether the capacity will allow the use of the selected equipment. Another study of the structure of the facilities will need to be implemented in order to determine whether the structure will stand up to the renovation and the installation of the equipment.

The renovation will have to be completed before the equipment is installed. As the installation of the equipment will be implemented in three stages, from the preparation of tender documents to the installation, a schedule for the renovation needs to be prepared that is coordinated with the schedules of the project as a whole and with the equipment installation. A detailed study needs to be carried out to determine whether or not it is possible to complete the renovation, including the installation of equipment, during the two-month-long summer break.

Completing the renovation within two months will require a plan that affects as small an area as possible. A schedule of works that can definitely be completed within two months need to be prepared by keeping to a minimum work that involves an entire facility such as plumbing and the renovation of common use areas.



Overview of the Renovation

- Area of renovation limited to the laboratories in which the equipment is to be installed
- (i) Construction work (reinforcement of the floors) + (ii) equipment and electrical work
- The work period for the renovation, including installation of equipment, is to be contained within the two-month-long summer break, between late June and late August.

<Facilities to be renovated>

Renovation	NUM : Improvement of the existing laboratories, Approx. 650 m^2 MUST : Improvement of the existing laboratories, Approx. 650 m^2 → Estimate and renovation of a hypothetical standard room

The renovation will be for the installation of equipment only. Physical factors, such as dilapidation of the existing facilities and insufficient infrastructure capacity, may make installation difficult in some rooms. The benefit of the renovation may not be realized in some rooms, depending on the type of equipment to be installed. Therefore, the renovation will not guarantee satisfactory operation of the equipment selected for installation as part of the renovation.

Following are our recommendations for renovation methods given the circumstances described above.

Content of the renovation Project

A study will be carried out of the state of the frameworks of the facilities selected for renovation in accordance with the results of the selection of equipment. After the study has confirmed the structural reliability of the frameworks, a decision will be made regarding the method and range of the renovation.

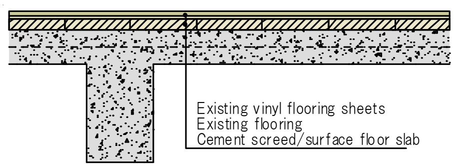
1) Construction Work

An additional study will be carried out of the facilities that in the above-mentioned structural study have been assessed as repairable. The following are the subjects recommended for study before the survey. The details will be finalized after the survey. Different methods may be considered, depending on the results of the survey.

- Comparison with drawings: Comparison and matching between the actual state of the facility and the drawings
- Study of vibration: Measurement of vibration caused by walking, etc.
- Study of exterior degradation: Clarification of the current state of the floors
- Concrete compression test: Collection of core samples
- Measurement of depth of neutralization: Identification of neutralized areas
- Study of the slab reinforcement layout: Measurement of the distance between longitudinal bars and thickness of concrete covering

Condition of the existing floors

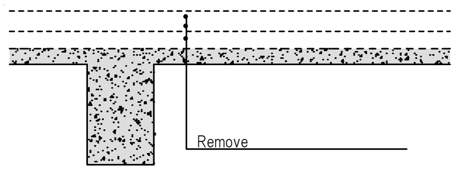
- Wooden flooring is installed over the floor base and vinyl sheets are laid over the wooden flooring to repair and mask damaged flooring.



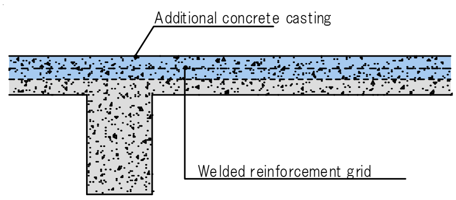
- Warping and vibration of the floor are perceptible.

■ Repair method (recommendation)

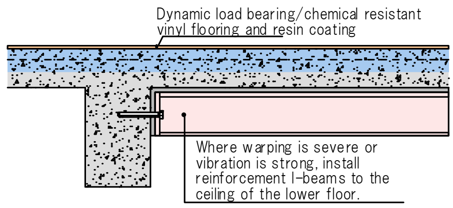
1. Remove the existing finishing materials
- Remove the existing vinyl sheets and flooring material.
- Remove the cement screed and the surface floor slab.



2. Repair of the floor slab
- Install welded reinforcement grids, cast concrete to the designated thickness and finish the surface with metal troweling



3. Selection of finishing materials
- Use vinyl flooring and resin coating with high dynamic load bearing performance and high chemical resistance, and that is pollution-resistant.
- Install reinforcement I-beams to the ceiling of the lower floor where warping is severe or vibration is strong.



2) Water Supply System

- New piping will be extended from the water mains to new and relocated water supply points as part of the renovation associated with the installation of research equipment on the three campuses.
- In practice, in a laboratory where a newly-installed sink or research equipment requires a water supply, piping will be installed from the existing water main in the ceiling of the adjacent corridor, through the wall and onto the ceiling as exposed piping until it is directly above the water supply point, and from there down the wall to the water taps of the sinks or to the water intake point of the research equipment.

3) Sewerage System

- In a laboratory where a newly-installed sink or research equipment needs to be connected to a sewerage system, a drain pipe will be installed from the sink or the equipment, through the floor or wall, depending on the location of the drainage system, onto the ceiling of the floor below as exposed piping, and from there to the sewer main in the ceiling of the corridor on the floor below.

4) Air-conditioning, Ventilation and Hot Water Supply System for Heating

- In a laboratory where the installation of new hot water radiators is required, exposed piping will be installed from the hot water supply pipe in the ceiling of the nearest corridor or exposed vertical hot water supply piping, through the wall, across the ceiling to the locations above the radiators, and from there down the wall and to the radiators.

- A laboratory requiring mechanical ventilation will, as a general rule, be equipped with an exhaust fan installed on a window frame. In a laboratory where a draft chamber is installed, an exhaust fan will be installed exclusively for the chamber. As a general rule, the renovation will not require the installation of air-conditioners. However, where the installation of an air-conditioner is required, an air-cooled ceiling-mounted cassette air conditioner or a wall-mounted air-conditioner will be installed. The outdoor unit of such an air-conditioner will be installed on an exterior wall or on the roof.

5) Electric Facilities

- Automatic voltage regulators (AVR) will be installed to protect important loads and equipment that could be damaged by voltage fluctuation, including experimental equipment.

- New power mains cables and distribution boards will be installed to supply sufficient power to the expanded / added air conditioning, sanitary facilities and experimental equipment. Consideration will be given to the installation in individual laboratories of distribution boards for experimental equipment. Installation in the existing electric and machine rooms and storerooms will be considered in the case of distribution boards for facilities and equipment intended for common use. The distribution boards may have to be installed in common areas because of the lack of installation spaces. In such cases, the distribution boards will be isolated from the rest of the common area with fences and doors so that only professionally-trained engineers can access to them.

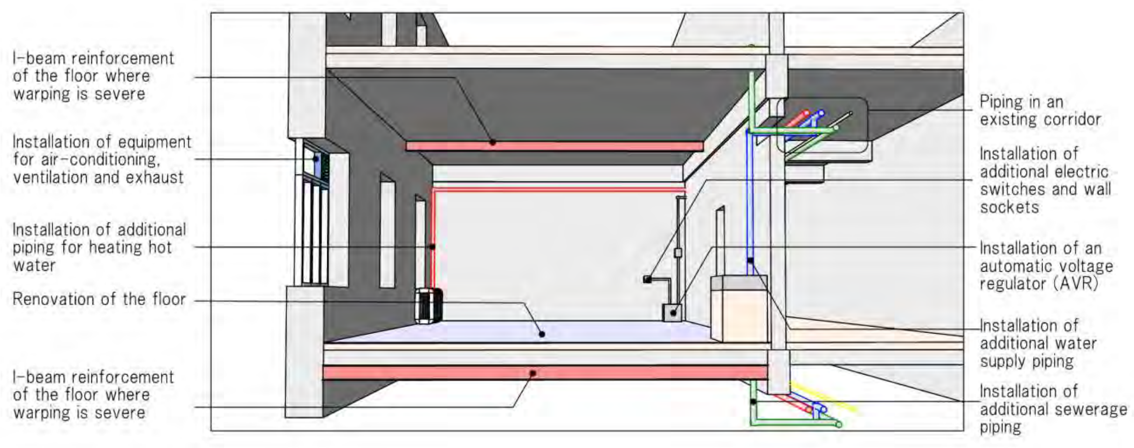
- Exposed wiring will be used for the extension of a power mains cable from the ceiling of the nearest corridor to a distribution board to be installed in a room in the renovation.

- If after the renovation the illuminance of the light fittings in a room is insufficient for its intended use, additional lighting fixtures will be installed. The additional fixtures will have the same light source with the existing fittings.

- If a room does not have a sufficient number of wall sockets, telephone outlets, LAN outlets or light switches, appropriate quantities of those will be additionally installed on the wall. Exposed wiring will be used for new installations, and conduits and moldings will be used to protect the exposed wiring.

- When the lighting in a room is to be improved, either the existing lighting fixtures will be replaced with fixtures with more bulbs or new lighting fixtures will be installed by extending the existing lighting circuit.

Because the specifications of the rooms in the three university campuses are basically identical, a model pattern for renovation incorporating the above components will be developed for a hypothetical standard room.



Proposed model pattern for the renovation for a hypothetical standard room

6) Additional Renovation – Renovation in MUST – Air-conditioning, Ventilation and Hot Water Supply Systems

In addition to the renovation described above, additional water supply and sewerage facilities, new heating hot water piping, new hot-water radiators and a new building ventilation system will be installed in the partially-extended building of the School of Civil Engineering and Architecture.

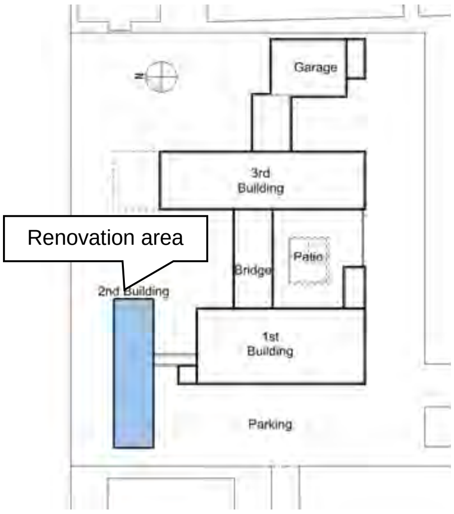
7) Additional Renovation in the School of Mechanical Engineering, MUST

Renovation of the existing engine room – Air-conditioning, Ventilation and Hot Water Supply Systems

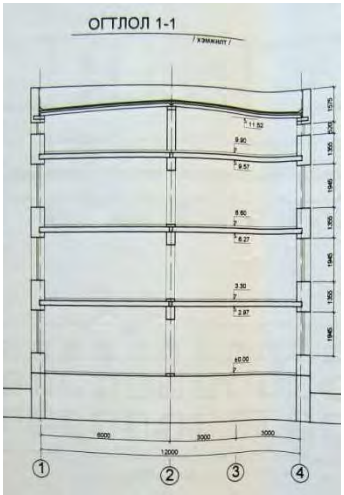
Consideration will be given to the installation of additional water supply and sewerage facilities and the installation of new air supply and exhaust fans, soundproofing and deodorization systems and appropriate air supply and exhaust filters in the existing engine room, in which additional experimental equipment is to be installed. A detailed investigation will be conducted as to how outdoor air should be supplied to the engine room in winter, including the installation of outdoor air intake traps and heating with hot water coils.

Construction of additional lecture rooms in the School of Mechanical Engineering

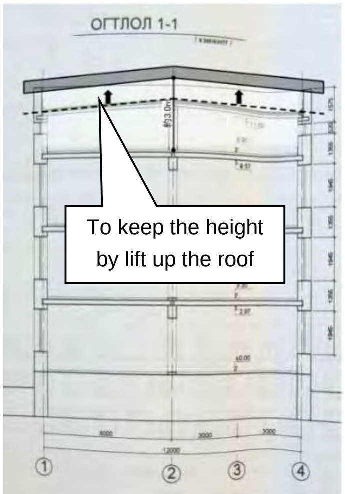
The School of Mechanical Engineering is planning to construct new lecture rooms in the 2nd Building. Currently, the 4th floor in the 2nd Building is used as a storage room. The school has a plan to change the storage room into the lecture room. This renovation is possible to transfer the lecture room to the upper floor, and the training and experimental setup can be located at the first floor.



2nd building in the school of Mechanical engineering



Present condition



After renovation

The school has already begun consultations with a local consultant and has estimated the construction cost.

Table 2-11 Request and estimation by the School of Mechanical Engineering

Project Title: Reconstruction of building /addition of 1 floor/ Project coordinator: D. Tsolmonbaatar						
	Required Work					
	Name	Room size	Rooms	Location	Quantity	Price
1	Add 1 floor to the building	552.8 $м^2$	6 (including toilets)	4th floor	1	300,000 USD
	TOTAL					300,000 USD

The estimate by the school gives a unit construction cost of approx. 540 USD/m^2. This figure is considered reasonable considering the scale and functions of the rooms to be constructed and taking into consideration the fact that the roof is the only framework to be renovated.

Cost estimation of the facility renovation

The cost of the renovation to be implemented in this project was estimated using the unit costs that are being used as the standard.

An interview survey has revealed that approximately 100,000 yen/m^2 is the current unit cost of the construction of school buildings. In general, the cost of the construction of the framework accounts for approximately 50 % of the total construction cost. Therefore, 50,000 yen/m^2, corresponding to the remaining 50%, is a reasonable figure for the renovation cost. However, the estimated costs of the work for the removal and partial renovation of the floor framework are added to the estimate.

Table 2-12 Facilities to be renovated

University	Content of renovation	Area of renovation	Estimated cost (million yen)	Unit cost/m^2
NUM	Renovation of the laboratories	approx. 650 m^2	39.00	**60,000 yen/m^2**
MUST	Renovation of the laboratories	approx. 650 m^2	39.00	
School of Mechanical Engineering	Renovation of the lecture rooms	approx. 550 m^2	30.00	**540,000 yen/m^2**
		Total	108.00	

Cost estimation of works outside the scope of the project

During the current survey period MUST submitted a concrete request for the construction of new laboratories for the installation of new experimental equipment.

The Aircraft Engine Laboratory Building requested by the School of Mechanical Engineering will require higher architectural and mechanical specifications than are required for other laboratories. Therefore, technical drawings of the building will be prepared and the construction cost will be estimated on the basis of the drawings.

Table 2-13 Request for construction of a new laboratory building

Department		Function	Scale
Mechanical Engineering	Construction	Aircraft Engine Laboratory Building ・Wind Tunnel Laboratory ・Laboratory of sound-proof and explosion-proof specifications for experiments with engines (Turbo Engine Laboratory) ・Assembly Room	12 m x 14 m Required ceiling height: 3.5 m 12 m x 8 m 6 m x 6 m 6 m x 6 m

i. Construction

- Foundation: To be constructed below the depth of frost penetration, partial installation of piping pits
- Framework: Use of reinforced concrete structure for the framework including walls, to enhance explosion-proof performance.
- Exterior walls: 150 mm-thick thermal insulator (polystyrene foam) + 50 mm-thick air layer + exterior wall members
- Roof: 150 mm-thick thermal insulator (polystyrene foam) + asphalt waterproofing + steel roofing sheets on flat roof
- Windows: Resin sashes + thermal insulating double-glazed glass windows
- Doors: Sound-proof steel fittings
- The sound-proof specifications will be applied to the engine laboratory. Acoustic materials will be installed on interior walls.

ii. Water Supply System

- Water will be supplied from the water main in the ceiling of the nearest corridor through exposed piping branching off from the main, installed along the ceiling and vertically down the laboratory wall to newly-installed taps. A multipurpose underground utility conduit will be installed outside the building and the water supply piping will be installed inside the conduit. The domestic hot water piping will have the same piping system.

iii. Sewerage System

- Sewer pipes will be connected to the nearest existing outdoor sewerage piping.

iv. Air-conditioning, Ventilation and Heating Hot Water Supply System for Heating

- New hot water supply branch piping will be installed from the existing main, for the installation of hot-water radiators.

- The outdoor piping for the heating hot water supply will be installed in the multi-purpose underground utility conduit in the same way as the water supply piping.
- Appropriate air supply and exhaust facilities will be installed in the laboratories to ensure sufficient ventilation.
- The installation of special equipment for the engine laboratory, such as a cooling unit and an engine exhaust system, will be included in the research equipment work.
- For the outdoor air intake, consideration will be given to the use of a heating system consisting of a framework trap, hot water coil and brine coil.

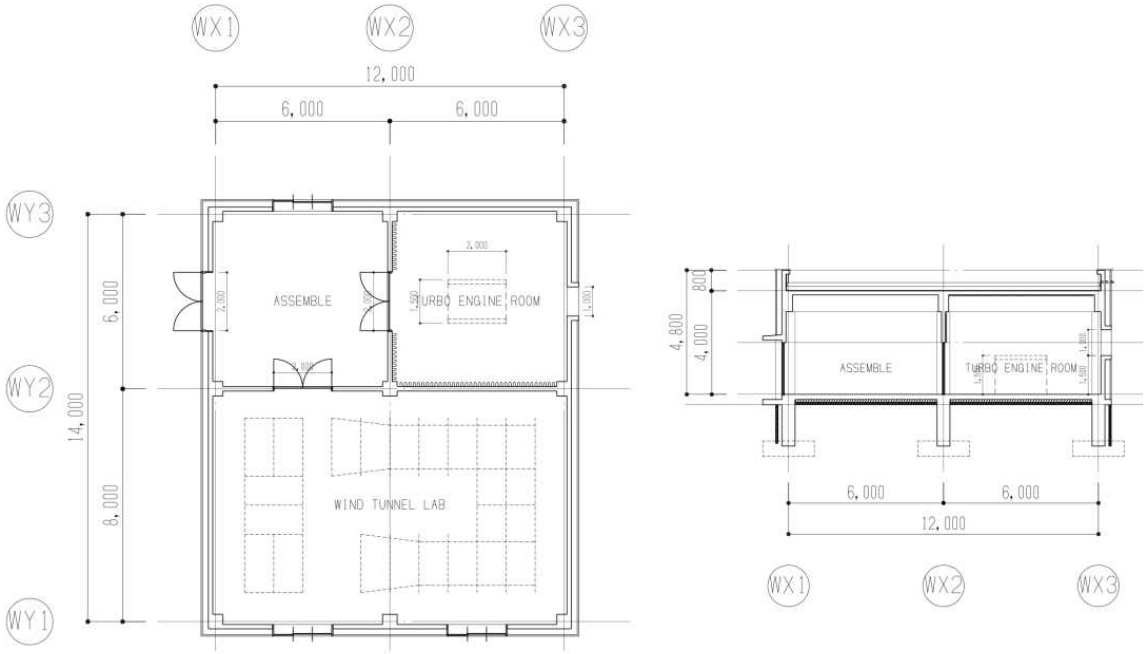
v. Special Equipment (for water treatment, wastewater treatment and specialty gases)

- The establishment of the engine laboratories will require an exhaust gas purification system, an oil separator for wastewater, an air supply system, a steam supply system, oil piping and special fire-fighting equipment. As a general rule the installation of all the systems and equipment mentioned above will be carried out as a single item as part of the research equipment installation work.

vi. Electric Facilities

- A distribution board dedicated for the new laboratory building will be installed in the building to supply power to the experimental equipment, air-conditioning and sanitation equipment, light fittings, wall sockets, etc.
- The expected load of the new laboratory building will be used as the basis for determining whether power will be supplied through a new extension from the power company or via a branch line from an existing building.
- Vertical wiring from the ceiling on the wall will be used for the power supply to each load so that the wiring does not disturb traffic lines in the building.
- Switches, lighting fixtures, electric conduits and wall sockets of explosion-proof specifications will be used in the areas and rooms considered to be in explosion-proof areas.

For the prompt announcement of fire detection and alarms, an automatic fire alarm system will be installed in the building. The system will issue an audio and visual fire alarm to inform people in other buildings in the event of fire.



Drawings of the Aircraft Engine Laboratory Building (Draft)

NUM and MUST have plans to construct new buildings. While the land areas required for the construction have been estimated, construction costs have not been estimated. For the amount estimated for the construction, a building consisting of lecture rooms only can be constructed. This amount is far less than the amount required for the construction of a building in which experiments and research using equipment equivalent to that to be installed in this project can be conducted. Therefore, the cost of installing the facilities required for minimum satisfactory performance of the equipment was included in the estimated construction cost.

Table 2-14 Cost estimation of construction and renovation outside the scope of the project

	Univ.	Building	Scale	Estimated cost	Unit cost per m^2
Construction	NUM	Library/Laboratory Building	approx. 10,000 m^2	approx. 1.2 billion yen	120,000 yen/m^2
	MUST	Laboratory/Hall Building	approx. 10,000 m^2	approx. 1.2 billion yen	
		Lab. of Aircraft engine	approx. 170 m^2	approx.0.02 billion yen	
				Total: 2.42 billion yen	

The estimated costs in the above table are for the works outside the scope of the ODA Loan assistance, and are given for reference only.

2.8 Program Development and Support Service (PDSS)

This project has very complex and various contents and many of its activities are carried out in relation to Japan. Also it is necessary to carry out the project following the rather complicated guidelines of JICA ODA loan projects. Although carrying out such activities is the responsibility of the PIU (refer to following section), they have no experience of implementing JICA's ODA loan projects of this kind. Therefore, the provision of Program Development and Support Services (PDSS) by the external experts is required in order to implement the project reliably and efficiently. The specific services include the two kinds of experts, such as "education and research exchange program development and implementation support experts" and "education and research equipment procurement support experts". The tasks of these experts are as follows.

(1) Education and Research Exchange Program Development and Implementation support experts

a) Assistance for establishment of project management system
- Advice on establishment of project implementation organization
- Advice on establishment of a financial system of yen loan funds operation

b) Assistance for Twinning Program development and implementation
- Assistance for program development
- Assistance for the activities relating to study in Japan for students

c) Assistance for development and implementation of study in Japan program for faculties
- Assistance for both countries' scholars to visit each country
- Assistance for scholars to study in Japan

d) Assistance for Joint Research Programs development and implementation
(same as c))

e) Assistance for Kosen Programs development and implementation
(same as c))

(2) Education and Research Equipment Procurement support experts
- Assistance for equipment procurement
- Assistance for detailed design
- Assistance for bid tender

For the draft term of reference (TOR), see Attachment 5.

2.9 Expected outcomes

As stated in 2.8, in order to cultivate human resources of engineering in which high knowledge and skills requested by the industrial sector of Mongolia can be acquired, this project is implementing three programs: Twinning program for undergraduate, joint research program for upgrading research and educational capability, and Kosen program for fostering industry-ready human resources. The summary of expected outcomes of this project is as follows:

Early response for Industrial Human Resource Needs

In order to respond to the current industrial human resource needs of Mongolia, especially for fostering mechanical, civil, and electrical engineers needed urgently in quantity and quality, Twinning program for undergraduates and Kosen program designed for high school graduates under 25 years old are to be implemented. These programs are also designed to shorten the education period overseas. Through both programs, it is expected that 520 engineers who can respond to industrial human resource need, will be produced. The evaluation of the outcome of the programs will be done by the number of the students who study in Japan through the Twinning program and Kosen program, and by the employment rate of the returnees who will take a job at Mongolian industries.

Fostering practical engineers

Quality improvement of engineering education is conducted in order to resolve the gap between industrial human resource needs of Mongolian industry and human resources currently produced by Mongolian universities. This project aims at quality enhancement through curriculum revision and Twinning program with Japanese universities.

Graduates of the Twinning program and Kosen programs will be employed by Mongolian and Japanese companies. As they utilizing their practical knowledge, they become practical engineers. After gaining practical field experience, they are expected to be engineering managers who can teach young engineers and technicians.

Moreover, producing people who can contribute to improve the quantity and quality of industrial human resources is expected as they give back by sharing their practical knowledge obtained by work experience to Mongolian universities, high schools, and TVET.

The evaluation of the project from industry is to be examined and analyzed by questionnaires and interviews to companies which employ the returnees.

Support for Japanese companies wishing to expand their business in Mongolia

This project expects to produce highly expert engineers with good knowledge of the Japanese language acquired from studying at Japanese universities and Kosen. Disseminating the information about this program to Mongolian and Japanese companies can give a great deal of leverage for Japanese companies wishing to expand their business in Mongolia and can also increase the potential for developing new business.

Enhancing the capability of scholars

Enhancing the capability of scholars can be achieved by the study abroad program for academic study and joint research program. It is expected that these two programs can enhance the capability of scholars of two universities.

Study abroad program plans to send 160 people to Japanese universities for the purpose of obtaining master's or doctoral degree. The evaluation of the project will be done by the number of people who study in Japan and the degree acquisition rate. Joint research program has 20 themes and its evaluation will be conducted by the number of international papers, patent, research grant from outside, and so on.

From a medium to long term perspective, the level of education and research will be upgraded which would make it possible to produce efficient engineers at Mongolian educational institutes when the returnees become employed as lecturers of state or private universities, and high schools or Kosen.

Promotion of university-industry relation

This project brings capacity building to the two universities by increasing the number of faculties who obtain master's or doctoral degree and by introducing the latest research equipment. Universities and industry have more opportunities to promote university-industry relation by utilizing the human resources and equipment. By activating joint research, contract research, and consultation, the gap between university and industry is expected to be resolved and the relation will be better as both respond to technical problems and industrial human resource needs.

As a spin-off, more employment for new scholars at universities will be possible if the revenue of the universities is increased by drumming up research grants through university-industry relation. This is also expected to help resolve the problem of lack of teachers for university students.

Chapter 3 Project Implementation and Maintenance Structure

3.1 Organizational framework of concerned agencies

For this project, the Ministry of Economic Development of Mongolia as the borrower and JICA will sign the L/A, based on the E/N exchanged between the Government of Mongolia and the Government of Japan. Concerning the implementation of the project, MECS of Mongolia will be primarily responsible for implementation as the Executing Agency, and MUST and NUM will be the Implementing Bodies.

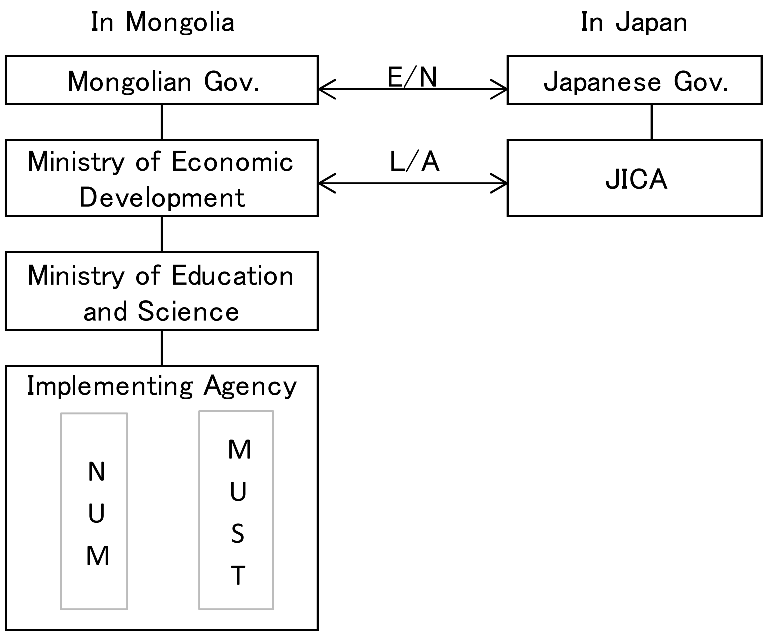


Figure 3-1 Governmental organizations in the project

MECS consists of 4 departments: Department of Strategic Policy and Planning, Minister's Secretariat, Department of Coordination of Policy Implementation, and Department of Audit Analysis and Evaluation, Internal Audit. After the change of government, administration related to vocational training was shifted to the Ministry of Labor.

The Department of Strategic Policy and Planning basically manages the policy formulation and budget, and consists of units in charge of preschool education, primary education, secondary education and higher education. Each unit is managed by a team of about 20 staff. This Department is the contact point of various projects operation, and the Department also serves as the contact point for the implementation of this project. The head of the Department as of September 2013 is Ms. Nasanbayar. The Minister's Secretariat manages the legal affairs and external relations. Its Division of Legal Affairs conducts various coordination for legal compliance concerning the shifting of TVET-related affairs to the Ministry of Labor. The Department of Coordination of Policy Implementation manages the coordination of policy implementation at different levels. The Department of Audit Analysis and Evaluation, Internal Audit conducts the monitoring, and at the time of survey, it was preparing the methods and indicators for evaluating universities.

The External Agencies of the MECS are as follows.

- Education Research Institute
- Centre for Educational Evaluation
- National Council for Education Accreditation
- Committee on Arts and Culture
- National Centre for Non-Formal Distance Education
- State Training Fund
- Science and Technology Development Fund

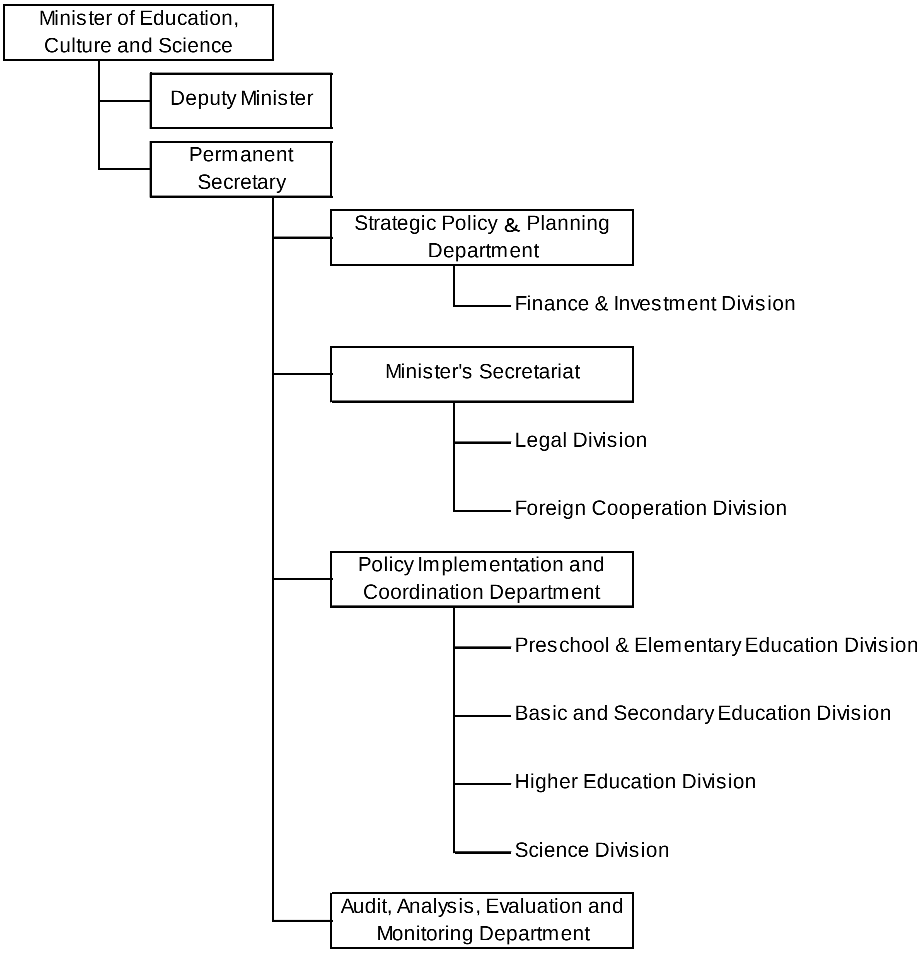


Figure 3-2 Organization diagram of MECS

In MUST, under the President, there are four Vice-Presidents in charge of Academic Affairs, Research and Technology, Economy and Social Development, and International Cooperation. MUST has 17 schools, two colleges, one TVET, three research institutes and three affiliated research institutes. The organizational chart is shown in Attachment 7.

In NUM, under the President and the Vice President, there are 14 schools, five research institutes and 15 research centers. It does not have a comprehensive school of engineering, but recently, it started introducing a part of engineering programs based on the recommendation from the government. This project targets six science schools: School of Mathematics and Computer Science, School of Physics and Electronics, School of Biology and Biotechnology, School of Chemistry and Chemical Engineering, School of Geography and Geology, and School of Information Technology. The organizational chart is shown in Attachment 8.

Concerning the financial capacity of MUST and NUM with reference to their financial statements, both universities have very little amount of owned equipment based on the past investment in equipment as shown in Table 3-1.

Table 3-1 Equipment owned by each university, by monetary value

University	Balance at the End of 2012 (million JPY)	Increase in 2012 (million JPY)	Number of Students
MUST	1,640	160	37,000
NUM	580	70	22,000
(reference) Tokyo Institute of Technology	43,000		9,300

Source: Made by survey team from the Financial Statements of MUST and NUM.

Concerning the present size of finance, if they will make procurement of some billions of yen annually, it is necessary to strengthen their administrative structures (setting up of PIU, recruitment of program development and support service, etc.). It is also necessary to allocate the equipment maintenance budget in accordance with the size of equipment purchased in this project.

The income and expenditure of MUST and NUM are as shown in Table 3-2.

Table 3-2 Annual income and expenditure of MUST and NUM (billion JPY)

University	Total Income in 2012	Budget allocated by National Government out of Total Income	Total Expenditure of Year 2012	Personnel expenses out of Total Expenditure
MUST	2.750	0.150	2.530	1.470
NUM	3.180	0.130	1.970	1.310

Source: Made from the Financial Statements of MUST and NUM

With reference to the size of income and expenditure, the percentages of budget allocated from the government to these universities are very low at 5.5% for MUST and 4.1% for NUM.

The size of overall income and expenditure is also small. If we estimate the size of this project to be around 7 billion yen for nine years, it will be around 800 million yen per year by average.

This amount is quite large concerning the present size of income for these universities. Therefore, it is financially impossible for these universities to bear the repayment of loan for this project. Also, strong implementation structure is indispensable for the smooth disbursement under the MECS.

3.2 Structure of the project implementation plan

For this project, as explained above, MECS will be the primary Executing Agency and the two universities will be the Implementing Bodies. Therefore, this project will be executed under the responsibility of MECS and will be practically implemented by the two universities. For the overall implementation structure, the structure as shown in Figure 3-3 is proposed.

MECS as the Executing Agency of this project will lead the implementation by assigning a person in-charge of this project in the Department of Strategic Policy and Planning, as well as serve as the main body for various contracts such as provision of scholarship and procurement and contracting of equipment.

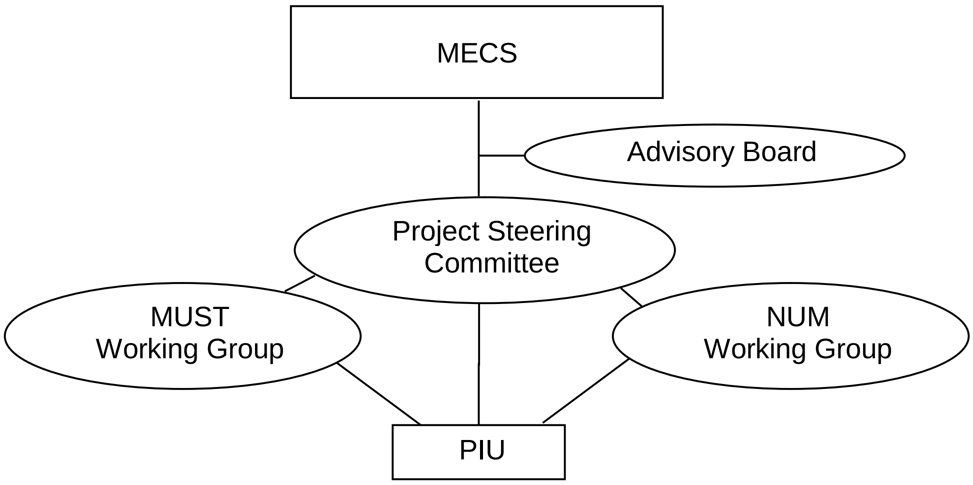


Figure 3-3 Project implementation framework (Draft)

It is proposed to establish the Project Steering Committee under the Ministry of Education and Science, as the agency to make decisions on the policies and important issues for the project implementation. The Steering Committee will consist of MUST, NUM, MECS, Ministry of Economic Development of Mongolia, JICA, etc. The Steering Committee is the venue for making decisions on policies and important issues. Since it will be difficult to conduct meetings frequently, it would be practical to convene for four to six times per year. It is desirable for the Ministry of Education and Science to serve as the chairperson of the Steering Committee. If possible, the chief of the Department of Strategic Policy and Planning, which will be the contact point for implementation of the project, is appropriate to serve as the chairperson. The main roles of the Committee are as follows.

- Making decisions on the project implementation policies
- Selection of personnel for PIU (refer to the description below)
- Final selection of the personnel for provision of scholarship
- Final selection to adopt the joint researches
- Making the final decisions on the procurement of equipment
- Final approval related to the invitation of dispatched scholars from Japan and external experts

Working groups to implement the practical tasks will be set up under each of the two universities. The working groups will make decisions on daily matters. The working groups will be centered on the Vice-Presidents in charge of research, education and finance of each university, and will be consisted of the main staff of related schools as its members.

MUST has already set up a working group. Under the overall leader (Vice-President in charge of research Dr. Baasandash) of the working group, they assigned a coordinator and three persons in-charge for each subject of the project components: Twinning program, program to dispatch scholars to Japan, joint research program, international relations and Kosen program, and finance and procurement. For the details, refer to Attachment 9.

The PIU, which consists of the members of each university's working group and full-time administrative staff, will manage the practical tasks, mainly management of the project and budgets as the project secretariat. An office will be established for the PIU. Two PIUs will operate the project while closely exchanging information with each other.

Two patterns of PIU structure are considered. It is because of the need to make accounting reports and claims for budget between JICA and the Government of Mongolia finalized into one summary based on the work of each PIU. One pattern is to set up one PIU jointly-shared by two universities. The other pattern is to set up one PIU in each university, and the PIU under MUST will be the leading PIU (PIU-1) to undertake the role of integrating the results of both PIUs' activities. This report proposes to set up the first pattern in consideration of the smooth operation of the project and the reduction of budget. However, for the implementation of the project, the most appropriate plan should be adopted after discussion between the two universities.

Full-time staff will be assigned to PIU. The necessary costs will be included in the Project Administration Cost of the project budget, and the Mongolian side will bear the costs for operation. As described in Section 2.8 in Chapter 2, the expert of program development and support services will support the activities of PIU.

The contents of assignments of PIU are mainly promotion of practical activities in each component of the project, management of JICA's Yen Loan budget and the Mongolian government's budget as the source of budgets for such activities, management of Special Account which will be opened for the disbursement of Yen Loan, preparation of budget, and reporting of expenditures.

If a part of the scholarship shall be the Conditional Loan, it will be necessary to have an organization which will manage the scholarship loan after the students' return to home country. A scholarship scheme of the Mongolian government has already provided the scholarship for studying abroad in the form of loan, and this scholarship has been managed by the State Training Foundation under MECS. The State Training Foundation is a new organization consisting of 13 staff, and they have not yet conducted the activities of collecting the scholarship loan because the conditions for repayment of governmental scholarship scheme have not been decided by the cabinet yet. If the conditions for repayment, which will be decided hereafter, shall be applied to this project as well, it is necessary to consider about entrusting the task of repayment management to the State Training Foundation.

It is proposed to set up the Advisory Board in order to reflect the voices of many stakeholders of this project onto the implementation of the project. The Advisory Board should consist not only of the members of Project Steering Committee such as MECS of Mongolia, Ministry of Economic Development of Mongolia, the targeted two universities, and JICA, but also of each Ministries which is related to the fields of Fellowship Program and Joint Researches of this project, the organizations representing the industries of Mongolia, and the Japanese Embassy in Mongolia,. The Advisory Board meeting will be held once a year and it will be the body to give advices on the major implementation policies as well as on the adjustments to be made based on such advices.

3.3 Present status of equipment maintenance and related issues

The maintenance management of equipment is carried out in each department or laboratory and involves training of newly assigned scholars and students to conduct experiments and operate training equipment, procurement of spare parts and consumables, securing maintenance budget, and performance of maintenance. The equipment of each department is targeted for asset management and should be registered in the asset book of the universities. Regarding their disposal, equipment and materials are to be disposed after disposal application to the authorities of the universities is approved. However, the procedure seems to be complicated, and thus some articles are kept temporarily at rooftop storage.

Each department or laboratory has a maintenance team headed by the head of the department/laboratory. The maintenance team checks, troubleshoots, and specifies the necessary spare parts when some equipment malfunction. When there is an equipment agent in the country, the spare parts will be procured from there but in the absence of an agent, repair through the sales agents from neighboring countries will be sought. Equipment manual is kept basically by each department or laboratory. Cases where information required for the repair such as circuit diagrams and spare parts lists are not stipulated in some manuals which could make trouble shooting and repair difficult may exist. One laboratory chief said that he could not read nor understand some existing manuals written in the language of the country of origin. Since there are many experienced scholars studying in Japan, it is possible to make manuals in Japanese. However, it is essential to procure manuals in English version. In addition, electricians and plumbers belonging to the maintenance unit of the universities also support its repair and check. Equipment should be used with much care taking into consideration the possibility of check and repair and the acquisition of spare parts. No example of maintenance service contract by equipment agents has been found out, but there is an example of equipment procurement by some development partners with three-year guarantee that covered the equipment maintenance. A challenge to be faced in repairs would be the fact that availability of spare parts in Mongolia depend on equipment maker. It is particularly difficult to procure spare parts from relatively small-scale makers.

In addition to the budget issued by the universities to each department, the income of each laboratory from fees such as those obtained from industrial examination/testing requested by private enterprises becomes the resource for expenses necessary for maintenance management. The summary of the equipment maintenance organization of each laboratory or department in the universities is shown in Table 3-3. The number of team members differ depending on the laboratory or department.

Table 3-3 Equipment maintenance organization

Job title	Position in maintenance team
Professor (Engineer)	Maintenance team leader
Associate professor	Deputy team leader
Senior lecturer	team member
Lecturer	team member
Research associate	team member

Equipment maintenance plan

There are some difficulties in equipment maintenance. It takes a lot of time to import spare parts from its countries of origin since most of the equipment do not have their agents in Mongolia except for large-scale makers and sometimes, contacts to the makers of some equipment are unknown. Also, import procedures are said to be complicated. In view of these issues, it is necessary to secure procurement routes for spare parts and consumables in procurement conditions, and at the same time, to enhance maintenance inspection ability to be performed after equipment procurement. Since maintenance service contract with the equipment agents are not included in the existing equipment of target facilities, it is proposed to add a three-year maintenance service or three-year warranty period in the procurement plan to secure the effective use of highly precision equipment in this project, and also to select models of equipment with agents that exist domestically or in the neighboring countries, which could allow maintenance management service by specialist engineers. For the equipment without agents in Mongolia, it is considered more practical to perform follow-up service, that is, periodical dispatch of equipment maintenance engineers from equipment agents in neighboring countries. In addition, it is planned to procure the technical data necessary for the above-mentioned maintenance service together to support inspection, and repair services, which will be performed in the target universities.

Chapter 4 Project cost estimation, Project schedule and other considerations

4.1 Project cost estimation

4.1.1 Project cost

Based on the project outline and implementation system proposed in chapters 2 and 3, project cost is estimated as shown in Table 4-1.

In the Table, the cost of each component is categorized into the cost incurred in foreign currency including Japanese Yen and the cost incurred in local currency, Mongolian Tugrik. Price escalation cost at 1.3% per annum for the foreign currency cost and 6.0% per annum for the local currency cost were added to the cost, as well as 5.0% per annum physical contingency following JICA's stipulations. The applied exchange rate is MNT1=JPY0.066 as of November 11, 2013 which brought the total project cost to 7,541,649,000 yen.

Although not included in direct project cost, other necessary costs for project implementation are estimated, namely value-added tax (VAT), front-end fee and interest during construction. VAT is established by Mongolian taxation system and costs 10% of equipment and facility renovation. For the Yen Loan portion, front-end fee of 0.2% and interest during construction of 0.3% are allocated to the local currency cost. Estimated total project related costs including these are shown in Attachment 10.

The above noted estimation is based on the cost categorization by purpose of each project component. For the case the finalized project plan by loan agreement categorizes the components by type of expenditure, project cost breakdown by type of expenditure is shown in Attachment 11.

The estimation by each year of foreign currency cost, local currency cost and total cost is shown in Appendices 12-1, 12-2 and 12-3 and summarized in Table 4-1. Table 4-2 shows the expenditure by each year. The cost estimations for each program are described in Appendices 13 to 20.

Table 4-1 Summary of project cost estimation

Unit:1,000JPY

Breakdown of Cost	Foreign Currency	Local Currency	Total
1 Improvement of Undergraduate Program (Curriculum Improvement & Twinning Program)	**1,756,148**	**0**	**1,756,148**
1-1 Visiting Scholars for Curriculum Improvement & Twinning Program Development			
1) Short-term visiting scholar (type A)	12,726		12,726
2) Short-term visiting scholar (type B)	35,596		35,596
3) Long-term visiting scholar	168,150		168,150
4) Japanese language lecturers	68,460		68,460
5) Local Japanese language lecturers	27,504		27,504
1-2 Scholarship for Twinning Program	1,405,312		1,405,312
1-3 Textbooks and teaching Instruments	38,400		38,400
2 Strengthening of Research and Educational Capability (Overseas Degree Program & Joint Research)	**1,495,873**	**0**	**1,495,873**
2-1 Scholarship for Academic Staff Development			
1) Master degree program	618,340		618,340
2) PhD degree program	376,068		376,068
3) Non-degree program (Visiting Scholar to Japan)	157,140		157,140
2-2 Visiting Scholars for Joint Research			
1) Short-term visiting scholar	141,575		141,575
2) Long-term visiting scholar	132,750		132,750
2-3 Joint Research Fund	70,000		70,000
3 Development of Ready-Engineers for Urgent Needs (Kosen Program)	**1,249,830**	**0**	**1,249,830**
3-1 Scholarship for Kosen Program	1,019,620		1,019,620
3-2 Visiting Scholars for Kosen Program			
1) Japanese language lecturers	53,790		53,790
2) Local Japanese lang. lecturers	5,760		5,760
3) Science subject lecturer	159,300		159,300
4) Local Science lecturers	5,760		5,760
3-3 Textbooks and teaching Instruments	5,600		5,600
4 Facility/Equipment Development	**1,600,000**	**108,000**	**1,708,000**
4-1 Educational Equipment	834,000		834,000
4-2 Research Equipment	766,000		766,000
4-3 Renovation of Building		108,000	108,000
Base Cost	**6,101,851**	**108,000**	**6,209,851**
Price Escalation	389,427		389,427
Physical Contingency (5%)	322,529	5,724	328,253
Total Base Cost	**6,813,807**	**113,724**	**6,927,531**
5 Project Administration		**380,431**	**380,431**
5-1 Mongolian Administration Staff		380,431	380,431
6 Program Development & Support Services	**715,302**	**0**	**715,302**
	640,680		640,680
Price Escalation	40,559		40,559
Physical Contingency (5%)	34,062		34,062
Project Cost	**7,529,108**	**494,155**	**8,023,263**
Other costs		**153,387**	**153,387**
VAT		12,020	12,020
Front end fee		15,229	15,229
Interest during construction		126,138	126,138
Total Cost	**7,529,108**	**647,542**	**8,176,651**

Table 4-2 Expenditure by each project year

Year	Total	JICA Loan Portion	Mongolian Gov. Portion	
	in JPY	in JPY	in JPY	in MNT
	=a+b1	a	b1	b2=b1*Ex.Rate
2014	240,577,365	116,593,365	123,984,000	1,878,545,455
2015	1,190,561,051	1,168,122,971	22,438,080	339,970,909
2016	1,281,853,608	1,258,069,243	23,784,365	360,369,164
2017	1,227,486,797	1,202,275,370	25,211,427	381,991,320
2018	762,720,736	735,996,623	26,724,113	404,910,800
2019	865,430,839	837,103,280	28,327,559	429,205,445
2020	823,258,338	793,231,126	30,027,212	454,957,761
2021	676,907,310	645,078,465	31,828,845	482,255,232
2022	382,544,665	348,806,089	33,738,576	511,190,543
2023	95,907,922	81,006,718	14,901,204	225,775,820
Total	7,547,248,632	7,186,283,250	360,965,382	5,469,172,450

4.1.2 Financial resource

In principle, JICA's yen loan project covers maximum 85% of overall project cost including non-eligible cost, and the rest of the project cost is financed by the borrower. Non-eligible cost includes administration cost, tax, customs and cost for land acquisition. However there are exceptional cases that JICA covers all foreign currency cost and the borrower shoulders local currency cost, for instance, in case the foreign currency cost is over 85% of whole project cost.

In this project, more than 90% of the whole project cost is in foreign currency and it is appropriate to apply the latter method. Therefore, 7,547, 249,000 yen of foreign currency cost would be covered by the Yen Loan.

4.1.3 Flow of project fund

Figure 4-1 is the outline diagram of the flow of project fund. Yen Loan fund from JICA to the project will be sent either via a special account which the executing agency opens at a Japanese bank or by direct payment from JICA to suppliers, consultants and experts to offer program development and support service by letter of credit or disbursement.

The former, special account is suitable to deliver scholarships, to pay tuition to universities and expenditures for visiting scholars, while for the latter, direct payment is often used to pay to suppliers including that of equipment. The payment by special account is often accompanied by opening sub-special accounts in Mongolia and in Japan for convenience and decrease of foreign currency remittance charge.

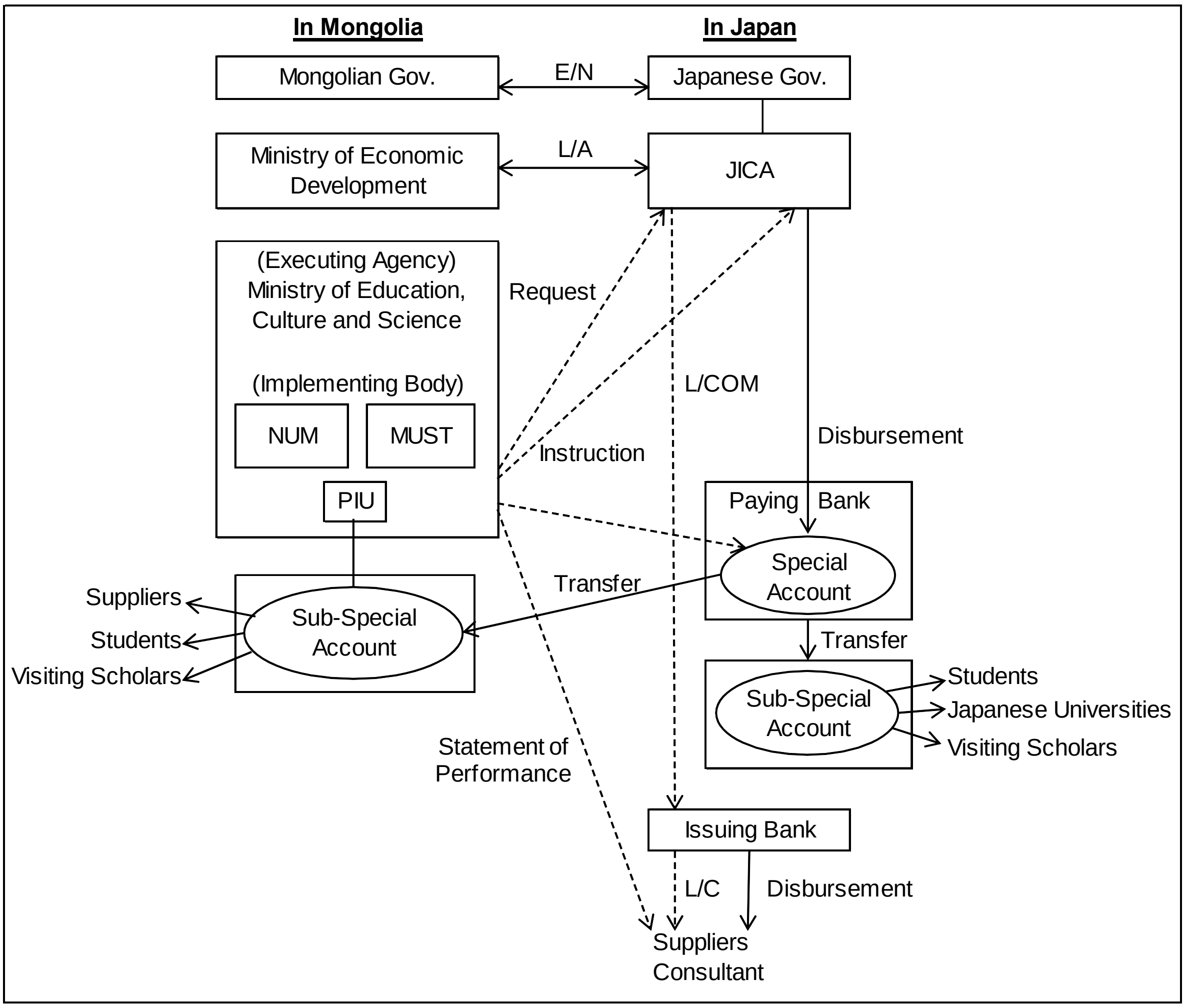


Figure 4-1 Fund flow of the project

4.2 Project implementation schedule

Detailed project implementation schedule is shown in Attachment 21 and below is a list of the main activities.

Feb. 2014	Pledge for Yen Loan project by Japanese government and commencement of project implementation
	Recruitment of Japanese language lecturers for preparatory education of Kosen Program
Mar. 2014	Conclusion of Exchange of Notes and Loan Agreement
May 2014	Recruitment of the first batch of Kosen program students

Jun. 2014	Recruitment for the first batch of scholarship programs for Mongolian scholars
	Selection of joint research themes
Sep. 2014	Beginning of preparatory education of Kosen program
	Finalization of the first list of equipment for procurement, beginning of procurement
Mar. 2015	Arrival of the first batch of Kosen program students to Japan
Sep. 2015	Beginning of Twinning Program in Mongolia
Mar. 2018	Arrival of the first batch of Twinning Program students to Japan
Mar. 2013	Graduation of the fourth batch of Twinning Program students

4.3 Risks, considerations and countermeasures in implementing the project

This project consists of four components shown in the project schedule mentioned above. Four components will be simultaneously conducted. Therefore, there are a lot of tasks in both Mongolia and Japan. The main task is to arrange the schedule of four components between Mongolian Universities and Japanese Universities and Kosen. The implementing agencies of this project include several organizations, MECS, NUM and MUST and other governmental agencies. In addition, fairness in every task, including scholarship programs under the project, has to be ensured. It is important to sufficiently proceed with every preparation as soon as possible for an early commencement of the project.

In order to deal with these risks, at the early stage of the project, implementing agencies should establish a project implementation organization and employ an external specialist with enough experience to help set-up a system that will aid in executing complex tasks and allow the project to proceed smoothly. Also, it is recommended that JICA and Embassy of Japan in Mongolia to be part of the policy-making body.

4.4 Verifiable indicators

Verifiable indicators of each component and program are shown in Table 4-3.

Table 4-3 Draft of Verifiable Indicator

	Component / Program	Verifiable Indicator	Means of verification
1. The quality improvement of the undergraduate education			
	Improvement of educational program	・Number of improved education program ・Feedback from Industry	・Monitoring / Completion Report ・Follow-up/Evaluation survey Report
	Twinning Program	・Number of participants ・Graduation rate ・Employment rate at Mongolian Industry	・Completion Report ・Monitoring Report ・Follow-up/Evaluation survey Report
2 Strengthening education and research capacity of faculties			
	Study in Japan for faculties	・Number of Participant ・Graduation rate ・Return rate to Universities	・Completion Report ・Monitoring Report ・Follow-up/Evaluation survey Report
	Joint research program	・Number of academic paper ・Number of patent ・Amount of external funds	・Completion Report ・Monitoring Report ・Follow-up/Evaluation survey Report
3 Kosen Program			
	Kosen Program	・Number of Participants ・Graduation Rate ・Employment Rate at Mongolian Industry	・Completion Report ・Monitoring Report ・Follow-up/Evaluation survey Report
4 Upgrading of equipment and facility			
	Educational Equipment	・Number of subjects for Training / Experiment ・Number of training hours	・Completion Report ・Monitoring Report ・Follow-up/Evaluation survey Report
	Research Equipment	・Number of research topic	・Completion Report ・Monitoring Report ・Follow-up/Evaluation survey Report

4.5 Environmental and social considerations

Before the implementation of this project, sufficient consideration must be given to the harmony of the planned extension/renovation works and the surrounding environment, including the existing facilities of NUM and MUST, in compliance with the Natural Environment Protection Law of Mongolia. The planned project consists of the extension and renovation of existing buildings on the existing campuses, instead of the construction of new buildings on new campuses. Given the scale of the buildings and sites concerned, the implementation of this project is not likely to cause major change to, or have any significant effect on, the surrounding environment.

The issues to be considered with regard to the effect of the implementation of this project on the surrounding environment are as follows:

1) Effect on the District Hot Water Supply System

The campuses of NUM, MUST and the School of Mechanical Engineering of MUST are located within the service area of the district hot water supply system. Since the extension and renovation works to be implemented in this project is not on a very large scale, there is not likely to be any significant increase in the demand for hot water supply following the extension/renovation. Therefore, although the system does not have much spare capacity, it is likely that the new demand to be generated by the implementation of this project can be met with some extension from the existing mains.

2) Treatment of Wastewater and Exhaust Gases from Laboratories, and Measures against Air Pollution

Wastewater generated in the laboratories must be neutralized and/or treated appropriately before being discharged into the sewer mains. The services of specialized companies need to be employed for the disposal of organic compounds. However, since the facilities to be extended / renovated in this project are not related to the schools in chemistry or food engineering but are mainly for the schools in civil, mechanical and electrical engineering, the amount of wastewater requiring special treatment is expected to be small. The construction of treatment facilities for this small amount of wastewater is not likely to affect the surrounding environment significantly. The situation is similar with relation to the exhaust gases from the laboratories. The impact on the environment can be minimized through appropriate treatment of the exhaust gases.

Air pollution has been a problem in Ulaanbaatar. The major pollutants are suspended particulate matter, SO_2 and NO_2. Of the air-polluting suspended particulate matter there is growing pollution from PM10 and PM2.5, which are deleterious to human health. Therefore, appropriate easy-to-maintain air filters will have to be installed in the air-intake systems. As the trees in and around the sites produce a large amount of seeds (spores) in certain seasons, measures will need to be taken to deal with those seeds (spores).

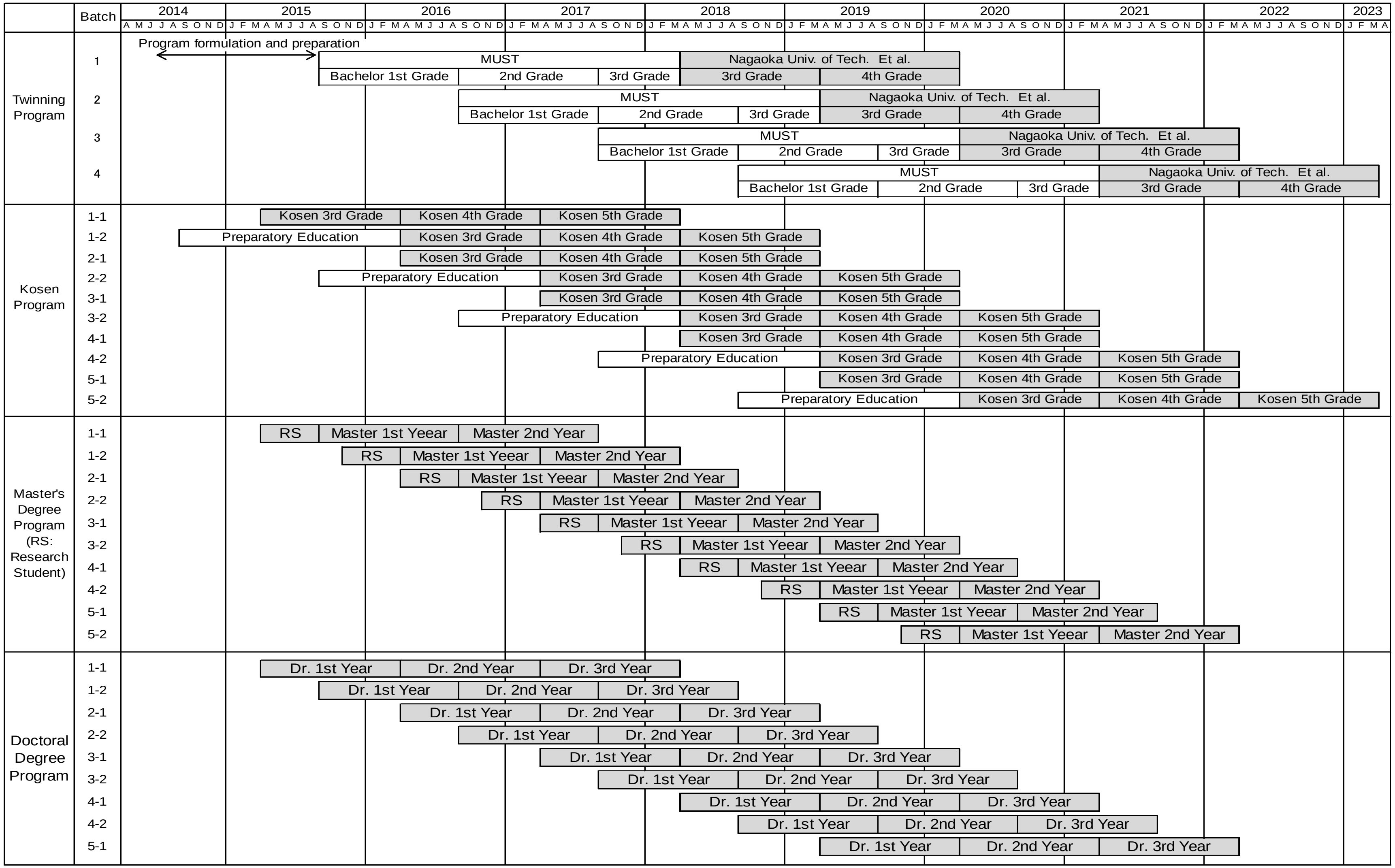
3) Increase in Waste

The extension / renovation of laboratory facilities will increase the amount of experimental waste. However, this quantitative increase is not expected to cause any problem because the increase will not be significant compared with the amount of waste generated from the existing facilities.

4) Vibration, Noise, Dust and Traffic Obstruction Caused by the Construction Work

Because the project sites are located within the campuses of the universities concerned, sufficient measures must be taken to minimize the impact of the implementation of the project on the surrounding areas. It will be necessary to install appropriate fencing in order to prevent or reduce the generation of noise, vibration and dust, and deliberate measures, including safety measures for construction vehicle traffic in the campuses and measures to maintain ordinary activities and traffic lines in the existing facilities, will need to be taken.

Attachment 1 Overall schedule of degree programs



Attachment 2 Number of program participants (Offer Basis)

Unit: Persons

Program	Total	Number of New Offer								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
1 Kosen Program										
Batch 1-1	7	7								
Batch 1-2	33	33								
Batch 2-1	7		7							
Batch 2-2	33		33							
Batch 3-1	7			7						
Batch 3-2	33			33						
Batch 4-1	7				7					
Batch 4-2	33				33					
Batch 5-1	7					7				
Batch 5-2	33					33				
Sub-Total	200	40	40	40	40	40	0	0	0	0
2 Twinning Program										
Batch 1	80		80							
Batch 2	80			80						
Batch 3	80				80					
Batch 4	80					80				
Sub-Total	320	0	80	80	80	80	0	0	0	0
3 Master degree program										
Batch 1-1 (April)	30	30								
Batch 1-2 (September)	20		20							
Batch 2-1 (April)	15		15							
Batch 2-2 (September)	20			20						
Batch 3-1 (April)	10			10						
Batch 3-2 (September)	1				1					
Batch 4-1 (April)	1				1					
Batch 4-2 (September)	1					1				
Batch 5-1 (April)	1					1				
Batch 5-2 (September)	1						1			
Sub-Total	100	30	35	30	2	2	1	0	0	0
4 PhD degree program										
Batch 1-1 (April)	15	15								
Batch 1-2 (September)	10		10							
Batch 2-1 (April)	10		10							
Batch 2-2 (September)	10			10						
Batch 3-1 (April)	10			10						
Batch 3-2 (September)	3				3					
Batch 4-1 (April)	2				2					
Sub-Total	60	15	20	20	5	0	0	0	0	0
5 Non-Degree Program										
2015 (1 year)	2		2							
2016 (1 year)	2			2						
2017 (1 year)	0				0					
2018 (1 year)	1					1				
2019 (1 year)	0						0			
2020 (1 year)	0							0		
2021 (1 year)	1								1	
2022 (1 year)	0									0
2014 (6 months)	15	15								
2015 (6 months)	15		15							
2016 (6 months)	15			15						
2017 (6 months)	1				1					
2018 (6 months)	1					1				
2019 (6 months)	1						1			
2020 (6 months)	1							1		
2021 (6 months)	1								1	
2022 (6 months)	1									1
2014 (1 week)	70	70								
2015 (1 week)	80		80							
2016 (1 week)	80			80						
2017 (1 week)	10				10					
2018 (1 week)	10					10				
2019 (1 week)	7						7			
2020 (1 week)	2							2		
2021 (1 week)	2								2	
2022 (1 week)	2									2
Sub-Total	320	85	97	97	11	12	8	3	4	3
Total	1,000	170	272	267	138	134	9	3	4	3
Visiting Scholar										
1 Twinning Program & Curriculum Improvement										
Short-term Type A (1 week)	40	8	12	6	4	4	4	2		
Short-term Type B (2 weeks)	58		14	14	12	8	8	2	0	0
Long-term (1 year)	19		0	4	4	4	4	3		
Japanese language lecturers (1 year)	17		3	3	3	3	3	2		
2 Kosen Program										
Japanese language lecturers (1 year)	11	1	2	2	2	2	1	1		
Local Japanese lang. lecturers (1 year)	11	1	1	2	2	2	2	1		
Science subject lecturer	18		3	3	3	3	3	3		
Local Science lecturers (1 year)	6		1	1	1	1	1	1		
3 Joint Research										
Short-term (2 weeks)	175	30	35	35	15	15	15	15	10	5
Long-term (1 year)	15		2	2	2	2	2	2	2	1
Total	370	40	73	72	48	44	43	32	12	6
Grand Total	1,370	210	345	339	186	178	52	35	16	9

Accumulated Number	M⇔J	210	555	**894**	1,080	1,258	1,310	1,345	1,361	1,370
	M⇒J	170	442	709	847	981	990	993	997	**1,000**

Attachment 3 Abstract of research profiles, MUST

Title	Sky-Infra project in Mongolia: Logistics, Environmental monitoring and Aero-space-Mechanical Engineering Education
Project Coordinator	Baasandash.Ch
Department / Faculty	Mechanical Engineering
Summary	Commercial unmanned flight vehicles (CUMV) are widely used in various fields. It is well-known that recently for Fukushima reactor accidents it carried a camera, and monitored above the reactor. For the present background of the project is following: some parts of Mongolia have been developing by huge investments to mining industries, and the new demands of the many kinds of infrastructures are increasing. The present infrastructure used in developed countries such as USA, JAPAN, EU, is not proper for Mongolian people except Ulaanbaatar (UB). In the most areas of Mongolia except UB, people are living sparsely in severe weather, where temperatures often fall below -30 C degree. Thus, it is valuable to develop a linking infrastructure connecting isolated communities. In the present project we plan to use new airlines of low cost logistics system by using CUMV, which can be used to reinforce the current infrastructure. This project will supply services of logistics, postal, local scale environmental monitoring, and medical supplying systems that cover most areas of Mongolia where urgent medical care and supply system are not constructed yet. In addition, it covers disaster mitigation by fast delivering to refugees in severe weather. The project can be split into five technical subprojects: (1) unmanned flight vehicle (CUMV) carrying 70kg, (2) aero engines, (3) navigation systems and guidance communication systems, (4) real-time environment monitoring systems, (5) aerospace engineering education including software development. We plan to start the preliminary study of preliminary conceptual design of the logistic system and environmental monitoring, and to do the educational programs of aero engine, aero craft, and software projects. We plan to incubate and innovate the developed technology by MUST to the Mongolian aerospace industries under the School of Engineering at Mongolian University of Science and Technology (MUST).

Title	Research on Material which based on Powder metallurgy and Nano-technology
Project Coordinator	Delgermaa.M
Department / Faculty	Mechanical Engineering

Summary	Research on material which based on Powder metallurgy and Nano technology is freshness in Mongolia, because there is not any research about above in Mongolia. There are a few institutes which do only background research about Nano technology, but Powder metallurgy is not at all in Mongolia. Further Mongolian industries always import many parts which made by Nano technology and powder metallurgy with very expensive. It is increasing Mongolian currency to abroad. If we can research deeply about material which based on Nano technology, Powder metallurgy and produce parts, it will develop Mongolian technique and technology. And Mongolian and Japanese researchers will communicate each other well. Certainly, it will decrease currency to abroad and affect well to Mongolian economic. Besides, above research will be helpful for increasing knowledge of Mongolian researchers and scientists. Therefore, value of Mongolian institutes, universities is increasing because of above experienced researchers.

Title	Study of Binder and Asphalt Designs for the Cold Region
Project Coordinator	Bolormaa R.
Department / Faculty	Civil Engineering and Architecture
Summary	Mongolia has a few specific features compared to other countries around the world; such as smaller population living across large territory where infrastructure is underdeveloped, in particular, all-weather (sealed) roads. It is important to establish a reliable road network that connects core economic centers thus saving time, improving level of services and safety to the road users, and extending vehicles' life and thereby increasing passenger and goods turnover and creating new job opportunities to alleviate poverty. Demand for transportation of goods and passengers have sharply increased in recent years in Mongolia. Hence, the Government of Mongolia (the Government) took measures to expand and develop its national road network extending 12,613 kilometers (km) as of 5th of May, 2010. As of December, 2012 the national paved roads reached 3,764 km (paved road 2,244 km and gravel road 1,520 km). The need for road construction, upgrading and maintenance is critical considering that the sealed roads represent only 7.6% (3764 km) of the entire road network (49,250 km) in Mongolia. The harsh climate and extreme temperature variations in Mongolia have a

	significant effect on the performance of bituminous pavement mixtures. Transverse cracks caused by thermal contraction are generally the first cracks to appear in pavement. About 85% of sealed road /asphalt pavement road/ have transverse cracks. It is affected on road lifetime, maintenance cost and increased LLC of road. It is required to develop asphalt mix design and to study modified binders. Therefore, we request to implement this project to improve knowledge and skill of our lecturers, to establish research laboratory for road testing materials.

Title	Utilization of Mongolian Fly Ash in Construction Industry for Greener Future
Project Coordinator	Danzandorj S.
Department / Faculty	Civil Engineering and Architecture
Summary	Mongolia has rich mineral deposits, in which Tavan Tolgoi area is the world's largest untapped coking coal deposit. Because of this vast coal deposits, it has good reason to depend Mongolia's energy on coal power generation. Four coal power plants occupied almost the whole of the capital city and the fifth is being planned. Vast usage of coal produces coal ash as its unavoidable byproduct. However, this vast ash deposits remained unused all over in Ulaanbaatar city area. Disposal and utilization of coal ash continue to be an important area of national concern. Mongolia had consumed 8.34 million tons of coal in year 2012 and it is assumed that burning of that amount of coal produces around 3 million tons of ash. Mongolia has almost no experience in utilizing fly ash in our booming construction industry. Purpose of this research is to investigate on possibility of using Mongolian fly ash in construction industry in general, and then focus into using Mongolian fly ash in concrete industry and brick making, thereby promoting the fly ash utilization in Mongolia for environmental friendly future. Majority of building materials including cement are imported from China at least transporting 720km from Erenhot, the border city of China and Mongolia. Therefore, all most all building materials in Mongolia are expensive and of course they are more environmentally weighty because of emission due to transportation. This high cost of cement makes concrete very expensive more than JPY 8600/m3, paying 40% of the cost for Chinese cement. On the other hand, bricks are one of the most important building materials used in Mongolia. Fired clay brick making is a traditional and energy intensive industry which consumes a greater amount of inferior coal. Major environmental problem of brick making is the emission from coal burning.

	This burning process typically consumes 100 g of coal per brick. Degradation of lands due to the extraction of clay, which is the major source of bricks, and large water consumption are identified as the other serious problems of brick industry. Bearing these issues in mind, the research team focus to investigate use of Mongolian fly ash, which is precious untapped resource readily available in locality, for concrete and brick making, then eventually introduce fly ash into the Mongolian construction industry. The output of the research work finally targets writing a manual for utilizing fly ash in Mongolia, and introducing simple measuring device that capable to identify suitable fly ash for each industrial application. Furthermore, the proposed project mobilizes researchers from Japan to Mongolia or vice versa with the help of counterpart in Japan. This helps in faculty development in MUST, and graduate and undergraduate education of MUST. Finally, we strongly persuade in establishing a Double Degree program with collaboration of Tohoku University, Sendai, Japan.

Title	The Research for Electromagnetic Influence in the Energy System
Project Coordinator	Bayar B.
Department / Faculty	Power Engineering
Summary	In Mongolian Energy Sector, This research will be covered on the main connection substations of the central energy system of Mongolia, power sources, and some big demand consumers. the electromagnetic compatibility of the control and management digital equipment will be studied in the laboratory also. The backgrounds of this research are followings: 1. Operation analyses of the existing power plant and substations. 2. The study of electromagnetic field impact and its positive and negative influence characters. 3. The study of an abnormal influence of the electromagnetic sources. 4. The methodology of reducing and elimination of an abnormal influence of the electromagnetic field. 5. The evaluation of the operation level of the digital equipment used in the energy system of Mongolia. 6. To establish and follow the general standard of electromagnetic compatibility in Mongolian energy system.

Title	New Laboratory for Electrical Supply and High Voltage Testing and Fault Detecting

Project Coordinator	Byambaa S.
Department / Faculty	Power Engineering
Summary	The faculty of electrical supply and high voltage trained almost 200 students in every year. But there is no any laboratory for electrical supply training and research work. There is only one laboratory purpose panel in the laboratory of electrical machinery. It is impossible to make some test and fault detection by using older equipment in the laboratory of high voltage. Under this research work, we need to establish new laboratory for electrical supply and high voltage. The research will be accomplished by Mongolian and Japanese researchers. After completion the training laboratory, the researcher both from Mongolia and Japan can accomplish the research work at the laboratory in Mongolia. After completion the research laboratory both students and researcher will be studied the electrical supply and high voltage test and fault detection by using new equipment. This research work will contribute for successful training both of students and researchers in future.

Title	Rheology laboratory of Food Products /Mongolian traditional food (meat and dairy products)/
Project Coordinator	Tuyatsetseg, J.
Department / Faculty	Food Engineering and Biotechnology
Summary	The Rheology is a new field for the study of Mongolian traditional food. Rheology is the science concerned with the deformation and flow of matter. Rheology is the study of the flow and texture of matter: mainly liquids but also soft solids or solids under conditions in which they flow rather than deform elastically. It applies to substances which have a complex structure, including suspension, polymers, many foods, bodily fluids, and other biological materials. Food rheology is important in the manufacture and processing of food products, e.g. cheese, aaruul, eezgii, urum, sour cream, milk oil and borts. Food rheology is the study of the rheological properties of food, that is, the consistency and flow of food under tightly specified conditions. The consistency, degree of fluidity, and other mechanical properties /hardness, solidity, dynamic and kinematic viscosity/ are important in understanding how long food can be stored, how stable it will remain, and in determining food texture. The acceptability of food products to the consumer is often

	determined by food texture, such as how spreadable and creamy a food product is. Food rheology is important in quality control during food manufacture and processing. Rheology is important in a number of different areas of food science. Many of the textural properties that human beings perceive when they consume foods are largely rheological in nature, e.g., creaminess, juiciness, smoothness, brittleness, tenderness, hardness, etc. The stability and appearance of foods often depends on the rheological characteristics of their components, e.g., emulsions, spreads and pastes. The flow of foods through pipes or the ease at which they can be packed into containers is largely determined by their rheology. The Mongolian traditional food is divided into dairy and meat products. Dairy products called "tsagaan idee" it is differ greatly about in variety and taste and include milk, which is urum (a thick layer of cream), Mongolian butter, aaruul (dried curd), eezgii (dried mass of cheese), airgan tos (one kind of butter oil), airag (fermented Mare's milk), and a soft of kefir yogurt. Meat products called “red food-ulaan idée” which is borts (dried meat of beef and chevon), shuuz (salted meat). This is all that is not produced in the food industry of Mongolia made so only at home in the countryside. Because we cannot obtain exact producing technology of Mongolian traditional dairy and meat products for industrial condition. So we need to define so many characteristics of physical and mechanical of dairy and meat products. Rheology laboratory not only for Food, it makes full usage of the other fields, which is agricultural materials, Pharmaceutical products, polymeric material’s study etc.

Title	Comparative study of drying methods for some traditional Mongolian food
Project Coordinator	Odbayar T.
Department / Faculty	Food Engineering and Biotechnology
Summary	The nomadic way of life of Mongolian people, and the severe climatic conditions of Central Asian range, offered to develop their staple foods in the herding culture of Mongolia. Mongolian people have prepared using various methods their staple food such as meat, some dairies and herbs preserved during a year. Preservation enables foods that are seasonally produced to be available all the year. Traditional forms of food preservation include salting, smoking, pickling, drying and preserving in some sour dairies. Modern food technology uses many novel processes. No preserved food is identical in quality to its fresh counterpart, therefore only food of the highest quality

	should be preserved. Drying is one of the oldest, simplest, and most effective ways of preserving foods. Traditionally, foods were dried in the sun and wind, but commercially today, products such as dried milk and instant coffee are made by spraying the liquid into a rising column of dry, heated air; solid foods, such as fruit, are spread in layers on a heated surface. Mongolia is developing, but we still need to modify the methods of preparation our food. Food technologists and engineers also need to specialize on industrial food drying technologies, still we using traditional methods. Solar dryer is simplest method of drying. The drying product depend on external variables like temperature, humidity and velocity of air stream and internal variables which is a function of material and depends on parameters like surface characteristics, chemical composition, physical structure and size and shape of the products. In a spray dryer, foods are transformed from a pumpable liquid in to a dry powder. Spray drying is especially advantageous for heat sensitive products because the particles are never subjected to a temperature higher than the wet bulb temperature of the drying air. Hybrid drying techniques have become popular recently because of flexibility of drying operation. The hybrid drying techniques may include either use of more than one dryer for drying of a particular product (multi-stage drying), use of more than one mode of heat transfer, various ways of heat transfer or multi-processing dryers. The multi stage drying is highly accepted way of enhancing the drying performance. Combination of microwave and vacuum drying and or microwave assisted freeze drying results in much faster rates with very high product quality.

Title	Geoenvironmental study in the Tuul and the Kharaa Rivers Basins, Central Mongolia for sustainable development
Project Coordinator	Oyun D.
Department / Faculty	Geology and Petroleum Engineering
Summary	Mongolia is the one of countries that well preserved nature and also lots of natural resources to develop. Increased mining activities without proper environmental protection measurement have caused significant environmental deterioration in suburban mining districts including water and land pollution problems. At the same time, growing urbanization is increasing the pollution of soil, surface and underground water resources, which has a significant impact on associated ecosystems. In addition overuse of groundwater resources has led to lowering of the groundwater table, which has consequently caused some springs, lakes and their associated ecosystems to

	dry up. Nowadays, environmental studies have been done separately in different sectors in Mongolia. Therefore the government's development policy is to set of integrated economic, social and ecological actions aimed to protect the environment including appropriate use of the air, land, mineral wealth, water, forest and to apply for proper utilization of mineral and water recourses. According to this government policy, The National Development Plan, adopted by the Mongolian Parliament in 1994, assigned a high priority to ecosystem protection. The basic guidelines for environmental protection were further identified in the Ecological Policy of the Mongolian State directive in 1997. These initial steps were followed by more than twenty laws on conservation. Practically speaking, the legal basis for sound environmental management is in place. Furthermore, the Ministry of Education, Culture and Science has included an environmental education program into the secondary school curriculum. However, due to the competing interests of different sectors and a lack of education for environmental protection, the rate of implementation of rules and regulations has been weak (MFA, 2004) . On the other hand, without sufficient funding and with limited number of trained personnel, the government policies cannot be implemented, and laws and regulations cannot be enforced. Best management of Mongolian nature and environmental issues are essential to precede the national development of Mongolia. Consequently, priority intention of the sector is needed to determine current geoenvironmental condition based on complex geological environmental studies of pollution of rock, soil, water and problems caused by human activity (land use, mining, groundwater exploitation and civil and industrial construction). Our proposed project is focusing on geoenvironmental complex study on the Tuul and the Kharaa Rivers Basins. The Tuul is the one of the biggest river, running throughout the capital city Ulaanbaatar, and the Kharaa is the main river in the Kharaa River Basin, which is the severely polluted by mining activities in Central Mongolia.

Title	Understanding and Developing Mineral Resources of Mongolia
Project Coordinator	Sereenen J. and Davaa L.
Department / Faculty	Geology and Petroleum Engineering
Summary	In regional geological view, Mongolia plays main role on evolution of Central Asian continent; consequently it is key position of distribution of main mineral commodities and metallogeny of Mineral Resources in Central Asia. Recently many significant mineral deposits were discovered and lots of

	foreign and domestic companies keen to work on mineral resources and mining sector. Mongolia has complex geological setting, and types of mineral deposits are not easily recognized, due to the overlapped geological events. Therefore to understand and develop mineral resources activity in Mongolia require highly educated human resources, various types of high level geological and geophysical analytical tools and equipment and complex interpretation and discussion based on results obtained by analytical works. Nowadays, university level education is mainly based on theoretic knowledge with combination of practical study at private company. Even students could get necessary knowledge of theoretical basis and exploration technique, during last decade field surveys and exploration works have considerably been improved, but understanding ore deposit genesis and its regularity of distribution is still limited. Therefore, it is important that students must involve laboratory analysis to understand how mineral resources formed in the depth of earth and they must care on the exploration procedure in combination with working experience on analytical methods and equipment. Due to the lack of modern, high level analytic equipment, students do not have a chance to know how the high level technologies are applicable for research and development of natural resources. Now, in Mongolia only three foreign companies actively engaged with high level analytical laboratories of mineral resources and almost 80% of exploration companies send samples to them. It means so much money flow is going out from Mongolia. Worst is, these laboratories do not engaged with scientific and research activities. As Mongolia is large country perspective for various natural resources in regional scale, therefore high level systematic research activities and detailed geological investigations are essentially important for better understanding and developing Natural Resources of Mongolia. Consequently, University level cooperation and research projects with universities, as well as famous scientists from developed country as Japan, through international organization like JICA, is very important in order to develop mineral resources, engineering activity.

Attachment 4 Abstract of research profiles, NUM

Title	Knowledge and technology based sustainable use of Mongolian biological resources
Project Coordinator	BATKHUU J.
Department / Faculty	Biology and Biotechnology
Summary	Mongolia is seriously dependent on mining industries. Mining for gold, copper and coal contributes significantly to Mongolia's economy, but mining have many negative side-effects on the biodiversity of the country, including land erosion, desertification, and so on. Mongolian government is working on to switch from brown economics based on mining to green economics based on environmental friendly technologies. To achieve this goal, it is very important to introduce modern technologies including genetic engineering biotechnology and bioengineering for sustainable use of natural resources. National University of Mongolia is heavily dependent on tuition fees of students and such lack of alternative financial source makes it in more vulnerable and uncertain situation. Therefore, we are in a complex plan with the mission to become a world class university by the 2020. According to this plan, our university will establish alternative financial resource based on innovation fund which is invested by royalty and business activities using intellectual properties of the university. Demonstration of this project will promote the business of Mongolian biological resources and also will increase the effectiveness of cooperation between Mongolian and Japanese researchers. The power created by summarizing of great potential of Japanese technology and huge Mongolian biological resources will have significant impact on the development of both countries which are searching new possibilities, and new business space. Also this project will obviously contribute for the new financial source of National University of Mongolia.

Title	Research and development of genetically engineered antibacterial peptides from Mongolian genetic resources
Project Coordinator	Odgerel O.
Department / Faculty	Biology and Biotechnology
Summary	Antibacterial peptides received great attention in last decade due to nature of being a simple, easy to be produced, minimal chance to induce bacterial resistance, improved possibilities to be genetically engineered and ability of digested in human stomach like other proteins. Genetic resources of

	Mongolia are relatively not well studied and its severe climate should makes it more diversified and one of the most attractive biological sources. In the framework of this project, we are aiming to start screen to find peptides from Mongolian plants and microorganisms for their antibacterial activities and genetically engineer peptide sequences of promising peptides to improve their antibacterial properties and heat, ph-resistance. Research outcome is this project is sophisticated knowledge creation of genetic engineering and its derived products, related intellectual properties.

Title	Study on Organic Photovoltaic and Organic Light Emitting devices
Project Coordinator	Munkhbayar G.. and Ganzorig C.
Department / Faculty	Chemistry and Chemical Engineering
Summary	Indium tin oxide (ITO) has properties of high conductivity and transparency in the visible spectral region and it is widely used for applications in photovoltaic (PV) and Organic Light Emitting Devices (OLEDs). While donor-acceptor heterojunction PV with a power conversion efficiency of 0.95% was first reported in 1986 by Tang [1]. Since this report, improvements have been explored by changes of materials selection and properties, the use of efficient photon harvesting architecture, post-production annealing, mixed molecular heterojunction structures, solution-proceed bulk heterojunction PV cells, and the inclusion of interfacial metallic nanoclusters. The work function of ITO is generally not sufficiently large for the contact to be ohmic and so there is a barrier to charge injection. Thus, various surface treatments of ITO have been attempted to change the work function of ITO in order to control the charge injection barrier height reviewed. In our previous study, the effect of various surface treatments and chemical modification is estimated to improve the performance of organic PV cells and OLEDs. In this work, in order to investigate the effect of variously modified ITO/organic interface on the performance of organic PV cells, it was further tune the contact properties of the ITO/organic interface by forming a self-assembled monolayer (SAM) across them with a different dipole moment. By using ITO with SAMs with permanent dipole moment has been developed for tuning the work function of the anode to improve device performances.

Title	Environment Microbiology for Engineering
Project Coordinator	Tumenjargal D.
Department / Faculty	Biology and Biotechnology

Summary	In Mongolia as the following problems effect significantly the quantity and quality of natural resources: impact of global climate change, overexploitation of water resources, diffuse pollution in soil, mining, water supply and waste water treatment in rural and urban areas, protection of ecological functions and nature conservation. We investigate the functioning of natural microbial communities and its expression as vital ecosystem services. In the center of our interest stands the capacity of microorganisms to degrade pollutants and to drive the natural biogeochemical cycles. Our research also serves to provide methods and indicators for environmental protection and the sustainable management of landscapes and to exploit the genetic resources of our landscapes for research and biotechnology. Our main research themes cover: · Structural and functional diversity of microbial communities · Ecology of contaminated environments · Experimental biodiversity research · Microbe-plant interactions · Development of biotechnologies for the restoration and prevention of environmental damage Brief economic and social benefits from Research outcomes: · Of the environmental microbiology research results to use for engineering; bioremediation, and biotreatment · To edify master's and doctoral students

Title	Clean Energy Technology and Carbon Resources conversion
Project Coordinator	Enkhsaruul B.
Department / Faculty	Chemistry and Chemical Engineering
Summary	**Objective** The purpose of this project is to perform the research works of conversion of Mongolian natural carbon resources to synthetic clean fuels, and consequently to study the possibilities of application of clean energy technology in Mongolia. **Economic and social benefits** Our country has a rich source of natural carbon resources – coal and oil shale. They are geologically estimated to be approximately more than 160 and 780 billion tons, respectively. The mined raw coals are directly consumed for electricity production until nowadays. Therefore, an application of raw coal for city energy generation causes drastic air pollution in the large cities of

	Mongolia. On the other hand, all of vehicle liquid fuels are imported from neighboring foreign countries. The liquid fuel dependence on foreign country effects strongly on an economic situation of Mongolia. Therefore, clean fuel (smokeless solid fuel; synthetic liquid and gas fuels) production processes have attracted much interest from the viewpoints of clean energy technological development in our country. As a result of those situations, the Coal Research Center in the National University of Mongolia aims to perform the research works of conversion of Mongolian natural resources to synthetic clean fuels. **Background of this research** ➢ Steam gasification processes of brown coals from the biggest mines (Baganuur and Shivee-ovoo) have been studied in recent years. Syngas production reactivity of brown coal gasification depends strongly on inherent mineral composition and their techno-chemical characteristics. Therefore, it would be desirable and important to study the gasification reactivity of a large number of Mongolian coals with different characteristics systematically. ➢ The low rank brown coals from 12 coal mines are being studied by steam gasification to produce the syngas which will be used further for synthesis of clean liquid and gas fuels. ➢ Dimethyl ether (clean liquid fuel) synthesis has been studied in recent years in our laboratory. Direct catalytic synthesis of DME using a mixture of syngas is studied with a fixed bed reactor system. The binary metal catalyst obtained by a unique precipitation method showed the highest catalytic activity for DME selectivity and yield. ➢ In order to produce efficiently a smokeless solid fuel, Baganuur brown coal has studied by the method of low temperature carbonization. We determined the optimal conditions to prepare the high quality smokeless fuel from Baganuur brown coal in our laboratory.

Title	Development of functional materials based on Mongolian Natural minerals for environmental remediation
Project Coordinator	Sarangerel D
Department / Faculty	Chemistry and Chemical Engineering
Summary	Research background In the framework of this research theme, we had conducted the two main investigations: 1) electrocoagulation; 2) research based on natural minerals such as bentonite, zeolite, activated coal and also nano silver and nano iron for removal of heavy metal such as arsenic and chromium, lead and cadmium and

bacteria.

a) We are carrying out electrocoagulation process for removal of organic and inorganic pollutants from wastewater. Now we are studying electrocoagulation-flotation of industrial wastewater for removal of organic pollutants such as lignin, phenols and organic dyes etc.

   The maximum removal of arsenic taken up by electrocoagulation process was 96.3% at the optimal condition. Electrocoagulation process owns the great benefit which is able to remove both As (III) and As (V) from wastewater without any preliminary treatment of the water sample. Besides by electrocoagulation, the color, turbidity, dissolved solid was decreased distinctly. Many industries are interesting electrocoagulation techniques for wastewater because of its' low cost, no additional reagent, easiness and automation. But still our research results are not sufficient at industrial scale.

b) We are carrying out the research for removal of heavy metals and organic pollutants by using natural adsorbents such as bentonite, zeolite and activated coal. Among the physico-chemical treatment process, adsorption is highly effective, cheap and easy to adapt. Adsorption has been proven to be a successful method for removal of heavy metals from wastewater. Recently we are interesting nano metal based natural adsorbent material for environmental remediation. The nano iron based activates coal was prepared and was studied as an adsorbent material for removal of heavy metals.

Economic and social benefits

We can decide the pollution problems of wastewater and drinking water. We can potentially recover metals and organic compounds from wastewater and reuse of treated effluent. While preparation of functional materials we can use natural minerals in Mongolia as main resources then the technological advantages such as low cost, easy to operate, high efficiency, simple operation manual will arise.

Research objectives

The objective of this study is the development of functional materials for environmental remediation including pilot scale up. The proposal will consist of the five main work packages as following:

1. Synthesis or preparation of functional materials based on natural minerals such as rock-forming minerals, clay minerals, hydroxide, zeolite etc. which can contribute to the solution of environmental pollution.
2. Physical and chemical characterization of the prepared functional materials

	3. Evaluation, parameterization and optimization of experiment for removal of heavy metals and organic pollutants. 4. Remediation of wastewater and soil by adsorption of heavy metals and organic pollutants. 5. Scale up applications and theoretical modeling

Title	Studies on Mine Optimization and Simulation
Project Coordinator	Mend-Amar M.
Department / Faculty	Applied Mathematics
Summary	Optimization as the main part of applied mathematics plays an important role in science and technology. Many engineering and economic problems are formulated as optimization problems. Resource allocation and electric power distribution problems as well as signal processing problems and computer network problems are examples of application of optimization in modern technology. Because of the importance of optimization in technology, it is necessary to develop efficient methods and algorithms for solving optimization problems arising in practice. On the other hand, some practical problems are too complex to model or analyze analytically so that the simulation based optimization approach needs to be considered. It is now widely known that Mongolia has rich mineral deposits. In the subsequent years, it is estimated that Mongolia will rank as one of the top in the world in terms of annual coal and copper production. In the recent future, it is expected that mining sector become the main driving force for Mongolia's economy. However, economic benefits from this sector necessarily depend on how the basic production activity is planned and managed. Our objective is to contribute to the optimal management of mine production and mine site rehabilitation processes. In order to establish this, we plan to do the following research. We will focus on a particular mine and examine its logistics management (both internal and external logistics) and rehabilitation plans, and evaluate it from the perspective of optimization theory and geo-statistics, and formulate these as mathematical problems and solve them. This in turn would improve the management these activities for the mine that we chose, as well as for the other mines with a similar structure. We also plan to develop computer algorithms that solves the kind of problems that we encounter, which can provide methodological tools to develop software that can be used by the mining industry.

Title	Machine translation among agglutinative languages: Mongolian and Japanese

Project Coordinator	Chagnaa A.
Department / Faculty	Information Technology
Summary	Natural language processing (NLP) is becoming more important research field in modern digital society. Especially Machine translation study is becoming emergent because of language divide. We need to access, search, and understand the information written/spoken in multi language environment. The Center for Research on Language Processing (CRLP) was established in 2007 during the implementation of the PAN localization project which was supported by IDRC. It is the first and only research center specialized in NLP in Mongolia. Since its establishment our center has done many projects in the field of Natural Language Processing including Machine translation, speech synthesis and automatic speech recognition. The aim of the joint research will focus on Machine Translation between agglutinative languages, especially between Japanese and Mongolian. CRLP has developed online rule based English-Mongolian Machine translation system. Nagoya university team has developed methods for morphological analysis of Japanese and for Japanese-Uighur translation, which are based on a derivational grammar for Japanese. We propose to extend these researches and apply it between Mongolian and Japanese language pairs first and may extend to other languages such as Korean and Turkish etc. Furthermore it is possible to include speech processing (automatic speech recognition and synthesis) in our research. CRLP has also good co-operations with other leading institutes in this field. One of them is a U-STAR consortium, which is a research collaboration group, first started out in the Asian regions to develop a network-based Speech to Speech Translation system. It has now over 23 member countries and includes over 30 languages. As information communication technology develops, our communication is becoming more natural and language barrier is becoming a key issue. The research outcomes help to overcome the barriers between languages, especially for translating between Mongolian and Japanese. Language barrier causes digital divide which is one of main indices of development of a country. Also automatic speech recognition will bring new era into many sectors in Mongolia.

Attachment 5 Terms of reference (TOR) of program development and support services

This project has very complex and various contents and many of its activities are carried out in relation to Japan. Also it is necessary to carry out the project following the rather complicated guidelines of JICA ODA loan projects. Although carrying out such activities is the responsibility of the PIU of the above, they have no experience of implementing JICA's ODA loan projects of this kind. Therefore, the provision of program development and support services by the external experts is required in order to implement the project reliably and efficiently. The specific services include the two kinds of experts, such as "education and research exchange program development and implementation support experts" and "education and research equipment procurement support experts". The tasks of these experts are as follows.

(2) **Education and Research Exchange Program Development and Implementation support experts**

Service Contents

"Education and Research Exchange Program Development and Implementation support experts" assist PIU to develop the programs, such as Twinning Program, Study Abroad Program for academic staff, Joint Research Program and Kosen Program, and assist implementation of those programs having close coordination with the partner institutions in Japan. The experts should have offices both in Mongolia and in Japan, and provide professional services in the areas where PIU has difficulties or not enough experiences, such as;

1. **Assistance for establishment of project management system**

   In order for the proper management of this project along with the guidelines of JICA Yen Loan project, it is required to establish a firm system of project management at an early stage. The most important thins among those are ① the construction of project implementation system for decision-making of appropriate and timely in each stage of the project and ②the construction of the system makes possible to manage the yen loan funds properly and efficiently. The experts take appropriate advice on these matters.

① Advice on establishment of project implementation organization
- Establishment of steering committee
- Establishment of PIU

② Advice on establishment of a financial system of yen loan funds operation
- Opening Special Accounts for the disbursement and operation of yen loan funds

- Opening of Sub-Special Accounts for efficient funds operation
- Effective remittance system for scholarship and tuition fees payment

2. Assistance for Twinning Program development and implementation

The twinning program in this project is carried out for the purpose of engineering training of human resources at the international level that required by the industry, together with the purpose of improvement of undergraduate education programs by introduction of it. For the development of the program, it is required to coordinate with the partner universities in Japan in addition to the provision of professional services of various types. It is described below more specifically.

① Assistance for program development such as;

- Various activities to increase Japanese partner universities
- Coordination with Japanese partner universities for the twinning program curriculum and syllabus development
- MOU signing with Japanese universities
- Operation of partner universities meeting
- Recruitment and selection of lecturers
- Dispatching lecturers
- Lecturers' settlement in Mongolia
- Purchasing of teaching materials
- Preparation of physical facilities
- Recruitment and selection of students
- Academic evaluation
- Review of Twinning Program Curriculum & Syllabus
- Discussion on MUST curriculum & syllabus improvement
- Determination of equipment procurement list
- University fair for students
- Distribution of recruitment guidelines
- Determination of 1st & 2nd-choice universities of students
- Submission of application and payment of examination fee
- Transfer examination in Mongolia

② Assistance for the activities relating to the study abroad in Japan, such as

- Admission decision
- Admission processing and payment of admission fee
- Student VISA arrangements
- Orientation in Mongolia
- Reception in Japan

- Arrangement of accommodation, public registrations and opening bank account
- Payment of tuition fees
- Payment of living allowances
- Student monitoring and emergency response
- Return preparation

3. Assistance for development and implementation of Study Abroad Program for academic staff

For the purpose of improving education and research capabilities of the faculties, various study abroad programs in Japan for them and its candidates are implemented in this project. The programs are consists of Master's degree program, PhD degree program and Non-degree program. For the development of the programs, it is required to work with universities in Japan in addition to the provision of professional services of various types. It is described below more specifically.

Assistance for the program implementation such as;

- Program announcement and candidate selection
- Matching with and placement to Japanese universities
- Submission of application
- Admission processing and documentation
- Student VISA arrangements
- Orientation in Mongolia
- Reception in Japan
- Accommodation, registrations, opening bank account
- Payment of tuition fees
- Payment of living allowances
- Student monitoring, Emergency response
- Return preparation

4. Assistance for Joint Research Programs development and implementation

For the purpose of upgrading research capabilities of the two universities, the Joint Research Programs are implemented in this project. For the proper implementation of this program, it is required several services provision including coordination with Japanese universities. The details of the services are as follows;

Assistance for the program implementation such as;

- Refinement of Research Profile
- Determining of equipment procurement list
- Matching with partner universities

- Dispatching scholars to Japan
- Receiving Visiting Scholars from Japan
- Periodical update of Research Profile and evaluation of research performances

5. **Assistance for Kosen Programs development and implementation**

For the purpose of development of industrial human resources urgently required by the Mongolian industries, the Kosen Programs are implemented in this project. For the proper development and implementation of this program, it is required several services provision including coordination with Japanese Kosen Institute. The details of the services are as follows;

Assistance for the program implementation such as;

- Discussion with Kosen Institute in Japan for program development and lecturer dispatch
- Recruitment of lecturers
- Dispatching of lecturers
- Lecturers' settlement support in Mongolia
- Purchasing of teaching materials
- Preparation of physical facilities
- Recruitment of students, Selection
- Sit for EJU Exam
- Admission decision
- Admission processing, admission fee
- Student VISA arrangements
- Orientation in Mongolia
- Reception in Japan
- Accommodation, registrations, opening bank account
- Payment of tuition fees
- Payment of living allowances
- Student monitoring, Emergency response
- Return preparation

Qualifications

The experts and their belonging organizations are required to have experiences of relevant project such as; Twinning Program by Yen Loan, Study in Japan Program, Joint Research Program and Equip Procurement, as well as capability to support PIU effectively and efficiently in both of Mongolia and Japan.

Reports Produced

The experts are obligated to submit below listed reports to PIU;

1) Inception Report
2) Monthly Report
3) Quarterly Progress Report
4) Monitoring Report
5) Project Completion Report
6) Other Reports as necessary

(2) **Education and Research Equipment Procurement support experts**

<u>Service Contents</u>

In this engineering service (ES), "Research & Education equipment procurement experts" will perform planning for equipment procurement and building modification, and supervising on equipment installation and facilities modification work. For this project, taking in to consideration that the said two executing organizations plan to strengthen the training and research function through joint research work with Japanese institutes specialists are required to design equipment installation work to install highly precision equipment. Therefore it is desirable to appoint international experts. The equipment procurement work will be divided into three packages. The contents of ES contain detailed design services for equipment procurement stage, installation work, and supervising stage as follows:

Equipment procurement support

- Analysis of related projects and of collected procurement information of research & education equipment,
- Review and finalization of the equipment plan after a series of discussion with PIU members,
- Assistance work for review of the equipment procurement cost estimation,
- Preparation of tender documents including draft Pre-qualification (PQ), and the tender documents (tender announcement, tender instructions, equipmentpecifications, general conditions, provisions and equipment installation plan)
- Equipment inspection including performance inspection, factory inspection, and pre-shipment inspection,
- PQ and evaluation of the PQ,
- Assistance services for tender announcement, tendering, tender evaluation, designation of a prioritized negotiator and recommendation of a successful renderer,
- Supervising including site inspection before installation, and supervising of equipment work, which supplier performs, including equipment delivery, commissioning of equipment in hand-over, test operation, and initial operation instruction,

- Providing of advice in hand-over of the equipmento that end users can perform smooth maintenance service, and inspection and providing of approval on maintenance manuals for both implementation organizations,
- Technical guidance such as preparation of the equipment database including the technical information necessary for equipment maintenance and operative instruction, the development of the periodic inspection repair plan, the development of the maintenance management budget plan, and
- Management during a guarantee period after the equipment work ends.

Qualifications

The equipment experts are required to include one senior expert with job experience of more than 13 years in projects including similar training and research equipment procurement plan and supervising as a senior equipment planner. The experts will be assigned to assist PIU members in preparation for the related documents in tendering, and other related works.

Reports Produced

The experts are to submit the following reports to PIU:

(1) Inception report
(2) Monthly progress report,
(3) Quarterly progress report
(4) Prequalification report (PQ) & Tender documents
(5) PQ evaluation report
(6) Tender evaluation report
(7) Project completion report
(8) Others

Attachment 6-1 List of equipment to be procured (Draft)

School of power engineering, MUST, Educational equipment

Total	¥64,000,000	miscellaneous expense	¥2,040,000	Total of each dep.	¥61,960,000

1) Department: Heat Supply and Automation

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	The equipment for determining of thermo physical characteristcis of solid and fluid materials	1	Japan			¥5,000,000	¥5,000,000
002	The stand for researching the process to evaporate, and to dry a materials	1	Japan			¥5,000,000	¥5,000,000
003	The software for the desing and Feasibilty Study of the air conditioner	1	Japan			¥5,000,000	¥5,000,000
004	F100 Airflow System Base Unit		P.A Hilton Ltd.			¥1,500,000	¥1,500,000
						Sub total	¥16,500,000

2) Department: Automation of Electrical system

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	Microprocessor Trainer Kit based on 8085 Microprocessor	15	Tesca Technologies Pvt.Ltd India	Order code-43204	Students training	¥40,000	¥600,000
002	ATMEG AVR Embedded Trainer	10	Tesca Technologies Pvt.Ltd India	Order code-43504	Students training	¥50,000	¥500,000
003	Device for meansurement of electromagnetic fields	5	Germany	Like MX-3951A	Students training	¥160,000	¥800,000
						Sub total	¥1,900,000

3) Department:Electrical Supply and High Voltage

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	Test equipment for industrial electrical supply	1				¥5,000,000	¥5,000,000
002	Test equipment for city's electrical supply	1				¥6,000,000	¥6,000,000
003	Test equipment for agricultural electrical supply	1				¥5,000,000	¥5,000,000
004	Test equipment for PV generation	1				¥5,000,000	¥5,000,000
005	Wind turbine	1				¥5,000,000	¥5,000,000
006	hydro turbines	1				¥5,000,000	¥5,000,000
						Sub total	¥31,000,000

4) Department: Heat Exchange and Thermodynamic

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	Thermometer	1	Testo	Testo -810-830-905	Student study	¥60,000	¥60,000
002	Marcet Boiler Experiment	1	TecQuipment Ltd,	TD-1006	Student study	¥1,000,000	¥1,000,000
003	Thermo vision display device	1	Testo	Testo 890	Student study	¥1,500,000	¥1,500,000
004	Raytek 3i Handheld Pyrometer	1	Raytek A Fluke Company	Raytek 3i series	Student study	¥600,000	¥6,000,000
005	Automatic Dust Sampler (Isokinetic Sampling Sampling Holder /Nozzle set, Dust Sampling Nozzle set	1	Japan Marunisience	M2-700DS, NG21-120, & NG25-4U	Student study	¥4,000,000	¥4,000,000
						Sub total	¥12,560,000

Attachment 6-2 List of equipment to be procured (Draft)

School of mechanical engineering, MUST, Educational equipment

Total	¥468,000,000	miscellaneous expense	¥17,939,403	Total of each dep.	¥450,060,597

1) Department: Mechatronic

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Advanced electronic system laboratory for Automobile and its ECU /set	1	Dae sung	G-7005	Students training	¥13,700,000	¥13,700,000
002	Oscilloscope Digital /SET	1	WAVERUNNER	WaveRunner 640Zi	for experiment	¥6,300,000	¥6,300,000
003	Actuating systems	1			Students training	¥5,000,000	¥5,000,000
004	Drive technology	1			Students training	¥6,000,000	¥6,000,000
005	Sensors	1			Students training	¥4,000,000	¥4,000,000
006	Softwares	1			Students training	¥5,000,000	¥5,000,000
007	CompactRIO	1	NATIONAL INSTRUMENT	CompactRIO	for experiment, Students training	¥9,000,000	¥9,000,000
008	Intuitive graphical interface of LabVIEW and ready-to-go drivers for sensors	1	NATIONAL INSTRUMENT		for experiment, Students training	¥6,000,000	¥6,000,000
009	Motor tester /power analyzer/	1	M.E.A. Testing Systems Ltd	Motor Testing Equipment for	for experiment, Students training	¥4,000,000	¥4,000,000
010	Motion control for robot technical	1	ED company	ed-vp6	for experiment, Students training	¥9,800,000	¥9,800,000
011-1	Machine vision Gige Camera	2	Photonfocus	MV1-D2048x1088-3D03-760-G2-8	High speed machine vision algorithm development and research for welding inspection	¥400,000	¥400,000
011-2	Close focus lens	1	Edmund optics inc	6x (18 - 108 mm FL) Close Focus Zoom Lens - C-Mount	Close range imaging application	¥49,500	¥49,500
	Wide angle lens	1	Edmund optics inc	6X Manual Zoom Video Lens (8-48 mm FL)	Higher Field of view application	¥49,500	¥49,500
012	Wind generator, DATA logging equipment for measure wind and solar resource / 3phase 380, ACV, 10-20 kBt/	1	Sawt	PK10-AB	3 phase inverter control system, 3 phase generator parallel connection with electric system, 3 phase generator synchron connection with electric system, Wind gear box breaking control system of	¥9,000,000	¥9,000,000
013	Motor Dynamometer	1	M.E.A. Testing Systems Ltd	Hysteresis Brake Dynamometer	for experiment, Students training	¥2,000,000	¥2,000,000
							¥80,299,000

2) Department: Internal combustion engine

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Fuel consumption meter	1	Johsai	high precision Johsai		¥700,000	¥700,000
002	Exhaust Gas Analyzer	1	Horiba	MEXA-7100FX	diesel and gasoline, high	¥7,000,000	¥7,000,000
003	Fuel octane and cetane number detector	1	shatox	Engine fuel anilyzer		¥1,000,000	¥1,000,000
004	spark mounted pressure sensors	8	Kistlers	6117B	with accessories	¥10,000	¥80,000
005	Ultrasonic Exhaust Gas Flowmeter	1	Horiba	EXFM-1000		¥3,800,000	¥3,800,000
006	Engine test stand	1	Horiba	TITAN D460	Include dynamo, engine mounting system, electric	¥7,600,000	¥7,600,000
007	Diesel fuel injection pump and injector test bench	1	ADMTECK	ADM800SEN	common rail, distributor type pump, in line pump test	¥2,000,000	¥2,000,000
008	Portable Leeb Hardness Tester	1	Mitech	MH320		¥200,000	¥200,000
009	Gasoline and Diesel fuel Analyzer	1	GRABNER INSTRUMENTS	MINISCAN IRXpert Gasoline and Diesel Analyzer	Internal combustion engine fuel analyzer	¥1,000,000	¥1,000,000
010	Particulate Mass and Number Measurement	1	Horiba	MEXA-2300SPCS		¥3,900,000	¥3,900,000
011	Engine test bed	1	EdLabQuip	TD 800 Engine Test Bed, Single Cylinder	For testing performance of internal combustion engine	¥5,800,000	¥5,800,000
012	Flammability Test Chamber	1	Hongdu Testing Equipment Co.,	HD-5010		¥1,200,000	¥1,200,000
013	Simulation software	1	ANSYS	ANSYS-FLUENT CFD mode	29,530 euro; plus 5 years * 5,512 annual license	¥7,669,756	¥7,669,756
014	labvew	1	National instrument	NI Developer Suite	plus 5 years SSP membership fee	¥529,900	¥529,900
015	Engine Analyzer Auto Equipment	1	Launch	EA2000	for the test of vehicle engines and electric control system	¥900,000	¥900,000
016	SEM	1	Hitachi	TM 3000		¥5,800,000	¥5,800,000
017	Continuous PM analyzer	1	horiba	MEXA 2300SPCS		¥1,900,000	¥1,900,000
018	cleaning equipment	1	Changsha City Okay Energy Equipment Co., Ltd.	CCS1500	clean carbon deposites from the engine	¥750,000	¥750,000
019	1 kW Newport solar simulator	1	Model No. 91190-1000	(equipped with AM1.5 global, AM1.0 & AM0.0 filters)		¥2,000,000	¥2,000,000
020	Various electrochemical test equipment	1	Scribner Associates Inc.			¥2,500,000	¥2,500,000
021	Universal Auto Diagnostic Equipment	1	Shenzhen OEMScan Technology Co., Ltd.	F3-W	for the test of engine	¥1,350,000	¥1,350,000
022	Assortment of computerized data acquisition and control systems	1 set	National Instruments and other brands		DAQ swiches sensors convertors	¥1,650,000	¥1,650,000
023	Collection of ovens, autoclaves, AC and DC power supplies and analyzers, and assortment of pumps and balances.	1				¥4,230,000	¥4,230,000
024	catalyst characterization instrument	1	Altamira instruments	Altamira AMI 300	capable of TPD, TPR, TPO, and TPRx	¥350,000	¥350,000
025	Moisture Meter	1	Shanghai Total Industrial Co., Ltd.	SR6825P/S/PS,		¥550,000	¥550,000
026	Lab Alliance High Performance Liquid Chromatographic pumps	2			maximum flow rate of 100ml/min at 27.5Mpa.	¥1,350,000	¥2,700,000
027	Three complete thermovolumetric analyzers (TVA)	1			TVAs range in size from 160 mL to 2 L, and are fully automated & operate from a	¥3,690,000	¥3,690,000
028	UV/VIS scanning spectrophotometer	1	Shimadzu	SolidSpec - 3700/3700DUV		¥6,900,000	¥6,900,000
029	IR spectrophotometer	1	Shimadzu	IRAffinity-1 FTIR Spectrometer		¥7,000,000	¥7,000,000
030	Ball mill	1	Fritsch	Fritsch Pulverisette V	capable of monitoring both temperature and pressure during use by way of a data	¥5,000,000	¥5,000,000
031	Spectrometer	1	Perkin-Elmer	Spectrum 100 FTIR	with Universal ATR Accessory	¥160,000	¥160,000
032	Volumetric sorption analyzer	1	Hiden Isochema HTP1-V	Hiden Isochema HTP1-V	(a Sieverts type system – the only unit of its kind in the U.S.) capable of 100 bar/500oC	¥200,000	¥200,000
033	Gas Chromatograph	1	SHIMADZU	GC-14B	with thermal conductive and flame ionization detectors	¥2,598,000	¥2,598,000
						Sub total	¥92,707,656

3) Department: Internal combustion engine

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
1	X-ray Fluorescence Sulphur Analyzer	1	Chongqing Gold Mechanical & Electrical Equipment Co., Ltd.	GD-17040	for Petroleum Products	¥1,650,000	¥1,650,000
2	Metal analyzer	1	Zhuhai Dshing Import&Export Co., Ltd.	MX-1	fluorescence handheld metal analyzer	¥40,000	¥40,000
3	All Purpose Crack Tester	1	Shandong China Coal Industrial & Mining Supplies Group Co., Ltd	ZM-F800		¥180,000	¥180,000
4	Portable Magnetic memory tester	1	EDDYSUN	EMS-2003	Eddy current tester for pipe	¥4,000,000	¥4,000,000
						Sub total	¥5,870,000

4) Department: Vehicle-Auto

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Chassis Dynamometer Test Control System	1	Horiba. Japan	CDTCS-5000		¥21,000,000	¥21,000,000
002	Emissions Chassis Dynamometer	1	Horiba. Japan	VULCAN EMSCD48	Study or experiment	¥16,000,000	¥16,000,000
003	Vehicle Emissions Test Systems	1	Horiba. Japan	VETS ONE		¥11,000,000	¥11,000,000
004	Automatic Driving System	1	Horiba. Japan	ADS-7000		¥950,000	¥950,000
005	Data Interpretation Visualization Analysis Creativity in Post-Processing	1	Horiba. Japan	DIVA		¥3,050,000	¥3,050,000
006	Diesel exhaust gas tester and analyzer. 5 Gas	2	Horiba. Japan	ADEGA01	Study or experiment	¥2,000,000	¥4,000,000
007	Gasoline exhaust gas tester and analyzer. 5 Gas	2	Horiba. Japan	MST-406EN	Study or experiment	¥2,000,000	¥4,000,000
008	Dynamometer for Brake NVH Investigations and Performance Check	1	Horiba. Japan	GIANT 9000	Study or experiment	¥8,000,000	¥8,000,000
009	Constant Volume Sampler	1	Horiba. Japan	CVS-7000	Study or experiment	¥4,000,000	¥4,000,000
010	Fuel Flow Meter	2	Horiba. Japan	FFM-1000	Study or experiment	¥1,450,000	¥2,900,000
011	NO/NOx Measurement System	1	Horiba. Japan	MEXA-1170HCLD	Study or experiment	¥1,000,000	¥1,000,000
012	Motor Exhaust Gas Analyzer	1	Horiba. Japan	MEXA-1170NX	Study or experiment	¥1,200,000	¥1,200,000
013	Real-Time Particle Mass Analyzer	1	Horiba. Japan	MEXA-1230 PM	Study or experiment	¥1,600,000	¥1,600,000
014	Portable Automotive Emission Analyzer	1	Horiba. Japan	MEXA-584L	Study or experiment	¥800,000	¥800,000
015	Lambda - Portable A/F Analyzer	1	Horiba. Japan	MEXA-700	Study or experiment	¥900,000	¥900,000
016	Superior and intelligent controller platform	1	Horiba. Japan	SPARC	Study or experiment	¥2,500,000	¥2,500,000
017	X-ray Analytical Microscope	1	Horiba. Japan	XGT-5200	Study or experiment	¥4,000,000	¥4,000,000
018	Fuel Consumption Measurement System allows measuring fuel mass flow rate continuously	1	Horiba. Japan	Fuel Flow Meter FQ-2200CR	Study or experiment	¥3,500,000	¥3,500,000
019	On Board emission measurement systems	1	Horiba. Japan	MEXA-7000 Version 3	Study or experiment	¥1,555,000	¥1,555,000
020	Durometers for Automotive Interior parts, tires, and elastomeric materials	1	Rex	Rex RX-DD-M Type M Precision Digital Shore Durometer	Study or experiment	¥2,500,000	¥2,500,000
021	Hardness Testers for Automotive Metallic Materials	1		COMPUTEST SC PORTABLE DIGITAL HARDNESS TESTER	Study or experiment	¥2,500,000	¥2,500,000
022	Tire Plunger Testers	1		Tire Plunger Tester		¥4,500,000	¥4,500,000
						Sub total	¥101,455,000

5) Department/school: Vehicle-Traffic

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
Simulation programs							
001-1	Cube Dynamism	1	Citilabs, Inc.	cube 6	For the research work, the joint project and also the master and doctorate students' research.	¥8,000,000	¥8,000,000
001-2	Cube Avenue	1					
001-3	Cube Cluster	1					
						Sub total	¥8,000,000

6) Department: Aerodynamics

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	High speed camera and lens with high speed strobe	1	Photron Limited	FASTCAM,SA3, TYPE 60KM3	Training and research	¥4,600,000	¥4,600,000
002	Hot wire anemometer	1	KANOMAX	IHW-100	Training and research	¥4,300,000	¥4,300,000
003	LDV (Laser Dopper Velocity meter)	1	KANOMAX	LDV set (F=1m)	Training and research	¥7,300,000	¥7,300,000
004	Smoke generator	1	KANOMAX	8304	Training and research	¥1,300,000	¥1,300,000
005	Thermo-camera	1	Mitsubishi and other jananese company		Training and research	¥400,000	¥400,000
006	Accoustic system	1	Mitsubishi and other jananese company	ICVIBA	Training and research	¥1,000,000	¥1,000,000
007	Machine-Center	1	MAKINO	V22Vertical Machining Centers/tools	Training and research	¥20,000,000	¥20,000,000
						Sub total	¥38,900,000

7) Department: Machine building

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Spectrometer for chemical analysis	1	"Shimadzu" company (Japan)		study	¥13,000,000	¥13,000,000
002	Melting induction furnace	1	COM, Co, Ltd		study	¥11,000,000	¥11,000,000
003	Universal hardness tester	1	mitutoyo	SHT-41	study	¥800,000	¥800,000
004	Universal strength testing machine with diagram recorder	1	MTS Systems Corporation	MTS Criterion. Model 44	Universal strength testing machine with diagram recorder	¥7,500,000	¥7,500,000
005	Surface Roughness Tester	1	mitutoyo	Surftest SJ-410	students training	¥1,000,000	¥1,000,000
006	CNC verticals	2	FANUC ROBODRILL	α-D21MiA5	students training	¥8,800,000	¥17,600,000
007	CNC lathes, toolroom lathe (cnc/manual toolroom	2	Haas automaction	TL-3	students training	¥4,300,000	¥8,600,000
008	500W Fiber Laser Metal Cutting Machine	1	GoldenLaser	XJG-130250 DT	students training	¥6,000,000	¥6,000,000
009	CNC plasma machine	1	RUIJIE	RJ 1325	students training	¥1,750,000	¥1,750,000
010	TIG welding set complete 300 Amps. AC/DC with water cooled torch	1	Miller	Dynasty 200	study	¥345,000	¥345,000
011	MIG welding machine	1	Miller	Millermatic® 350P	study	¥450,000	¥450,000
012	SMAW Welding machine	1	Miller	Dialarc® 250 AC/DC	students training	¥450,000	¥450,000
013	Welding simulator	1	123 Certification inc	teachWELD® Welding Simulator	students training	¥10,800,000	¥10,800,000
							¥79,295,000

8) Department: Industral mechanization

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Crane simulator (simulator) PROFESSIONAL	1	Russia	TR3-NC	for students training	¥1,644,994	¥1,644,994
002	Simulators truck crane	1	Russia	STK-4	for students training	¥1,721,508	¥1,721,508
003	Educational stand-simulator "Electrical and Electronic hoisting tower crane"	1	Russia	ESS-EEH	for students training	¥2,677,912	¥2,677,912
004	Laboratory complex "Electronics tower crane"	1	Russia	ETC-6	for students training	¥147,284	¥147,284
005	Laboratory complex "sensors in hoisting"	1	Russia	LCSH-14	for students training	¥131,601	¥131,601
006	Laboratory complex "Safety equipment hoisting"	1	Russia	LCSEH-5	for students training	¥208,495	¥208,495
007	Mechanized model of tower crane with a remote	1	Russia	MMTK-RC	for students training	¥420,808	¥420,808
008	Simulators single-bucket hydraulic excavator	1	Russia	DIGGER ZAXIS240	for students training	¥1,644,994	¥1,644,994
009	Simulators career EKG 8	1	Russia	EKG 8	for students training	¥2,295,344	¥2,295,344
010	Simulators bulldozer	1	Russia	SBS-5	for students training	¥2,104,076	¥2,104,076
011	Stand-plate light dynamic "Attachments bulldozer"	1	Russia	SPLD-07.05.02.1	for students training	¥267,781	¥267,781
012	Engine construction machines such as the A-41 (units in cross section)	1	Russia	ECMS-02.06.05.1	for students training	¥994,644	¥994,644
013	Wire rope tester for cranes	1	China	TCK-BX30/40/55/65	for experiment	¥3,947,500	¥3,947,500
014	Vibrating table	1	China	VT-U68/VT-U88	for students training	¥1,245,000	¥1,245,000
015	Compression testing machine	1	China	SYE-3000	for students training	¥3,786,000	¥3,786,000
016	MF-1200 muffle furnaces	1	China	MF-1200	for students training	¥1,835,000	¥1,835,000
017	Concrete mixers, PM-05	1	China	PM-05	for students training	¥125,000	¥125,000
018	CD-E core drilling machine	1	China	DB40	for students training	¥456,000	¥456,000
019	HT-225V Concrete test hammer	1	China	HT-225V	for students training	¥680,000	¥680,000
020	Electrical machines teaching system	1	China	FH2, FH3, MPM1015	for students training	¥6,250,000	¥6,250,000
021	Stand electric drive of construction machinery	1	Russia	SECM	for students training	¥2,750,000	¥2,750,000
022	Intelligent metal magnetic memory diagnostic	1	Russia	EMS-2000.	for experiment	¥2,450,000	¥2,450,000
023	Non destructive testing of metal construction	1	Russia	NDT-VM	for experiment	¥3,150,000	¥3,150,000
024	Handheld hydraulic test systems /Flow-Pressure-Temperatory-Speed-Analogue inputs/	1	USA	HPM Series-Webtec	for experiment	¥1,600,000	¥1,600,000
							¥42,533,941

9) Department: Logistics and Transport Management

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Logistics programs	10				¥100,000	¥1,000,000
						Sub total	¥1,000,000

Attachment 6-3 List of equipment to be procured (Draft)

School of civil engineering and architecture, MUST, Educational equipment

Total	¥302,000,000	miscellaneous expense	¥11,012,838	Total of each dep.	¥290,987,152

1) Department: Department: Architecture Laboratory

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Desktop Computer	1	Dell	Core i7	for students of dual degree training program	¥200,000	¥200,000
002	Desktop Computer	3	Dell	Core i5		¥150,000	¥450,000
003	Monitor	4	Dell	S2440L 27" LED		¥37,000	¥148,000
004	Wireless Router	1	TP-Link	TL-WR series		¥6,000	¥6,000
005	A1 Plotter	1	HP	Designjet T790	Study for students training	¥430,000	¥430,000
006	3D Printer	1	Cubify 3DSystems	Cube X Trio		¥440,000	¥440,000
007	Digital photo camera	1	Canon	7D		¥160,000	¥160,000
008	Multi Function Meter	5	Testo	435-4		¥150,000	¥750,000
009	Thermal Imager	1	Testo	875-1		¥250,000	¥250,000
						Sub total	¥2,834,000

2) Department: Structural Diagnosis & Testing Laboratory

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	High speed Digital Dynamic Strainmeter	1	Tokyo Sokki	DRC-3410	building	¥5,209,588	¥5,209,588
002	Cable interconnection Unit	10	-ditto-	B-723	-ditto-	¥160,295	¥1,602,950
003	Bridge box	3	-ditto-	SB-120SB-10	-ditto-	¥340,627	¥1,021,881
004	Histogram recorder System	4	-ditto-	TMR-211	-ditto-	¥420,774	¥1,683,096
005		4	-ditto-	TMR-281	-ditto-	¥130,240	¥520,960
006		4	-ditto-	TMR-221	-ditto-	¥430,793	¥1,723,172
007		4	-ditto-	TMR-211-01	-ditto-	¥420,774	¥1,683,096
008	Histogram Measurement software	1	-ditto-	TMR-7630-H	-ditto-	¥295,544	¥295,544
009	Data logger	1	-ditto-	TDS-630	-ditto-	¥1,883,467	¥1,883,467
010	High speed switching box	1	-ditto-	IHW-50H-05	-ditto-	¥1,783,282	¥1,783,282
011	Data logger used with static measurement software	1	-ditto-	TDS-7130	-ditto-	¥360,664	¥360,664
012	Automatic calibrator	1	-ditto-	CBM-123A	-ditto-	¥198,365	¥198,365
013	Automatic calibrator	1	-ditto-	CBM-352A	-ditto-	¥198,365	¥198,365
014	Acceleration transducer	20	-ditto-	ARJ-2000A	-ditto-	¥49,090	¥981,800
015	Load cell	3	-ditto-	CLJ-10MNB	-ditto-	¥1,703,135	¥5,109,405
016	Shaking table /related accessory such as software,	1	-ditto-	-	-ditto-	¥15,000,000	¥15,000,000
017	Reaction wall	1	-ditto-	-	-ditto-	¥8,000,000	¥8,000,000
018	Wind tunnel	1	-ditto-	-	-ditto-	¥8,000,000	¥8,000,000
019	Micro tremor	6	-ditto-	-	-ditto-	¥3,500,000	¥21,000,000
						Sub total	¥76,255,635

3) Department: Soil Mechanics Lab

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Direct shear testing mashine	2	Humboldt Mfg. Co. USA	HM-2560A.3F; Humboldt	Study for students training to increase nos.	¥1,200,000	¥2,400,000
002	Automated consolidation System -Oedometer	2	-ditto-	HM-2470A.3F; Humboldt	-ditto-	¥760,000	¥1,520,000
003	Automated sieve set for particle size analysis	1	Japan or USA	Humboldt	-ditto-	¥350,000	¥350,000
004	Soil Volume Change Meter (PVC)	1	Humboldt Mfg. Co. USA	HM-2415	-ditto-	¥800,000	¥800,000
005	Basic Swell/Expansion Consolidometers	1	-ditto-	HM-1972-1D	-ditto-	¥800,000	¥800,000
006	Automatic Triaxial Compression Apparatus for Soil "HI-MULTI"	1	Marui&Co.Ltd Japan	MIS-235-1-76	new equipment to carry out additional	¥3,500,000	¥3,500,000
007	Automatic Mechanical Compactor	2	Humboldt Mfg. Co. USA	H-4169 Modified Proctor, 6"	-ditto-	¥450,000	¥900,000
008	Laboratory Ovens	1	Japan or USA	Humboldt	-ditto-	¥830,000	¥830,000
009	Power Mechnical Earth Drill	1	Humboldt Mfg. Co. USA	H-4050 Humboldt	-ditto-	¥600,000	¥600,000
010	Portable Bearing Tester " CASPFOL "	1	Marui & Co.Ltd Japan	MIS-244-0-62	-ditto-	¥500,000	¥500,000
011	Swedish Weight Sounding Apparatus Electric Power Driver	1	-ditto-	MIS-248-1-02/21	-ditto-	¥800,000	¥800,000
						Sub total	¥13,000,000

4) Department: Road Material Testing Laboratory

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Asphalt thickness measuring device (E-spott)	1	Cooper, UK	E-Spott	2+2 progam and basic	¥2,010,000	¥2,010,000
002	Laboratory mixer for preparation asphalt mixtures (Single Pugmill Mixer)	1	PTI,USA	Single Pugmill Mixer	new eguipment to carry out additional training programme	¥7,650,000	¥7,650,000
003	Universal Testing Machine	1	PTI,USA		-ditto-	¥16,500,000	¥16,500,000
004	Laboratory Roller Sector Compactor	1	Infratest, Germany	20-4030 Roller Sector Compactor	-ditto-	¥6,500,000	¥6,500,000
005	Deflectometers	1	Controls	58-C0223	-ditto-	¥59,895	¥59,895
006	AUTOMAX, Super- Automatic EN testers for cubes,	1	-ditto-	EN 12390-4	-ditto-	¥1,300,000	¥1,300,000
007	Electric poker vibrator	1	-ditto-	55-C0162/E	-ditto-	¥44,145	¥44,145
008	Chloride field test set	1	-ditto-	58-E0064	-ditto-	¥291,870	¥291,870
009	Cor Map apparatus for rebar corrosion location	1	-ditto-	58-E0065/A	-ditto-	¥113,400	¥113,400
010	Covermeter, Bartracker	1	-ditto-	58-E6102	-ditto-	¥20,380	¥20,380
011	Oxigen permeameter. Cembureau method	1	-ditto-	58-E0031	-ditto-	¥626,850	¥626,850
012	Carbonation test set	1	-ditto-	1 58-E0063	-ditto-	¥5,877	¥5,877
						Sub total	¥35,122,417

5) Department: Hydraulic pump station

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Universal Dynamometer	1	-	MFP100	new equipment for student treaning	¥344,344	¥344,344
002	Centre of Pressure	1	-	H11	replace obsolete with new equipment	¥70,949	¥70,949
003	Pelton Turbine	1	-	H19	new equipment for student treaning	¥146,835	¥146,835
004	Hydraulic Ram Pump	1	-	H31	-ditto-	¥243,250	¥243,250
005	Jet Trajectory and Flow Through an Orifice	1	-	H33	-ditto-	¥196,046	¥196,046
006	Fluid Friction Apparatus	1	-	H408	additional treaning programme	¥736,525	¥736,525
007	Centrifugal Pump Module	1	-	MFP101/A,B,C,D/	replace obsolete with new	¥1,127,113	¥1,127,113
008	VDAS	1	-	VDAS/software/	using for students laboratory	¥85,502	¥85,502
						Sub total	¥2,950,564

6) Department: Laboratory for Building Physics and Air study, Environmental Engineering Department

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Fluegas dust meter including optional assessiors	1	Woehler	SM500	study	¥1,450,000	¥1,450,000
002	Blower check with assessiors	1	Woehler	BC21	study	¥520,000	¥520,000
003	Klima set	4	Woehler	KM410	experiment for students training	¥48,900	¥195,600
004	Aerosol monitor with enclosure	1	TSI	DustTrak 5830	study	¥2,069,000	¥2,069,000
005	Air handling unit	1	VTS	Ventus VS15 AHU	experiment for students training	¥3,500,000	¥3,500,000
006	Water heating system	1	KOSPEL,	KOSPEL 15kW and other equipments	experiment for students training	¥1,400,000	¥1,400,000
007	Solar hot water system	1	HAIER	Solar water heating system	experiment for students training	¥1,900,000	¥1,900,000
						Sub total	¥11,034,600

7) Department:Structural Analysis And CAD laboratory

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	High performance computers	2	Dell	dell precision T5600	for students of dual degree training program & research study	¥546,270	¥1,092,540
002	High performance computers	14	Dell	new XPS 8700	-ditto-	¥99,999	¥1,399,986
003	LUSAS Civil & Structural Plus	1	LUSAS	-	-ditto-	¥150,000	¥150,000
004	SAP2000	1	CSI	SAP 2000 15V	-ditto-	¥103,000	¥103,000
005	Autodesk Revit Structure 2014	1	Autodesk	2014	-ditto-	¥510,000	¥510,000
006	Autodesk Revit Architecture 2014	1	Autodesk	2014	-ditto-	¥510,000	¥510,000
007	Autodesk Revit MEP 2014	1	Autodesk	2014	-ditto-	¥510,000	¥510,000
008	GEO5 – geotechnical software	1	FINE	GEO5 – geotechnical software	-ditto-	¥1,546,000	¥1,546,000
						Sub total	¥5,821,526

8) Department: Testing Laboratory of Construction Materials

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Curing Tank, Steel, Length 8t(SP) (3'x2'x8')	1	Marui	MIT-600-0-11	for students of dual degree training program & research study	¥3,808,459	¥3,808,459
002	Production Cylinder end grinder 220V 50Hz	1	Kansaikiki	KC-2281C	-ditto-	¥3,676,433	¥3,676,433
003	Concrete Air Meters	3	Marui	MIC-138-0-02	-ditto-	¥1,188,239	¥3,564,717
004	Volumetair Air Meters	3	-ditto-	MIC-313-0-01	-ditto-	¥558,574	¥1,675,722
005	Masonry Saw	1	-ditto-	NIC-194-0-08	-ditto-	¥6,398,212	¥6,398,212
006	Dyna Z pull -off tester, 3600Lbf (16kN)	1	A&D	3600Lbf (16kN)	-ditto-	¥3,000,000	¥3,000,000
007	Cement Autoclave	1	YMT	SN510	-ditto-	¥1,939,775	¥1,939,775
008	Cement Calorimeter	1	Kansaikiki	KC-39	-ditto-	¥5,281,064	¥5,281,064
009	Steam curing chamber	1	Marui	MIT-631-3-09	-ditto-	¥12,187,071	¥12,187,071
010	Oven /1800^{0}C/	1	Advantec	FUU812PB	-ditto-	¥9,952,775	¥9,952,775
011	Photon correlation spectroscopy	1	SMD	IRTracer-100	-ditto-	¥33,000,000	¥33,000,000
012	Intelligent X-ray diffraction system (Rigaku)	1	-ditto-	XRD-6100	-ditto-	¥42,000,000	¥42,000,000
013	TGA analyzer	1	-ditto-	TMA-60	-ditto-	¥9,000,000	¥9,000,000
014	Young's Modules Rigidity Meter (PC auto-scan type)	1	Marui	MIN-011-0-09	-ditto-	¥5,484,182	¥5,484,182
						Sub total	¥140,968,410

9) Department: Engineering Drawing

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	High performance computers	15	Dell	20 XPS Intel I7 Quad Core	training program & research study	¥200,000	¥3,000,000
						Sub total	¥3,000,000

Attachment 6-4 List of equipment to be procured (Draft)

NUM, Research equipment

Total	¥288,000,000	miscellaneous expense	¥10,505,100	Total of each dep.	¥277,494,900

① Project title: Knowledge and technology based sustainable use of Mongolian biological resources
Department/School: Interdisciplinary Project with BBTS&CCES/Biology and Biotechnology

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	Biotron	1			To cultivate transgenic plants	¥3,000,000	¥3,000,000
002	LC-MS	1			To isolate and identify active compounds	¥20,000,000	¥20,000,000
003	Bioshaker	1			Carry out suspension culture	¥280,000	¥280,000
004	Macro- and micro-refrigerated centrifuges	1			To isolate genes	¥1,800,000	¥1,800,000
005	Spectrophotometer	1			Cell imaging	¥400,000	¥400,000
007	Microtome, mini-water bath, slide oven (set)	1			To prepare tissue slide for RNA or protein expression	¥800,000	¥800,000
008	Immuno-Electron microscope	1			To capture immune-histochemistry or in-situ	¥15,000,000	¥15,000,000
009	Confocal microscope	1			To capture cell imaging, protein expression and	¥25,000,000	¥25,000,000
010	Upright microscope	1			Electrophoresis and WB-documentation	¥2,000,000	¥2,000,000
						Sub total	¥68,280,000

②Project title: Research and development of genetically engineered antibacterial peptides from Mongolian genetic resources
Department/School: Genetic Engineering/Biology and Biotechnology

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	Refrigerated centrifuges	1			Molecular biological experiments	¥1,000,000	¥1,000,000
002	Ultra low temperature freezer	1			Store of biological samples	¥1,800,000	¥1,800,000
003	Ultra pure water purification system	1			Molecular biological experiments	¥600,000	¥600,000
004	Fluorescence upright microscope	1			Imaging cells and tissues	¥2,500,000	¥2,500,000
005	Laminar box	1			Cell culture works	¥700,000	¥700,000
006	Incubators	1			Cell cultures and staining	¥650,000	¥650,000
007	Thermo shakers	1			Molecular biology and biochemistry experiments	¥150,000	¥150,000
008	Stereo microscope	1			Embryonic manipulation	¥800,000	¥800,000
009	Warm plate	1			Embryonic manipulation	¥300,000	¥300,000
010	Microscope camera	1			Imaging micrographs	¥150,000	¥150,000
011	Liquid nitrogen generators	1			Fueling liquid nitrogen stores	¥3,500,000	¥3,500,000
012	High pressure liquid chromatography (HPLC)	1			Purification of macromolecules (peptides)	¥5,000,000	¥5,000,000
						Sub total	¥17,150,000

③Study on Organic Photovoltaic and Organic Light Emitting Devices
Department/School: Chemical Technology

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	Solar Simulator	1	-	-	study (Solar Simulators are used to simulate "real" solar radiation conditions and are widely used for the photovoltaic device research and QA etc)	¥2,000,000	¥2,000,000
002	Sputtering Apparatus	1	-	-	Applicable to lithium ion battery lab research and Supply more bigger Inert gas environment work space	¥5,000,000	¥5,000,000
003	Glove Box	1	TOB	New	To provide full asistance in all PVD area and raw materials & spare parts as required	¥1,500,000	¥1,500,000
004	Deposition Systems	1	Yuxiang	Deposition System	Most efficient system for parylene coating and Low energy cost	¥2,000,000	¥2,000,000
005	I-V-L curve measurement	1	Gyeonggi-do South Korea	M6100	for Parametric Analysis of Nonlinear and I-V-L Measurement of Display Devices	¥6,000,000	¥6,000,000
006	Liquid Nitrogen Distillator	1			for experiment	¥2,500,000	¥2,500,000
007	Spin Coater with Glove Box	1	Tianjin	GP-2000	easy to operate and detection and vacuum pump with PLC	¥6,000,000	¥6,000,000
008	Photoluminescence Spectrophotometer	1	Beijing China (Mainland)	ZLX-PL	Accurate analysis, Stable performance, High speed measurment	¥6,000,000	¥6,000,000
009	Contact Angle Measurement	1	Beijing China (Mainland)	JYSP-360	Liquid drop, Solid surface energy, pendant drop and PC controlled	¥1,000,000	¥1,000,000
010	Transient current and Photoluminescence Measurement	1	Hubei China (Mainland)	GTM-B-F/GTM-5A-F	for electrical performance auto test and result record of solar Mono-Si ,Poly-Si or A-Si cell module	¥1,500,000	¥1,500,000
011	Oscilloscopes (400-500MHz)	1	Guangdong China (Mainland)	MSO8202T	for all kinds of electronic products testing.	¥150,000	¥150,000
012	UV-Vis Spectrophotometer	1	Jinan	UV-5200	to directly display wavelength, transmittance, absorbance, purity and standard curve.	¥1,000,000	¥1,000,000
013	Infra-red Spectrometer	1	China (Mainland)	FTIR-850	for analysis in petroleum chemical industry, organic polymer chemistry, medicine, food analysis and new technology filed.	¥6,000,000	¥6,000,000
014	Thickness meter	1	Liaoning China (Mainland)	MT160	to measure thickness	¥250,000	¥250,000
						Sub total	¥40,900,000

④Project title: Environmental microbiology for engineering
Department/School: Microbiology/Biology and Biotechnology

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	Deep freezer	1	Sanyo	MDF	To keep biological samples	¥1,800,000	¥1,800,000
002	Freeze dryer	1			To keep biological components	¥2,950,000	¥2,950,000
003	Steam water distiller	1			To remove impurities	¥150,000	¥150,000
004	Phasecontrast microscope	1			To observe and identify biological samples	¥339,900	¥339,900
005	Portable water testing kit	1			To analyze drinking, recreational and waste water to monitor water quality and environmental factors.	¥500,000	¥500,000
006	Automated identification system for general	1			Automatic identification	¥1,200,000	¥1,200,000
007	Air sampler	1			Bacteria, yeast and mold sampling in the air	¥470,000	¥470,000
008	Incubator	1			To grow and maintain microbiological cultures or	¥320,000	¥320,000
009	Centrifuge	1			To separate biological substances	¥500,000	¥500,000
010	Microplate reader	1			To measure DNA, GFP etc.	¥1,200,000	¥1,200,000
						Sub total	¥9,429,900

⑤Project title: Clean energy technology and carbon resource conversion
Department/School: Organic Chemistry/Chemistry and Chemical Engineering

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	TGA equipment	1	Japan/USA		Conversion reaction	¥5,800,000	¥5,800,000
002	XRD (X ray diffractometer)	1	Japan	XRD-6100	Analysis of catalyst	¥22,000,000	¥22,000,000
003	S analysis equipment	1	Japan/China		Analysis of fossil fuels	¥500,000	¥500,000
004	Gas phase reaction	100	USA		Conversion reaction	¥10,000	¥1,000,000
005	Infrared image furnace	2	Japan/USA		Conversion reaction	¥500,000	¥1,000,000
006	Micro gas chromatograph	1	USA		Analysis of gas products	¥3,000,000	¥3,000,000
007	High pressure autoclave reactor	1	any		Conversion reaction	¥5,000,000	¥5,000,000
008	TPR equipment	1	Japan/USA		Analysis of catalyst	¥1,000,000	¥1,000,000
009	Solid sample crusher & pulverizer	1	China		Sample preparation	¥300,000	¥300,000
010	*(Glass & quartz) maker*				engineering support		¥0
011	*(Stainless materials and tools) maker*				engineering support		¥0
012	*High tech maintenance operator*				engineering support		¥0
						Sub total	¥39,600,000

⑥Project title: Study on Photovoltaic system and Solar Resource in Mongolia
Department/School: Renewable Energy Lab, Department of Application Physics/Physics and Electronics

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	First class pyranometer	3	Eko Instrument, Japan	MS802	study	¥260,000	¥780,000
002	First class pyranometer	2	Hukseflux, Netherlands	DR01-05	study	¥250,000	¥500,000
003	Sun Tracker	2	Eko Instrument, Japan	STR-22G	study	¥1,300,000	¥2,600,000
004	I-V Curve Tracer	1	Eko Instrument, Japan	MP-160	study	¥2,500,000	¥2,500,000
005	PV module selector	1	Eko Instrument, Japan	MI-520	study	¥680,000	¥680,000
006	TC selector	1	Eko Instrument, Japan	MI-540	study	¥640,000	¥640,000
007	I-V curve Tracer/ Portable type	1	Kernel, Japan	PVA1I270	study	¥1,800,000	¥1,800,000
						Sub total	¥9,500,000

⑦Project title: Development of functional materials based on Mongolian natural minerals for environmental remediation
Department/School: Inorganic Chemistry/Chemistry and Chemical Engineering

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	Adsorption reactor	1			To carry out adsorption experiments in pilot scale	¥20,000,000	¥20,000,000
002	XRD (X-ray diffractometer)	1		XRD-6100	To carry out mineral analysis	¥22,000,000	¥22,000,000
003	X-ray fluorescent spectrometer	1			To carry out elemental/chemical analysis	¥3,000,000	¥3,000,000
						Sub total	¥45,000,000

⑧Project title: Floating point arithmetic processor
Department/School: Electronics/Information Technology

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	High capacity personal computer	10			Mapping, data analyses and modeling	¥180,000	¥1,800,000
002	Urban design and architectural software	10			Mapping, data analyses and modeling	¥50,000	¥500,000
						Sub total	¥2,300,000

⑨Project title: Studies on Mine Optimization and Simulation
Department/School: Applied Mathematics/Mathematics and Computer Science

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	Desktop PC	25			study	¥300,000	¥7,500,000
002	LCD monitor	25			study	¥100,000	¥2,500,000
003	Wireless LAN card	25			study	¥10,000	¥250,000
004	Optical mouse	75			study	¥5,000	¥375,000
005	UPS for PC	25			study	¥300,000	¥7,500,000
006	Wireless LAN access point	5			study	¥50,000	¥250,000
007	LCD Display	1			study	¥330,000	¥330,000
008	Large format printer	1	(HP Designjet)		study	¥350,000	¥350,000
009	Color laser printer	1	HP Laserjet		study	¥300,000	¥300,000
						Sub total	¥19,355,000

⑩Study on Machine translation among agglutinative languages: Mongolian and Japanese

Department/School: School of Information Technology

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total amount
001	High performance personal computer	10	Apple		To train language models and to load with heavy calculations.	¥480,000	¥4,800,000
002	Server	3			Data accumulation	¥500,000	¥1,500,000
003	Router	1			Data packet forwarding	¥30,000	¥30,000
004	Large format printer	1	HP Designjet		Software development	¥350,000	¥350,000
005	UPS for PC	10			Software development	¥300,000	¥3,000,000
006	Software, dictionaries & others	10			Software development	¥1,000,000	¥10,000,000
007	Programming software	10			Software development	¥300,000	¥3,000,000
008	High quality speech recording studio	1			To collect speech data, speech corpus	¥3,000,000	¥3,000,000
009	Color laser printer	1	HP Laserjet		Software development	¥300,000	¥300,000
						Sub total	¥25,980,000

Attachment 6-5 List of equipment to be procured (Draft)

MUST, Research equipment

Total	**¥478,000,000**	miscellaneous expense	¥17,780,000	Total of each dep.	¥460,220,000

A) Mechanical Engineering

1) Department: Mechanical & Aerodynamics/Mechanical Engineering

Project title: Sky Infra Project in Mongolia

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Turbojet engine	1	Honda Aerospace		Aircraft jet engine's Lab	¥30,000,000	¥30,000,000
002	Wind Tunnel with PIB	1			Aerodynamics Lab	¥25,000,000	¥25,000,000
003	Turboshaft engine	1	Honda Aerospace		Aircraft jet engine's Lab	¥30,000,000	¥30,000,000
004	Structure	1			Aircraft structure lab	¥15,000,000	¥15,000,000
005	NC (Numerical Control)	1	Makino		Aircraft jet engine's Lab	¥20,000,000	¥20,000,000
						Sub total	¥120,000,000

2) Department: Machine Building/Mechanical Engineering

Project title: Research on material which based on Powder metallurgy and Nano technology

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Vacuum oven	1				¥6,000,000	¥6,000,000
002	SEM (Scanning electron microscopy)	1				¥25,500,000	¥25,500,000
003	Advanced etching machine	1				¥500,000	¥500,000
004	Thermal evaporator	1				¥130,000	¥130,000
005	Metal spinning machine	1				¥1,500,000	¥1,500,000
006	Metal spectrometer machine	1				¥4,500,000	¥4,500,000
007	Powder metallurgy mixing machine	1				¥400,000	¥400,000
008	High energy ball milling machine	1				¥320,000	¥320,000
009	Sintering furnace	1				¥5,500,000	¥5,500,000
010	Plating and coating machine	1				¥700,000	¥700,000
011	Advanced hardness tester	1				¥500,000	¥500,000
012	Advanced hardness tester	1				¥200,000	¥200,000
013	Heat treatment furnace	1				¥5,000,000	¥5,000,000
014	X-ray diffractometer	1				¥1,500,000	¥1,500,000
015	chemical analysis test sieve machine	1				¥600,000	¥600,000
016	Optical microscope	1				¥350,000	¥350,000
						Sub total	¥53,200,000

B) Civil Engineering & Architecture

1) Department: Civil Engineering/CEAS

Project title: Study of Binder and Asphalt Designs for the Cold Region

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Automatic laboratory mixer	1			For preparing asphalt mixture	¥200,000	¥200,000
002	Breaking point apparatus	1			for testing bituminous material	¥200,000	¥200,000
003	Set equipments for preparing asphalt mixture	1			For preparing asphalt mixture	¥1,000,000	¥1,000,000
004	Set equipments for testing asphalt mix design	1			For preparing asphalt mixture	¥1,000,000	¥1,000,000
005	Laboratory for asphalt binder and asphalt concrete	1			For testing asphalt mixture and mix design	¥1,000,000	¥1,000,000
006	Wheel Trackers	1			For testing asphalt concrete sample	¥1,000,000	¥1,000,000
007	Falling-Weight-Deflectometer measurement	1			For field testing	¥1,000,000	¥1,000,000
008	Bump integrator	1			For field measurement of roughness IRI	¥1,000,000	¥1,000,000
						Sub total	¥6,400,000

2) Department: Construction materials/CEAS

Project title: Utilizaiton of Mongolian Fly Ash in Construction Industry for Greener Future

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Cement Autoclave	1			For cement test	¥2,000,000	¥2,000,000
002	Blaine air permeability apparatus	1			For cement test	¥2,000,000	¥2,000,000
003	Cement calorimeter	1			For cement test	¥2,000,000	¥2,000,000
004	Reaction Container	1			For cement test	¥2,000,000	¥2,000,000
005	Block and prism compression Machines	1			For concrete test	¥2,000,000	¥2,000,000
006	Electron-microscope investigation	1			for determination of structural compositions of	¥2,000,000	¥2,000,000
007	Photon correlation spectroscopy	1				¥2,000,000	¥2,000,000
008	X-ray powder diffractometer	1				¥2,000,000	¥2,000,000
009	TGA analyzer	1				¥32,000,000	¥32,000,000
010	ASTM unit weight Measures	1			For concrete test	¥2,000,000	¥2,000,000
011	Concrete beam tester	1			For concrete test	¥2,000,000	¥2,000,000
012	Concrete beam forms	1			For concrete test	¥2,000,000	¥2,000,000
013	Masonry saw and blade	1			For concrete test	¥2,000,000	¥2,000,000
						Sub total	¥56,000,000

C) Power Engineering

1) Department: Automation of Electrical System/Power Engineering

Project title: The Research for Electromagnetic Influence in the Energy System

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Electromagnetic current meter (laboratory)	2				¥3,000,000	¥6,000,000
002	Centrifugal Pump 300 liter/min	2				¥1,200,000	¥2,400,000
003	Software Package	1				¥5,500,000	¥5,500,000
004	Underwater Digital Camera	1				¥200,000	¥200,000
005	Desktop PC	1				¥250,000	¥250,000
006	UPS	1				¥300,000	¥300,000
007	Laptop PC	1				¥250,000	¥250,000
008	LCD Projector	1				¥250,000	¥250,000
						Sub total	¥15,150,000

2) Department: Electrical Supply and High Voltage/Power Engineering

Project title: New Laboratory for Electrical Supply and High Voltage Testing and Fault Detecting

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Printed Circuit boards Prototyping and Through-hole Plating Line	1	MITS Electronics	Auto lab 100 with optional equipment	study	¥5,200,000	¥5,200,000
002	Electronics laboratories-1	5	Zhejiang Tianhuang		study	¥80,000	¥400,000
003	Electronics laboratories-2	5	-ditto-		study	¥80,000	¥400,000
004	Electronics laboratories-3	5	-ditto-		study	¥40,000	¥200,000
005	Electronics laboratories-4	5	-ditto-		study	¥40,000	¥200,000
006	Electronics laboratories-5	5	-ditto-		study	¥70,000	¥350,000
007	Electronics laboratories-6	5	-ditto-		study	¥40,000	¥200,000
008	Electronics laboratories-7	5	-ditto-		study	¥40,000	¥200,000
009	Electronics laboratories-8	5	-ditto-		study	¥40,000	¥200,000
010	Electronics laboratories-9	5	-ditto-		study	¥40,000	¥200,000
011	Electronics laboratories-10	5	-ditto-		study	¥40,000	¥200,000
012	Electronics laboratories-11	5	-ditto-		study	¥40,000	¥200,000
013	Electronics laboratories-12	5	-ditto-		study	¥40,000	¥200,000
014	Electronics laboratories-13	5	-ditto-		study	¥40,000	¥200,000
015	Electronics laboratories-14	5	-ditto-		study	¥40,000	¥200,000
016	Electronics laboratories-15	5	-ditto-		study	¥80,000	¥400,000
017	Electronics laboratories-16	5	-ditto-		study	¥80,000	¥400,000
018	Electronics laboratories-17	5	-ditto-		study	¥80,000	¥400,000
019	Electronics laboratories-18	5	-ditto-		study	¥40,000	¥200,000
						Sub total	¥9,950,000

D) Food Engineering

1) Department: Food Engineering/Food Engineering and Biotechnology

Project title: Rheology of Food Products /Mongolian traditional food

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Capillary Rheometers	1			measures the rheological behavior of composites under processing conditions	¥1,500,000	¥1,500,000
002	MCR Rheometer	1			Is a laboratory device used to measure the way in which a liquid, suspension or slurry flows in response to applied forces.	¥1,500,000	¥1,500,000
003	TA.XT Plus Texture	1			It measures texture and quantifies the hardness, brittleness, fracturability, adhesiveness, stiffness, elasticity, Bloom strength, etc. of foods, cosmetics, pharmaceuticals, gels, adhesives, and other chemical products.	¥1,500,000	¥1,500,000
004	Penetrometer	1			a device to test the strength of a material such as Food products	¥5,000	¥5,000
005	Valorigraf	1			Unit to compare the effect of pin and Z-arm-type mixing actions on mixing properties of wheat flour dough	¥5,000	¥5,000
006	Viscometer /Viscosimeter/	1			is an instrument used to measure the viscosity of a fluid	¥5,000	¥5,000
007	Plastometer	1			a tool used to determine the flow properties of plastic materia	¥5,000	¥5,000
						Sub total	¥4,520,000

2) Department: Food preparation and Nutrition/Food engineering and biotechnology

Project title: Comparative study of drying methods for some traditional Mongolian food

No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Spray dryer	1			Drying food	¥1,500,000	¥1,500,000
002	Hybrid dryer	1			Drying food	¥1,500,000	¥1,500,000
003	Color analyzer	1			Determine colors	¥1,500,000	¥1,500,000
004	Texture analyzer	1			Texture analysis	¥1,500,000	¥1,500,000
						Sub total	¥6,000,000

E) Geology and Petroleum Engineering

1) Department: Mineral Exploration/Geology and Petroleum Engineering

Project title: Understanding and Developing Mineral Resources of Mongolia

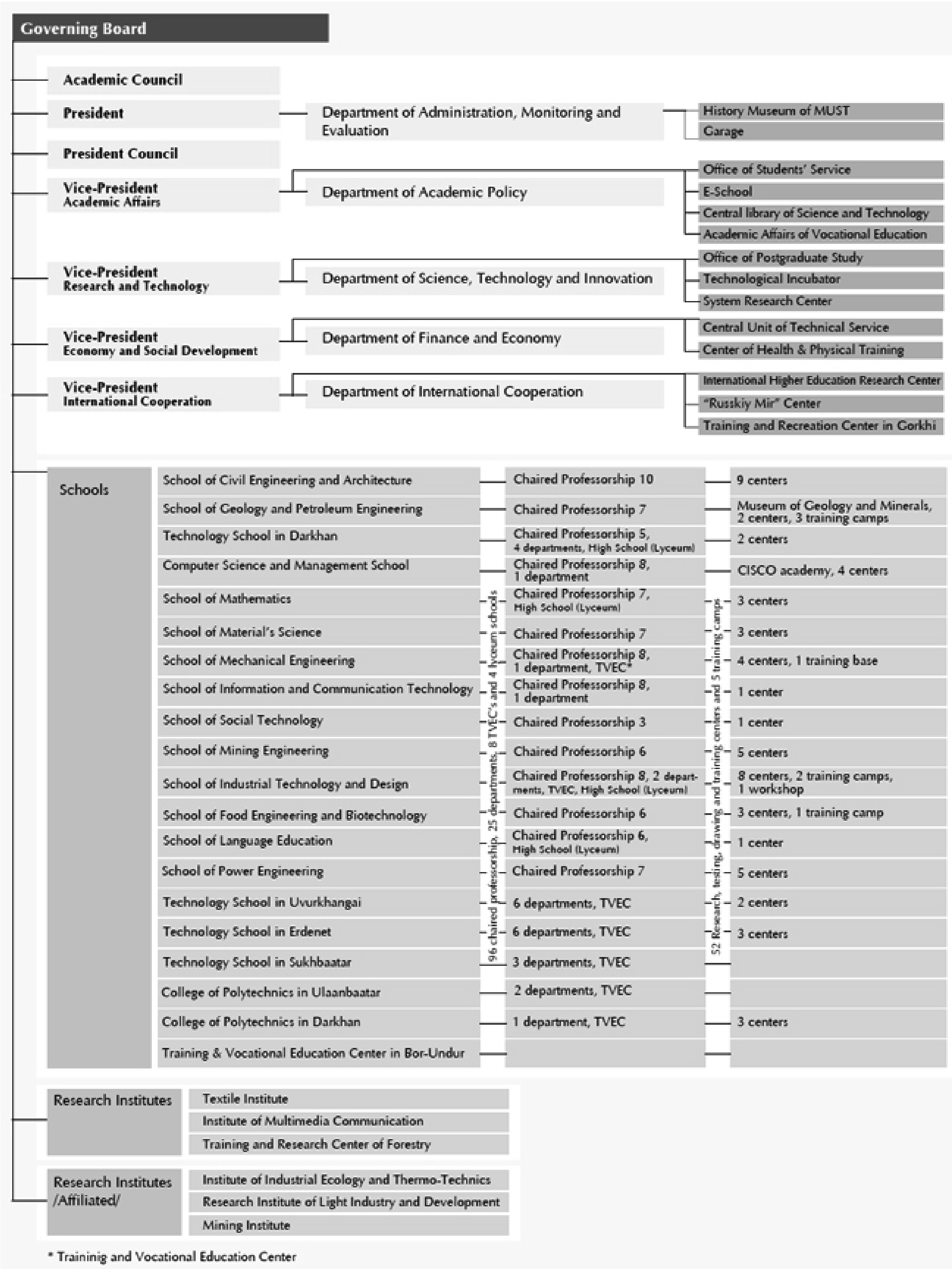
No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Microscope	1			study	¥3,500,000	¥3,500,000
002	Stereoscope	1			study	¥6,500,000	¥6,500,000
003	Fluid Inclusion analytic equipment	1			study	¥3,500,000	¥3,500,000
004	XRD (X-Ray Diffractrometer)	1			study	¥34,000,000	¥34,000,000
005	SEM-EDX	1			study	¥25,500,000	¥25,500,000
006	Gamma ray spectrometer	1			To measure radioactive properties	¥35,000,000	¥35,000,000
007	Schonstedt magnetometer	1			To measure remanent magnetization	¥25,000,000	¥25,000,000
						Sub total	¥133,000,000

2) Department: Geophysics and Geo-information/Geology and Petroleum Engineering

Project title:Higher education in Mineral Resources Engineering Mongolia

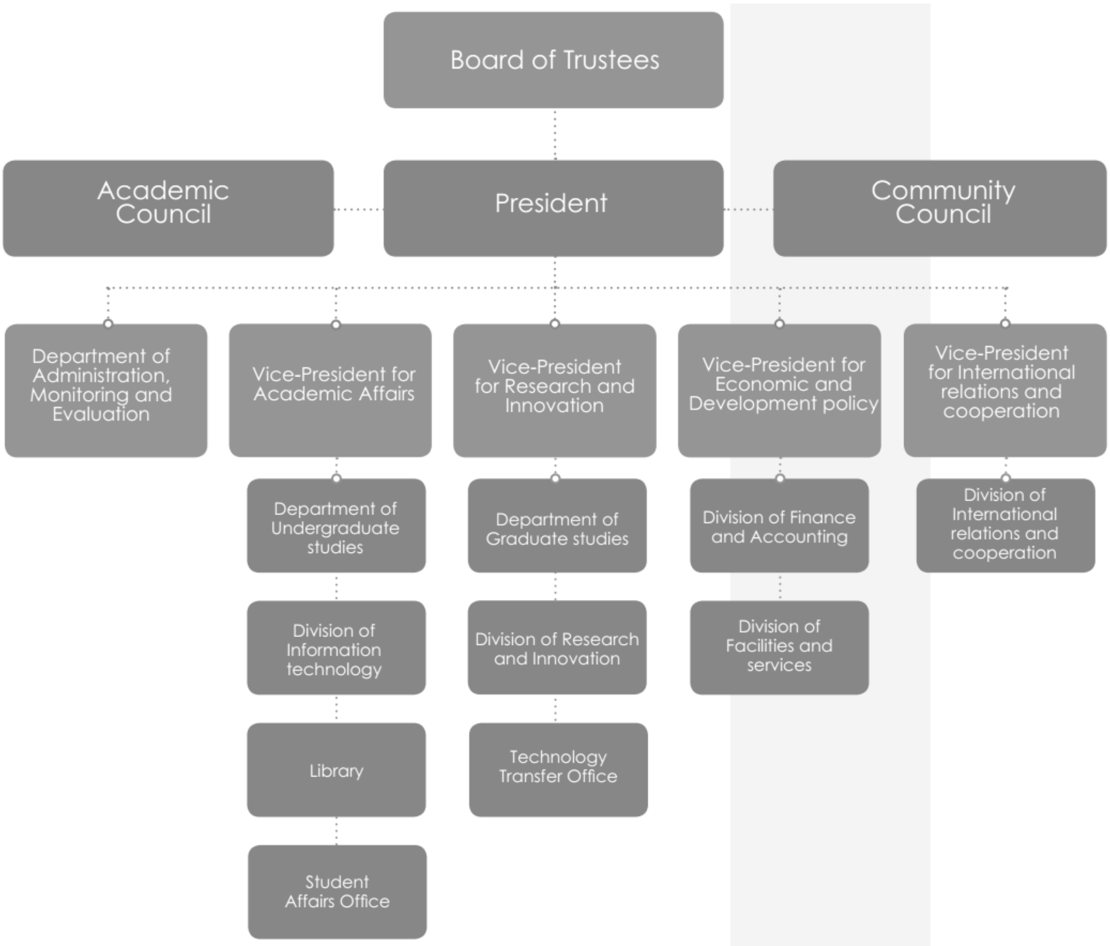
No.	Equipment name	Quantity	Manufacturer	Model	Purpose of procurement	Unit price	Sub total
001	Elemental Analyzer	1			Chn Analysis of Soil and Water	¥14,100,000	¥14,100,000
002	X-ray diffraction system	1			Qualitative analysis of Soil	¥18,800,000	¥18,800,000
005	Water Quality -MultiProbe	5			Field Monitoring (water)	¥300,000	¥1,500,000
006	Automatic water level/Temp/Ec data logger	1			Field Analysis - Heavy metals	¥2,800,000	¥2,800,000
007	Running stores for analysis	1			Analysis	¥18,800,000	¥18,800,000
						Sub total	¥56,000,000

Attachment 7 MUST organization chart



Source: MUST website

Attachment 8 NUM organization chart



Attachment 9 Working Group of MUST

Workgroup of Mongolian University of Science and Technology with JICA and Nagaoka University of Technology (The Project for Higher Education on Engineering in Mongolia)

GANGER: BAASANDASH.CH HEAD OF RESEARCH DEPARTMENT of MUST (basanda.c.aa@must.edu.mn)

№	Work group coordinator	Mechanical	Architecture	Electrical	Japanese language
1.	Bachelor (Twin program & Kosen program)				
	Enkhjargal.KH Head of Academic Policy enkhjargal@must.edu.mn	Boldbaatar**/Japanese/** Teacher of school of Mechanical engineering dalaibold@yahoo.com	Ninjgaraw.E Vice principal of studying office ninjgarav@yahoo.com	Erdene.A/**Japanese/** Teacher of power supply and height voltage A_erdene@must.edu.mn A_eegii@yahoo.com	Sainbileg.E**/Japanese/** Head of department Japanese language and culture enkhtumur@yahoo.com Sarangerel.L**/Japanese/** Teacher of Japanese language Sara_0707@yahoo.com
2.	Graduate school				
	Enkhtsatsral .T Head of postgraduate office enkhtsatsral@must.edu.mn	Naidandorj.R Vice principal of research and innovation naidan@must.edu.mn	Bolormaa.R Vice principal of research innovation Bolor_r@yahoo.com	Bat-erdene.B Vice principal of research and innovation Bat_erd@yahoo.com Sarangerel@must.edu.mn	
3.	Joint research activity				
	Baasandash.CH **/Japanese/** Head of Research Department Basanda.c.aa@must.edu.mn	Naidandorj.R Vice principal of Research and Innovation Department naidan@must.edu.mn	Bolormaa.R Vice principal of Research and Innovation Department Bolor_r@yahoo.com	Bat-erdene.B Vice principal of Research and Innovation Department Bat_erd@yahoo.com	
4.	Finance and economic activity joint start up				
	Khashbayar.D Khashbayar@must.edu.mn	Tsolmonbaatar.D President of School of Mechanical Engineering tsbilguun@yahoo.com	Otgonbayar.P President of School of Civil engineering and Architecture otgonpeljee@yahoo.com	Mangaljalav.CH President of School of power Engineering Mangal85@yahoo.com	Batbayar.T President of Language School batbayar@must.edu.mn
5.	Foreign relations and co-operation				
	Bolortuya.M**/Japanese/** Liaison officer of International Cooperation Department Boloroo0707@yahoo.com	Tsolmonbaatar.D President of School of Mechanical Engineering dtsolmon@must.edu.mn	Otgonbayar.P President of School of Civil engineering and Architecture otgonpeljee@yahoo.com	Mangaljalav.CH President of School of power Engineering Mangal85@yahoo.com	

Attachment 10 Total project cost estimation

in 1,000JPY

Breakdown of Cost	Foreign Currency Portion			Local Currency Portion			Total		
	Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others
1 Improvement of Undergraduate Program (Curriculum Improvement & Twinning Program)	**1,756,148**	**1,756,148**	**0**	**0**	**0**	**0**	**1,756,148**	**1,756,148**	**0**
1-1 Visiting Scholars for Curriculum Improvement & Twinning Program Development	0								
1) Short-term visiting scholar (type A)	12,726	12,726					12,726	12,726	
2) Short-term visiting scholar (type B)	35,596	35,596					35,596	35,596	
3) Long-term visiting scholar	168,150	168,150					168,150	168,150	
4) Japanese language lecturers	68,460	68,460					68,460	68,460	
5) Local Japanese language lecturers	27,504	27,504					27,504	27,504	
1-2 Scholarship for Twinning Program	1,405,312	1,405,312					1,405,312	1,405,312	
1-3 Textbooks and teaching Instruments	38,400	38,400					38,400	38,400	
2 Strengthening of Research and Educational Capability	**1,495,873**	**1,495,873**	**0**	**0**	**0**	**0**	**1,495,873**	**1,495,873**	**0**
(Overseas Degree Program & Joint Research)								0	
2-1 Scholarship for Academic Staff Development								0	
1) Master degree program	618,340	618,340					618,340	618,340	
2) PhD degree program	376,068	376,068					376,068	376,068	
3) Non-degree program (Visiting Scholar to Japan	157,140	157,140					157,140	157,140	
2-2 Visiting Scholars for Joint Research									
1) Short-term visiting scholar	141,575	141,575					141,575	141,575	
2) Long-term visiting scholar	132,750	132,750					132,750	132,750	
2-3 Joint Research Fund	70,000	70,000					70,000	70,000	
3 Development of Ready-Engineers for Urgent Needs	**1,249,830**	**1,249,830**	**0**	**0**	**0**	**0**	**1,249,830**	**1,249,830**	**0**
(Kosen Program)									
3-1 Scholarship for Kosen Program	1,019,620	1,019,620					1,019,620	1,019,620	
3-2 Visiting Scholars for Kosen Program									
1) Japanese language lecturers	53,790	53,790					53,790	53,790	
2) Local Japanese lang. lecturers	5,760	5,760					5,760	5,760	
3) Science subject lecturer	159,300	159,300					159,300	159,300	
4) Local Science lecturers	5,760	5,760					5,760	5,760	
3-3 Textbooks and teaching Instruments	5,600	5,600					5,600	5,600	
4 Facility/Equipment Development	**1,600,000**	**1,600,000**	**0**	**108,000**	0	**108,000**	**1,708,000**	**1,600,000**	**108,000**
4-1 Educational Equipment	834,000	834,000				0	834,000	834,000	
4-2 Research Equipment	766,000	766,000				0	766,000	766,000	
4-3 Renovation of Building				108,000		108,000	108,000		108,000
Base Cost	**6,101,851**	**6,101,851**	**0**	**108,000**	**0**	**108,000**	**6,209,851**	**6,101,851**	**108,000**
Price Escalation	389,427	389,427					389,427	389,427	
Physical Contingency (5%)	322,529	322,529		5,724		5,400	328,253	322,529	5,400
Total Base Cost	**6,813,807**	**6,813,807**	**0**	**113,724**	**0**	**113,400**	**6,927,531**	**6,813,807**	**113,400**
5 Project Administration				**380,431**		380,431	**380,431**		**380,431**
5-1 Mongolian Administration Staff				380,431		380,431	380,431		380,431
6 Program Development & Support Services	**715,302**	**715,302**	**0**	**0**	**0**		**715,302**	**715,302**	**0**
	640,680	640,680					640,680	640,680	
Price Escalation	40,559	40,559					40,559	40,559	
Physical Contingency (5%)	34,062	34,062					34,062	34,062	
Project Cost	**7,529,108**	**7,529,108**	**0**	**494,155**	**0**	**494,155**	**8,023,263**	**7,529,108**	**494,155**
Other costs				**153,387**			**153,387**		
VAT				12,020			12,020		
Front end fee				15,229			15,229		
Interest during construction				126,138			126,138		
Total Cost	**7,529,108**	**7,529,108**	**0**	**647,542**	**0**	**1,368,416**	**8,176,651**	**7,529,108**	**1,368,416**

Attachment 11 Total project cost estimation, breakdown by type of expenditure

in 1,000JPY

Breakdown of Cost	Foreign Currency Portion			Local Currency Portion			Total		
	Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others
1 Scholarship	**3,576,480**	**3,576,480**		**0**		**0**	**3,576,480**	**3,576,480**	
1-1 Scholarship for Twinning Program	1,405,312	1,405,312		0		0	1,405,312	1,405,312	
1-2 Scholarship for Academic Staff Development									
1) Master degree program	618,340	618,340		0		0	618,340	618,340	
2) PhD degree program	376,068	376,068		0		0	376,068	376,068	
3) Non-degree program (Visiting Scholar to Japan	157,140	157,140		0		0	157,140	157,140	
1-3 Scholarship for Kosen Program	1,019,620	1,019,620		0		0	1,019,620	1,019,620	
2 Visiting Scholars	**925,371**	**925,371**		**0**		**0**	**925,371**	**925,371**	
2-1 Visiting Scholars for Curriculum Improvement & Twinning Program Development									
1) Short-term visiting scholar (type A)	12,726	12,726		0		0	12,726	12,726	
2) Short-term visiting scholar (type B)	35,596	35,596		0		0	35,596	35,596	
3) Long-term visiting scholar	168,150	168,150		0		0	168,150	168,150	
4) Japanese language lecturers	68,460	68,460		0		0	68,460	68,460	
5) Local Japanese language lecturers	27,504	27,504		0		0	27,504	27,504	
6) Textbooks and teaching Instruments	38,400	38,400		0		0	38,400	38,400	
2-2 Visiting Scholars for Joint Research									
1) Short-term visiting scholar	141,575	141,575		0		0	141,575	141,575	
2) Long-term visiting scholar	132,750	132,750		0		0	132,750	132,750	
3) Joint Research Fund	70,000	70,000		0		0	70,000	70,000	
2-3 Visiting Scholars for Kosen Program									
1) Japanese language lecturers	53,790	53,790		0		0	53,790	53,790	
2) Local Japanese lang. lecturers	5,760	5,760		0		0	5,760	5,760	
3) Science subject lecturer	159,300	159,300		0		0	159,300	159,300	
4) Local Science lecturers	5,760	5,760		0		0	5,760	5,760	
5) Textbooks and teaching Instruments	5,600	5,600		0		0	5,600	5,600	
3 Facility/Equipment Development	**1,600,000**	**1,600,000**		**108,000**		**108,000**	**1,708,000**	**1,600,000**	**108,000**
3-1 Educational Equipment	834,000	834,000		0		0	834,000	834,000	
3-2 Research Equipment	766,000	766,000		0		0	766,000	766,000	
3-3 Renovation of Building		0		108,000		108,000	108,000		108,000
Base Cost	**6,101,851**	**6,101,851**		**108,000**		**108,000**	**6,209,851**	**6,101,851**	**108,000**
Price Escalation	389,427	389,427		6,480		0	389,427	389,427	
Physical Contingency (5%)	322,529	322,529		5,724		5,400	328,253	322,529	5,400
Total Base Cost	**6,813,807**	**6,813,807**		**120,204**		**113,400**	**6,927,531**	6,813,807	113,400
4 Project Administration				**380,431**		**380,431**	**380,431**		**380,431**
5 Program Development & Support Services	**715,302**	**715,302**		**0**		**0**	**715,302**	**715,302**	
Base Cost	640,680	640,680		0		0	640,680	640,680	
Price Escalation	40,559	40,559		0		0	40,559	40,559	
Physical Contingency (5%)	34,062	34,062		0		0	34,062	34,062	
Project Cost	**7,529,108**	**7,529,108**		**500,635**		**493,831**	**8,023,263**	**7,529,108**	**493,831**
Other costs				**153,387**		**153,387**	**153,387**		**153,387**
VAT				12,020		12,020	12,020		12,020
Front end fee				15,229		15,229	15,229		15,229
Interest during construction				126,138		0	126,138		126,138
Total Cost	**7,529,108**	**7,529,108**		**654,022**		**647,218**	**8,176,651**	**7,529,108**	**647,218**

Attachment 12-1 Project cost by year

Project Cost by Year (in JPY) Unit: JPY

Component	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1 Improvement of Undergraduate Program											
(Curriculum Improvement & Twinning Program)											
1-1 Visiting Scholars for Curriculum Improvement & Twinning Program											
1) Short-term visiting scholar (type A)	12,726,000	3,636,000	2,727,000	1,818,000	1,818,000	1,818,000	909,000	0	0	0	0
2) Short-term visiting scholar (type B)	35,596,000	0	11,326,000	9,708,000	6,472,000	6,472,000	1,618,000	0	0	0	0
3) Long-term visiting scholar	168,150,000	0	35,400,000	35,400,000	35,400,000	35,400,000	26,550,000	0	0	0	0
4) Japanese language lecturers	68,460,000	0	14,670,000	14,670,000	14,670,000	14,670,000	9,780,000	0	0	0	0
5) Local Japanese language lecturers	27,504,000	0	1,344,000	2,496,000	7,920,000	8,016,000	6,672,000	1,056,000	0	0	0
1-2 Scholarship for Twinning Program	1,405,312,000	0	0	0	0	160,064,000	315,248,000	351,328,000	351,328,000	191,264,000	36,080,000
1-3 Textbooks and teaching Instruments	38,400,000	0	3,200,000	6,400,000	9,600,000	9,600,000	6,400,000	3,200,000	0	0	0
2 Strengthening of Research and Educational Capability											
(Overseas Degree Program & Joint Research)											
2-1 Scholarship for Academic Staff Development											
1) Master degree program	618,340,000	0	66,042,000	170,061,000	211,230,000	115,922,000	39,916,200	9,898,400	4,737,200	533,200	0
2) PhD degree program	376,068,000	0	49,070,000	81,306,000	105,411,400	82,550,600	44,050,000	12,610,000	1,070,000	0	0
3) Non-degree program (Visiting Scholar to Japan)	157,140,000	46,200,000	45,150,000	45,150,000	3,870,000	5,820,000	3,150,000	1,950,000	3,900,000	1,950,000	0
2-2 Visiting Scholars for Joint Research											
1) Short-term visiting scholar	141,575,000	24,270,000	28,315,000	28,315,000	12,135,000	12,135,000	12,135,000	12,135,000	8,090,000	4,045,000	0
2) Long-term visiting scholar	132,750,000	0	17,700,000	17,700,000	17,700,000	17,700,000	17,700,000	17,700,000	17,700,000	8,850,000	0
2-3 Joint Research Fund	70,000,000	0	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	0	0
3 Development of Ready-Engineers for Urgent Needs											
(Kosen Program)											
3-1 Scholarship for Kosen Program	1,019,620,000	0	9,589,300	66,266,200	131,810,200	189,041,000	203,924,000	194,334,700	137,657,800	72,113,800	14,883,000
3-2 Visiting Scholars for Kosen Program											
1) Japanese language lecturers	53,790,000	4,890,000	9,780,000	9,780,000	9,780,000	9,780,000	4,890,000	4,890,000	0	0	0
2) Local Japanese lang. lecturers	5,760,000	0	0	960,000	960,000	960,000	960,000	960,000	960,000	0	0
3) Science subject lecturer	159,300,000	0	26,550,000	26,550,000	26,550,000	26,550,000	26,550,000	26,550,000	0	0	0
4) Local Science lecturers	5,760,000	0	960,000	960,000	960,000	960,000	960,000	960,000	0	0	0
3-3 Textbooks and teaching Instruments	5,600,000	1,400,000	1,400,000	1,400,000	1,400,000	0	0	0	0	0	0
4 Facility/Equipment Development											
4-1 Educational equipment	834,000,000	0	278,000,000	278,000,000	278,000,000	0	0	0	0	0	0
4-2 Research equipment	766,000,000	0	255,333,333	255,333,333	255,333,334	0	0	0	0	0	0
4-3 Renovation of Building	108,000,000	108,000,000	0	0	0	0	0	0	0	0	0
Base Cost	6,209,851,000	188,396,000	866,556,633	1,062,273,533	1,141,019,934	707,458,600	731,412,200	647,572,100	535,443,000	278,756,000	50,963,000
Price Escalation	395,906,979	7,525,148	22,676,921	41,969,574	60,500,091	47,196,058	58,936,735	57,426,332	58,286,747	34,362,864	7,026,510
Physical Contingency (5%)	328,252,849	9,796,057	44,461,678	55,212,155	60,076,001	37,732,733	39,517,447	33,214,872	29,686,487	15,655,943	2,899,475
Total Base Cost	6,921,820,957	193,513,205	933,336,072	1,159,091,435	1,262,333,141	792,387,391	829,866,381	738,213,304	623,416,234	328,774,807	60,888,985
5 Project Administration											
Project Administration	380,430,574	13,189,800	51,701,809	62,851,563	67,762,640	44,046,364	45,552,233	38,918,333	33,730,933	18,573,908	4,102,990
6 Program Development & Support Services											
Base Cost	640,680,300	54,603,300	93,125,800	89,397,500	84,705,600	79,050,100	71,547,400	70,347,400	43,977,000	36,206,600	17,719,600
Price Escalation	40,559,364	709,843	2,437,009	3,532,023	4,491,329	5,273,599	5,765,244	6,656,757	4,787,207	4,463,267	2,443,085
Physical Contingency (5%)	34,061,983	2,765,657	4,778,140	4,646,476	4,459,846	4,216,185	3,865,632	3,850,208	2,438,210	2,033,493	1,008,134
Total Project Cost	8,012,153,884	259,381,806	1,085,360,873	1,319,500,806	1,423,789,413	924,973,639	956,596,891	857,986,002	708,349,583	390,052,076	86,162,795

Attachment 12-2 Foreign currency project cost by year

Foreign Currency Project Cost by Year (in JPY) Unit: JPY

Component	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1 Improvement of Undergraduate Program											
(Curriculum Improvement & Twinning Program)											
1-1 Visiting Scholars for Curriculum Improvement & Twinning Program											
1) Short-term visiting scholar (type A)	12,726,000	3,636,000	2,727,000	1,818,000	1,818,000	1,818,000	909,000	0	0	0	0
2) Short-term visiting scholar (type B)	35,596,000	0	11,326,000	9,708,000	6,472,000	6,472,000	1,618,000	0	0	0	0
3) Long-term visiting scholar	168,150,000	0	35,400,000	35,400,000	35,400,000	35,400,000	26,550,000	0	0	0	0
4) Japanese language lecturers	68,460,000	0	14,670,000	14,670,000	14,670,000	14,670,000	9,780,000	0	0	0	0
5) Local Japanese language lecturers	27,504,000	0	1,344,000	2,496,000	7,920,000	8,016,000	6,672,000	1,056,000	0	0	0
1-2 Scholarship for Twinning Program	1,405,312,000	0	0	0	0	160,064,000	315,248,000	351,328,000	351,328,000	191,264,000	36,080,000
1-3 Textbooks and teaching Instruments	38,400,000	0	3,200,000	6,400,000	9,600,000	9,600,000	6,400,000	3,200,000	0	0	0
2 Strengthening of Research and Educational Capability		0	0	0	0	0	0	0	0	0	0
(Overseas Degree Program & Joint Research)		0	0	0	0	0	0	0	0	0	0
2-1 Scholarship for Academic Staff Development		0	0	0	0	0	0	0	0	0	0
1) Master degree program	618,340,000	0	66,042,000	170,061,000	211,230,000	115,922,000	39,916,200	9,898,400	4,737,200	533,200	0
2) PhD degree program	376,068,000	0	49,070,000	81,306,000	105,411,400	82,550,600	44,050,000	12,610,000	1,070,000	0	0
3) Non-degree program (Visiting Scholar to Japan)	157,140,000	46,200,000	45,150,000	45,150,000	3,870,000	5,820,000	3,150,000	1,950,000	3,900,000	1,950,000	0
2-2 Visiting Scholars for Joint Research		0	0	0	0	0	0	0	0	0	0
1) Short-term visiting scholar	141,575,000	24,270,000	28,315,000	28,315,000	12,135,000	12,135,000	12,135,000	12,135,000	8,090,000	4,045,000	0
2) Long-term visiting scholar	132,750,000	0	17,700,000	17,700,000	17,700,000	17,700,000	17,700,000	17,700,000	17,700,000	8,850,000	0
2-3 Joint Research Fund	70,000,000	0	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	0	0
3 Development of Ready-Engineers for Urgent Needs		0	0	0	0	0	0	0	0	0	0
(Kosen Program)		0	0	0	0	0	0	0	0	0	0
3-1 Scholarship for Kosen Program	1,019,620,000	0	9,589,300	66,266,200	131,810,200	189,041,000	203,924,000	194,334,700	137,657,800	72,113,800	14,883,000
3-2 Visiting Scholars for Kosen Program		0	0	0	0	0	0	0	0	0	0
1) Japanese language lecturers	53,790,000	4,890,000	9,780,000	9,780,000	9,780,000	9,780,000	4,890,000	4,890,000	0	0	0
2) Local Japanese lang. lecturers	5,760,000	0	0	960,000	960,000	960,000	960,000	960,000	960,000	0	0
3) Science subject lecturer	159,300,000	0	26,550,000	26,550,000	26,550,000	26,550,000	26,550,000	26,550,000	0	0	0
4) Local Science lecturers	5,760,000	0	960,000	960,000	960,000	960,000	960,000	960,000	0	0	0
3-3 Textbooks and teaching Instruments	5,600,000	1,400,000	1,400,000	1,400,000	1,400,000	0	0	0	0	0	0
4 Facility/Equipment Development		0	0	0	0	0	0	0	0	0	0
4-1 Educational equipment	834,000,000	0	278,000,000	278,000,000	278,000,000	0	0	0	0	0	0
4-2 Research equipment	766,000,000	0	255,333,333	255,333,333	255,333,334	0	0	0	0	0	0
4-3 Renovation of Building	0	0	0	0	0	0	0	0	0	0	0
Base Cost	6,101,851,000	80,396,000	866,556,633	1,062,273,533	1,141,019,934	707,458,600	731,412,200	647,572,100	535,443,000	278,756,000	50,963,000
Price Escalation	389,426,979	1,045,148	22,676,921	41,969,574	60,500,091	47,196,058	58,936,735	57,426,332	58,286,747	34,362,864	7,026,510
Physical Contingency (5%)	322,528,849	4,072,057	44,461,678	55,212,155	60,076,001	37,732,733	39,517,447	33,214,872	29,686,487	15,655,943	2,899,475
Total Base Cost	6,813,806,828	85,513,205	933,695,231	1,159,455,263	1,261,596,026	792,387,391	829,866,381	738,213,304	623,416,234	328,774,807	60,888,985
5 Project Administration											
6 Program Development & Support Services											
Base Cost	640,680,300	54,603,300	93,125,800	89,397,500	84,705,600	79,050,100	71,547,400	70,347,400	43,977,000	36,206,600	17,719,600
Price Escalation	40,559,364	709,843	2,437,009	3,532,023	4,491,329	5,273,599	5,765,244	6,656,757	4,787,207	4,463,267	2,443,085
Physical Contingency (5%)	34,061,983	2,765,657	4,778,140	4,646,476	4,459,846	4,216,185	3,865,632	3,850,208	2,438,210	2,033,493	1,008,134
Total Project Cost	7,529,108,475	143,592,005	1,034,036,181	1,257,031,262	1,355,252,802	880,927,275	911,044,658	819,067,668	674,618,651	371,478,167	82,059,805

Attachment 12-3 Local currency project cost by year

Local Currency Project Cost by Year (in JPY) : The equivalent amount of local portion in Japanese Yen Unit: JPY

Component	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1 Improvement of Undergraduate Program (Curriculum Improvement & Twinning Program)											
1-1 Visiting Scholars for Curriculum Improvement & Twinning Program											
1) Short-term visiting scholar (type A)	0	0	0	0	0	0	0	0	0	0	0
2) Short-term visiting scholar (type B)	0	0	0	0	0	0	0	0	0	0	0
3) Long-term visiting scholar	0	0	0	0	0	0	0	0	0	0	0
4) Japanese language lecturers	0	0	0	0	0	0	0	0	0	0	0
5) Local Japanese language lecturers	0	0	0	0	0	0	0	0	0	0	0
6) Industrial trainer / technician	0	0	0	0	0	0	0	0	0	0	0
1-2 Scholarship for Twinning Program	0	0	0	0	0	0	0	0	0	0	0
1-3 Textbooks and teaching Instruments	0	0	0	0	0	0	0	0	0	0	0
2 Strengthening of Research and Educational Capability (Overseas Degree Program & Joint Research)											
2-1 Scholarship for Academic Staff Development											
1) Master degree program	0	0	0	0	0	0	0	0	0	0	0
2) PhD degree program	0	0	0	0	0	0	0	0	0	0	0
3) Non-degree program (Visiting Scholar to Japan)	0	0	0	0	0	0	0	0	0	0	0
2-2 Visiting Scholars for Joint Research											
1) Short-term visiting scholar	0	0	0	0	0	0	0	0	0	0	0
2) Long-term visiting scholar	0	0	0	0	0	0	0	0	0	0	0
2-3 Joint Research Fund	0	0	0	0	0	0	0	0	0	0	0
3 Development of Ready-Engineers for Urgent Needs (Kosen Program)											
3-1 Scholarship for Kosen Program	0	0	0	0	0	0	0	0	0	0	0
3-2 Visiting Scholars for Kosen Program											
1) Japanese language lecturers	0	0	0	0	0	0	0	0	0	0	0
2) Local Japanese lang. lecturers	0	0	0	0	0	0	0	0	0	0	0
3) Science subject lecturer	0	0	0	0	0	0	0	0	0	0	0
4) Local Science lecturers	0	0	0	0	0	0	0	0	0	0	0
3-3 Textbooks and teaching Instruments	0	0	0	0	0	0	0	0	0	0	0
4 Facility/Equipment Development											
4-1 Educational equipment	0	0	0	0	0	0	0	0	0	0	0
4-2 Research equipment	0	0	0	0	0	0	0	0	0	0	0
4-3 Renovation of Building	108,000,000	108,000,000	0	0	0	0	0	0	0	0	0
Base Cost	108,000,000	108,000,000	0	0	0	0	0	0	0	0	0
Price Escalation	6,480,000	6,480,000	0	0	0	0	0	0	0	0	0
Physical Contingency (5%)	5,724,000	5,724,000	0	0	0	0	0	0	0	0	0
Total Base Cost	120,204,000	120,204,000	0	0	0	0	0	0	0	0	0
5 Project Administration											
Project Adminstration	380,431,280	13,189,800	51,683,851	62,833,372	67,799,496	44,046,364	45,552,233	38,918,333	33,730,933	18,573,908	4,102,990
6 Program Development & Support Services	0										
Price Escalation	0										
Physical Contingency (5%)	0										
Total Project Cost	500,635,280	133,393,800	51,683,851	62,833,372	67,799,496	44,046,364	45,552,233	38,918,333	33,730,933	18,573,908	4,102,990

Attachment 13 Scholarship Cost

Scholarship Cost Unit: JPY

Program	No. of Students	Total Cost	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
			FC	FC	FC	FC	FC	FC	FC	FC	FC	FC
1 Kosen Program												
Batch 1-1	7	35,686,700		9,589,300	11,470,200	11,470,200	3,157,000					
Batch 1-2	33	168,237,300			45,206,700	54,073,800	54,073,800	14,883,000				
Batch 2-1	7	35,686,700			9,589,300	11,470,200	11,470,200	3,157,000				
Batch 2-2	33	168,237,300				45,206,700	54,073,800	54,073,800	14,883,000			
Batch 3-1	7	35,686,700				9,589,300	11,470,200	11,470,200	3,157,000			
Batch 3-2	33	168,237,300					45,206,700	54,073,800	54,073,800	14,883,000		
Batch 4-1	7	35,686,700					9,589,300	11,470,200	11,470,200	3,157,000		
Batch 4-2	33	168,237,300						45,206,700	54,073,800	54,073,800	14,883,000	
Batch 5-1	7	35,686,700						9,589,300	11,470,200	11,470,200	3,157,000	
Batch 5-2	33	168,237,300							45,206,700	54,073,800	54,073,800	14,883,000
Total	200	611,772,000	0	9,589,300	66,266,200	131,810,200	189,041,000	203,924,000	194,334,700	137,657,800	72,113,800	14,883,000
2 Twinning Program												
Batch 1	80	351,328,000					160,064,000	155,184,000	36,080,000			
Batch 2	80	351,328,000						160,064,000	155,184,000	36,080,000		
Batch 3	80	351,328,000							160,064,000	155,184,000	36,080,000	
Batch 4	80	351,328,000								160,064,000	155,184,000	36,080,000
Total	320	1,405,312,000	0	0	0	0	160,064,000	315,248,000	351,328,000	351,328,000	191,264,000	36,080,000
3 Master degree program												
Batch 1-1 (April)	30	185,502,000		50,022,000	77,418,000	58,062,000						
Batch 1-2 (September)	20	123,668,000		16,020,000	51,612,000	45,372,000	10,664,000					
Batch 2-1 (April)	15	92,751,000			25,011,000	38,709,000	29,031,000					
Batch 2-2 (September)	20	123,668,000			16,020,000	51,612,000	45,372,000	10,664,000				
Batch 3-1 (April)	10	61,834,000				16,674,000	25,806,000	19,354,000				
Batch 3-2 (September)	1	6,183,400				801,000	2,580,600	2,268,600	533,200			
Batch 4-1 (April)	1	6,183,400					1,667,400	2,580,600	1,935,400			
Batch 4-2 (September)	1	6,183,400					801,000	2,580,600	2,268,600	533,200		
Batch 5-1 (April)	1	6,183,400						1,667,400	2,580,600	1,935,400		
Batch 5-2 (September)	1	6,183,400						801,000	2,580,600	2,268,600	533,200	
Total	100	618,340,000	0	66,042,000	170,061,000	211,230,000	115,922,000	39,916,200	9,898,400	4,737,200	533,200	0
4 PhD degree program												
Batch 1-1 (April)	15	94,017,000		33,792,000	26,100,000	26,100,000	8,025,000					
Batch 1-2 (September)	10	62,678,000		15,278,000	17,400,000	17,400,000	12,600,000					
Batch 2-1 (April)	10	62,678,000			22,528,000	17,400,000	17,400,000	5,350,000				
Batch 2-2 (September)	10	62,678,000			15,278,000	17,400,000	17,400,000	12,600,000				
Batch 3-1 (April)	10	62,678,000				22,528,000	17,400,000	17,400,000	5,350,000			
Batch 3-2 (September)	3	18,803,400				4,583,400	5,220,000	5,220,000	3,780,000			
Batch 4-1 (April)	2	12,535,600					4,505,600	3,480,000	3,480,000	1,070,000		
Total	60	376,068,000	0	49,070,000	81,306,000	105,411,400	82,550,600	44,050,000	12,610,000	1,070,000	0	
5 Non-Degree Program												
2015 (1 year)	2	3,900,000		3,900,000								
2016 (1 year)	2	3,900,000			3,900,000							
2017 (1 year)	0	0				0						
2018 (1 year)	1	1,950,000					1,950,000					
2019 (1 year)	0	0						0				
2020 (1 year)	0	0							0			
2021 (1 year)	1	1,950,000								1,950,000		
2022 (1 year)	0	0									0	
2014 (6 months)	20	29,400,000	29,400,000									
2015 (6 months)	15	22,050,000		22,050,000								
2016 (6 months)	15	22,050,000			22,050,000							
2017 (6 months)	1	1,470,000				1,470,000						
2018 (6 months)	1	1,470,000					1,470,000					
2019 (6 months)	1	1,470,000						1,470,000				
2020 (6 months)	1	1,470,000							1,470,000			
2021 (6 months)	1	1,470,000								1,470,000		
2022 (6 months)	1	1,470,000									1,470,000	
2014 (1 week)	70	16,800,000	16,800,000									
2015 (1 week)	80	19,200,000		19,200,000								
2016 (1 week)	80	19,200,000			19,200,000							
2017 (1 week)	10	2,400,000				2,400,000						
2018 (1 week)	10	2,400,000					2,400,000					
2019 (1 week)	7	1,680,000						1,680,000				
2020 (1 week)	2	480,000							480,000			
2021 (1 week)	2	480,000								480,000		
2022 (1 week)	2	480,000									480,000	
Total	325	157,140,000	46,200,000	45,150,000	45,150,000	3,870,000	5,820,000	3,150,000	1,950,000	3,900,000	1,950,000	
Grand Total	1,005	3,168,632,000	46,200,000	169,851,300	362,783,200	452,321,600	553,397,600	606,288,200	570,121,100	498,693,000	265,861,000	50,963,000

Attachment 14 Unit cost of scholarship program

Unit Cost of Fellowship Program

KOSEN Program

Unit: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Year 4	Total
				FC	FC	FC	FC	FC
Entrance Examination Fee	Once	16,500	1	16,500				16,500
Admission Fee	Once	84,600	1	84,600				84,600
Tuition Fee	Year	234,600	3	234,600	234,600	234,600		703,800
School Support Fund	Once	-118,800	1	-118,800				-118,800
Air Fare to & from Japan	One way	100,000	2	100,000			100,000	200,000
Living Allowance	Monthly	117,000	36	1,053,000	1,404,000	1,404,000	351,000	4,212,000
				1,369,900	1,638,600	1,638,600	451,000	5,098,100

Twinning Program

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Total
				FC	FC	FC	FC
Entrance Examination Fee	Once	30,000	1	30,000			30,000
Admission Fee	Once	282,000	1	282,000			282,000
Tuition Fee	Year	535,800	2	535,800	535,800		1,071,600
Air Fare to & from Japan	One way	100,000	2	100,000		100,000	200,000
Living Allowance	Monthly	117,000	24	1,053,000	1,404,000	351,000	2,808,000
				2,000,800	1,939,800	451,000	4,391,600

Master Degree Program (Starting from April)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Total
				FC	FC	FC	FC
Entrance Examination Fee	Once	30,000	1	9,800	30,000		39,800
Admission Fee	Once	282,000	1	84,600	282,000		366,600
Tuition Fee	Year	535,800	2	173,400	535,800	535,800	1,245,000
Air Fare to & from Japan	One way	100,000	2	100,000		100,000	200,000
Living Allowance	Monthly	144,400	24	1,299,600	1,732,800	1,299,600	4,332,000
				1,667,400	2,580,600	1,935,400	6,183,400

Master Degree Program (Starting from October)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Year 4	Total
				FC	FC	FC	FC	FC
Entrance Examination Fee	Once	30,000	1	9,800	30,000			39,800
Admission Fee	Once	282,000	1	84,600	282,000			366,600
Tuition Fee	Year	535,800	2	173,400	535,800	535,800		1,245,000
Air Fare to & from Japan	One way	100,000	2	100,000			100,000	200,000
Living Allowance	Monthly	144,400	24	433,200	1,732,800	1,732,800	433,200	4,332,000
				801,000	2,580,600	2,268,600	533,200	6,183,400

Ph.D. Degree Program (Starting from April)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Year 4	Total
				FC	LC	LC	LC	FC
Entrance Examination Fee	Once	30,000	1	30,000				30,000
Admission Fee	Once	282,000	1	282,000				282,000
Tuition Fee	Year	535,800	2	535,800				535,800
Air Fare to & from Japan	One way	100,000	2	100,000			100,000	200,000
Living Allowance	Monthly	145,000	36	1,305,000	1,740,000	1,740,000	435,000	5,220,000
				2,252,800	1,740,000	1,740,000	535,000	6,267,800

Ph.D. Degree Program (Starting from September)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	Year 1	Year 2	Year 3	Year 4	Total
				FC	LC	LC	LC	FC
Entrance Examination Fee	Once	30,000	1	30,000				30,000
Admission Fee	Once	282,000	1	282,000				282,000
Tuition Fee	Year	535,800	2	535,800				535,800
Air Fare to & from Japan	One way	100,000	2	100,000			100,000	200,000
Living Allowance	Monthly	145,000	36	580,000	1,740,000	1,740,000	1,160,000	5,220,000
				1,527,800	1,740,000	1,740,000	1,260,000	6,267,800

Non-Degree Program (1 year)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	1 yar
				FC
Air Fare to & from Japan	Return	150,000	1	150,000
Accommodation*1	Monthly	50,000	12	600,000
Living Allowance	Monthly	100,000	12	1,200,000
				1,950,000

*1: Unit Cost ofr Accommodation is a ceiling amount and actual expenses will be reimbursed.

Non-Degree Program (6 months)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	6 months
				FC
Air Fare to & from Japan	Return	150,000	1	150,000
Accommodation*1	Monthly	120,000	6	720,000
Living Allowance	Monthly	100,000	6	600,000
				1,470,000

*1: Unit Cost ofr Accommodation is a ceiling amount and actual expenses will be reimbursed.

Non-Degree Program (1 week)

Unit: FC: JPY

Item	Unit	Unit Cost	Quantity	1 week
				FC
Air Fare to & from Japan	Return	150,000	1	150,000
Accommodation*1	dayly	10,000	6	60,000
Living Allowance	dayly	5,000	6	30,000
				240,000

*1: Unit Cost ofr Accommodation is a ceiling amount and actual expenses will be reimbursed.

Attachment 15 Cost of visiting scholar

Cost of Visiting Scholar

Unit: JPY

Component/Cost Items	Unit Cost	Note	Total Cost	2014	2015	2016	2017	2018	2019	2020	2021	2022
1 Improvement of Undergraduate Program (Curriculum Improvement & Twinning Program)												
1) Short-term visiting scholar (type A)		Number	40	8	12	6	4	4	4	2	0	0
	454,500	Amount	18,180,000	3,636,000	5,454,000	2,727,000	1,818,000	1,818,000	1,818,000	909,000	0	0
2) Short-term visiting scholar (type B)		Number	58	0	14	14	12	8	8	2	0	0
	809,000	Amount	46,922,000	0	11,326,000	11,326,000	9,708,000	6,472,000	6,472,000	1,618,000	0	0
3) Long-term visiting scholar		Number	19	0	0	4	4	4	4	3	0	0
	8,850,000	Amount	168,150,000	0	0	35,400,000	35,400,000	35,400,000	35,400,000	26,550,000	0	0
4) Japanese language lecturers		Number	17	0	3	3	3	3	3	2	0	0
	4,890,000	Amount	83,130,000	0	14,670,000	14,670,000	14,670,000	14,670,000	14,670,000	9,780,000	0	0
2 Strengthening of Research and Educational (Overseas Degree Program & Joint Research)												
1) Short-term visiting scholar		Number	175	30	35	35	15	15	15	15	10	5
	809,000	Amount	141,575,000	24,270,000	28,315,000	28,315,000	12,135,000	12,135,000	12,135,000	12,135,000	8,090,000	4,045,000
2) Long-term visiting scholar		Number	15	0	2	2	2	2	2	2	2	1
	8,850,000	Amount	132,750,000	0	17,700,000	17,700,000	17,700,000	17,700,000	17,700,000	17,700,000	17,700,000	8,850,000
3 Development of Ready-Engineers for Urgent Needs (Kosen Program)												
1) Japanese language lecturers (1 year)		Number	11	1	2	2	2	2	1	1	0	0
	4,890,000	Amount	53,790,000	4,890,000	9,780,000	9,780,000	9,780,000	9,780,000	4,890,000	4,890,000	0	0
2) Local Japanese lang. lecturers (1 year)		Number	11	1	1	2	2	2	2	1	0	0
	960,000	Amount	10,560,000	960,000	960,000	1,920,000	1,920,000	1,920,000	1,920,000	960,000	0	0
3) Science subject lecturer		Number	18	0	3	3	3	3	3	3	0	0
	8,850,000	Amount	159,300,000	0	26,550,000	26,550,000	26,550,000	26,550,000	26,550,000	26,550,000	0	0
4) Local Science lecturers (1 year)		Number	6	0	1	1	1	1	1	1	0	0
	960,000	Amount	5,760,000	0	960,000	960,000	960,000	960,000	960,000	960,000	0	0
Total			820,117,000	33,756,000	115,715,000	149,348,000	130,641,000	127,405,000	122,515,000	102,052,000	25,790,000	12,895,000

Attachment 16 Unit cost of visiting scholar and Japanese language lecturer

Visiting Scholar from Japanese University (Short-term : 1 week)

Unit: JPY

Item	Unit Cost			Short-Term	
				Type A: 1 week	Type B: 2 weeks
Airfare	JPY	150,000	per trip	150,000	150,000
Insurance	JPY	15,000	per month	4,500	9,000
Per-diem	JPY	50,000	per day	300,000	650,000
Total				454,500	809,000

Visiting Scholar from Japanese University (Long-term : 1 week)

Unit: JPY

Item	Unit Cost			Long-term
				1 year
Airfare	JPY	150,000	per trip	150,000
Insurance	JPY	15,000	per month	180,000
Accommodation	JPY	110,000	per month	1,320,000
Honorarium	JPY	600,000	per month	7,200,000
Total				8,850,000

Japanese Language Lecturer from Japan

Unit: JPY

Item	Unit Cost			Long-Term
				1 year
Airfare	JPY	150,000	per trip	150,000
Insurance	JPY	15,000	per month	180,000
Accommodation	JPY	80,000	per month	960,000
Honorarium	JPY	300,000	per month	3,600,000
Total				4,890,000

Local Japanese Language Lecturer

Unit: JPY

Item	Unit Cost			Part-time	Long-Term
				1 month	1 year
Salary	JPY	80,000	per month	80,000	960,000
Total				80,000	960,000

Science subject lecturer for teaching in Kosen program

Unit: JPY

Item	Unit Cost			Long-Term
				1 year
Airfare	JPY	150,000	per trip	150,000
Insurance	JPY	15,000	per month	180,000
Accommodation	JPY	110,000	per month	1,320,000
Honorarium	JPY	600,000	per month	7,200,000
Total				8,850,000

Local Science subject lecturer for teaching in Kosen program

Unit: JPY

Item	Unit Cost			Part-time	Long-Term
				1 month	1 year
Salary	JPY	80,000	per month	80,000	960,000
Total				80,000	960,000

Attachment 17 Joint Research Fund

Joint Research Fund

Unit: JPY

JR No.	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022
1	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
2	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
3	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
4	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
5	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
6	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
7	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
8	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
9	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
10	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
11	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
12	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
13	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
14	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
15	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
16	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
17	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
18	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
19	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
20	3,500,000		500,000	500,000	500,000	500,000	500,000	500,000	500,000	
Total	70,000,000	0	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	0

Attachment 18 Cost for equipment and facility renovation

Equipment & Building Renovation

Unit: JPY

	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022
4-1 Educational Equipment	834,000,000		278,000,000	278,000,000	278,000,000					
4-2 Research Equipment	766,000,000		255,333,333	255,333,333	255,333,334					
4-3 Renovation of Building	108,000,000	108,000,000								

Attachment 19 Project Administration Cost

Project Administration Cost

Unit: JPY

Item	Unit Cost per Month	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
5 Project Administration											
1) Number of PIU Staff											
Head	150,000	1	1	1	1	1	1	1	1	1	1
Finance	80,000	8	8	8	8	8	8	8	8	8	8
Student Affairs	80,000	8	8	8	8	8	8	8	8	8	8
Academic Affairs	80,000	8	8	8	8	8	8	8	8	8	8
International Cordination	80,000	2	2	2	2	2	2	2	2	2	2
Clerk	40,000	5	5	5	5	5	5	5	5	5	5
2) Month	111	10	12	12	12	12	12	12	12	12	5
3) Miscellaneous Management Cost	1,000,000										
	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
4) Amount											
Head	16,629,705	1,500,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	729,705
Finance	70,953,408	6,400,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	3,113,408
Student Affairs	70,953,408	6,400,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	3,113,408
Academic Affairs	70,953,408	6,400,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	7,680,000	3,113,408
International Cordination	17,738,352	1,600,000	1,920,000	1,920,000	1,920,000	1,920,000	1,920,000	1,920,000	1,920,000	1,920,000	778,352
Clerk	22,172,940	2,000,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	972,940
Sub-total	269,401,221	24,300,000	29,160,000	29,160,000	29,160,000	29,160,000	29,160,000	29,160,000	29,160,000	29,160,000	11,821,221
5) Miscellaneous Management Cost	110,864,700	10,000,000	12,000,000	12,000,000	12,000,000	12,000,000	12,000,000	12,000,000	12,000,000	12,000,000	4,864,700
Total	380,265,921	34,300,000	41,160,000	41,160,000	41,160,000	41,160,000	41,160,000	41,160,000	41,160,000	41,160,000	16,685,921

Attachment 20-1 Cost of program development and support services (M/M)

Item		Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1) M/M of Consulting Service (in M/M)												
Academic Project Management Support												
- Foreign Consultant												
Project Management Expert	M/M in Mongolia	12.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1	0.5	0.5
	M/M in Japan	12.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1	0.5	0.5
	Sub-Total	25.0	3	3	3	3	3	3	3	2	1	1
Educational Exchange Expert 1	M/M in Mongolia	68.0	4	10	10	10	10	10	10	2	1	1
	M/M in Japan	1.0	1	0	0	0	0	0	0	0	0	0
	Sub-Total	69.0	5	10	10	10	10	10	10	2	1	1
Educational Exchange Expert 2	M/M in Mongolia	0.0	0	0	0	0	0	0	0	0	0	0
	M/M in Japan	45.0	5	5	5	5	5	5	5	4	4	2
	Sub- Total	45.0	5	5	5	5	5	5	5	4	4	2
Educational Exchange Expert 3	M/M in Mongolia	0.0	0	0	0	0	0	0	0	0	0	0
	M/M in Japan	92.0	6	11	11	11	11	11	11	9	8	3
	Sub-Total	92.0	6	11	11	11	11	11	11	9	8	3
Total		231.0	19	29	29	29	29	29	29	17	14	7
- Local Personnel												
Expert 1		107.0	6	12	12	12	12	12	12	12	12	5
Expert 2		84.0	6	12	12	12	12	12	12	6	0	0
Expert 3		84.0	6	12	12	12	12	12	12	6	0	0
Expert 4		72.0	6	12	12	12	12	12	6	0	0	0
Secretary		107.0	6	12	12	12	12	12	12	12	12	5
Total		454.0	30	60	60	60	60	60	54	36	24	10
Procurement Support												
- Foreign Consultant												
Equipment planner 1	M/M in Mongolia	6.0	3	1.5	1.5							
	M/M in Japan	4.5	1.5	1	2							
	Sub-Total	10.5	4.5	2.5	3.5	0	0	0	0	0	0	0
Equipment planner 2	M/M in Mongolia	6.0		4.5		1.5						
	M/M in Japan	4.5		2.5		2						
	Sub-Total	10.5	0	7	0	3.5	0	0	0	0	0	0
Equipment planner 3	M/M in Mongolia	6.0			3	1.5	1.5					
	M/M in Japan	4.5			1.5	1	2					
	Sub-Total	10.5	0	0	4.5	2.5	3.5	0	0	0	0	0
Total		31.5	4.5	9.5	8	6	3.5	0	0	0	0	0
Grand Total		685.0	49	89	89	89	89	89	83	53	38	17

Attachment 20-2 Cost of program development and support services (Quantity related to direct Cost)

Item	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
2) Quantity related to direct Cost											
Number of International Trip											
Project Management Expert	26	3	3	3	3	3	3	3	2	2	1
Educational Exchange Expert 1	20	1	2	2	2	2	2	2	3	3	1
Educational Exchange Expert 2	10	1	1	1	1	1	1	1	1	1	1
Educational Exchange Expert 3	10	1	1	1	1	1	1	1	1	1	1
Equipment planner 1	4	2	1	1							
Equipment planner 2	4		3		1						
Equipment planner 3	4			2	1	1					
	78	8	11	10	9	8	7	7	7	7	4
Number of Domestic Trip											
Project Management Expert	23	4	4	4	4	2	1	1	1	1	1
Educational Exchange Expert 1	23	4	4	4	4	2	1	1	1	1	1
Educational Exchange Expert 2	88	10	10	10	10	10	10	10	10	5	3
Educational Exchange Expert 3	88	10	10	10	10	10	10	10	10	5	3
Equipment planner 1	4	2	1	1							
Equipment planner 2	4		2	1	1						
Equipment planner 3	4			2	1	1					
	234	30	31	32	30	25	22	22	22	12	8
Number of days in Mongolia											
Project Management Expert	275	45	30	30	30	30	30	30	20	20	10
Educational Exchange Expert 1	1,990	120	300	300	300	300	300	300	30	30	10
Educational Exchange Expert 2	0	0	0	0	0	0	0	0	0	0	0
Educational Exchange Expert 3	0	0	0	0	0	0	0	0	0	0	0
Equipment planner 1	180	90	45	45	0	0	0	0	0	0	0
Equipment planner 2	180	0	135	0	45	0	0	0	0	0	0
Equipment planner 3	180	0	0	90	45	45	0	0	0	0	0
	2,805	255	510	465	420	375	330	330	50	50	20
Month of Office use											
Office in UB	107	6	12	12	12	12	12	12	12	12	5
Office in Tokyo	107	6	12	12	12	12	12	12	12	12	5

Attachment 20-3 Cost of program development and support services (Unit Cost)

3) Unit Cost

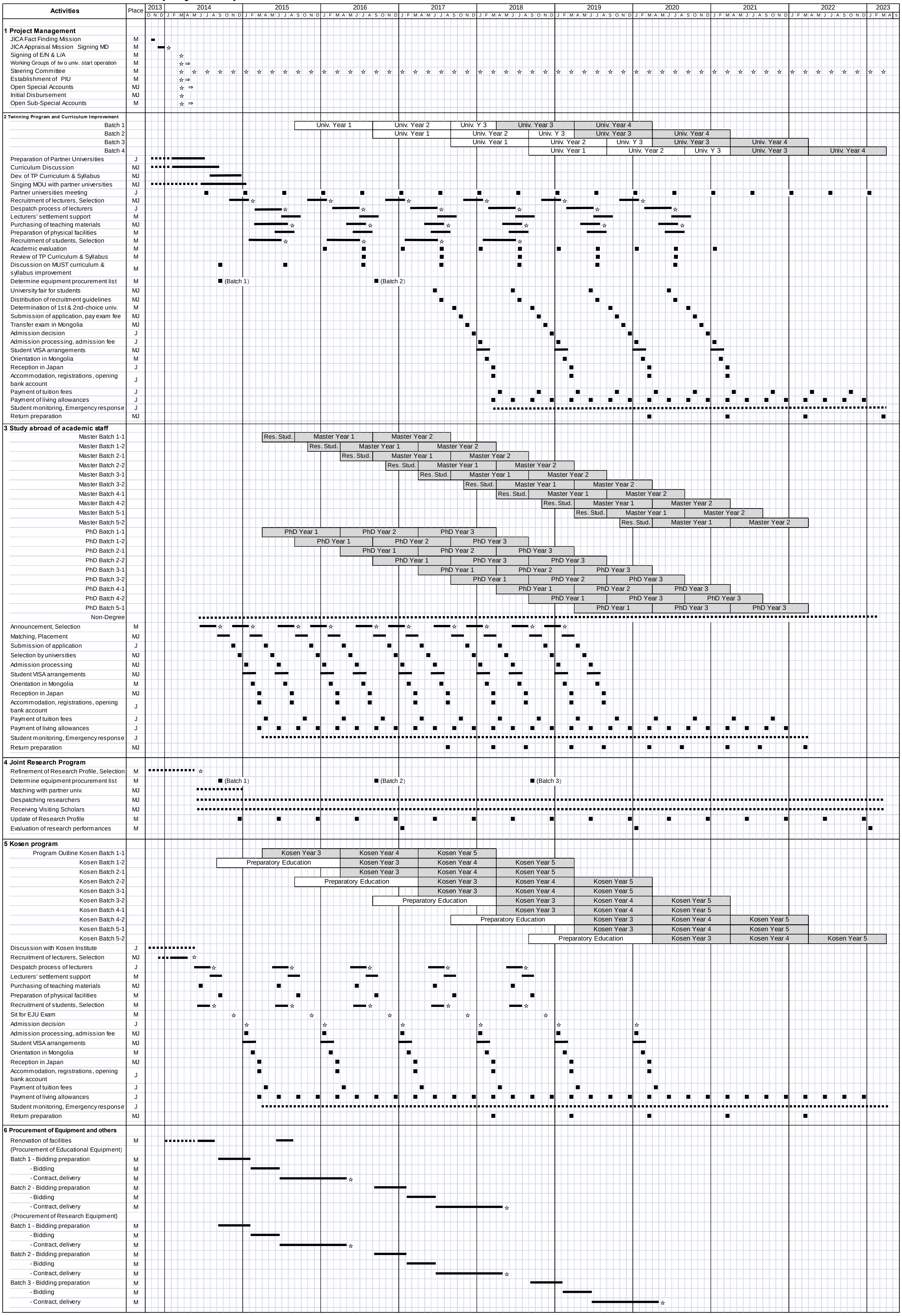
Item	JICA Grade	a Personnel Cost	b=a*100% Management Fee 100%	c=(a+b)*20% Technical Fee 20%	Total
Personnel related Unit Cost per month					
- Foreign Consultant					
Project Management Expert	Grade 2	894,000	894,000	357,600	2,145,600
Educational Exchange Expert 1	Grade 3	778,000	778,000	311,200	1,867,200
Educational Exchange Expert 2	Grade 4	630,000	630,000	252,000	1,512,000
Educational Exchange Expert 3	Grade 5	524,000	524,000	209,600	1,257,600
Equipment planner 1	Grade 3	778,000	778,000	311,200	1,867,200
Equipment planner 2	Grade 3	778,000	778,000	311,200	1,867,200
Equipment planner 3	Grade 3	778,000	778,000	311,200	1,867,200
- Local Personnel					
Expert		100,000	100,000		200,000
Secretary		50,000	50,000		100,000
- Other Cost					
International Transportation	150,000	per trip			
Domestic Transportation	10,000	per trip			
Insurance	500	per day			
Accomodation (a)	150,000	per month			
Accomodation (b)	12,000	per day			
Per-diem	5,000	per day			
Office & Miscellaneous Cost					
in Mongolia	350,000	per month			
in Japan	400,000	per month			

Attachment 20-4 Cost of program development and support services (in JPY)

4) Cost of Consul tinting Service (in JPY)

Item	Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
- Remuneration : Foreign Consultant											
Project Management Expert	53,640,000	6,436,800	6,436,800	6,436,800	6,436,800	6,436,800	6,436,800	6,436,800	4,291,200	2,145,600	2,145,600
Educational Exchange Expert 1	128,836,800	9,336,000	18,672,000	18,672,000	18,672,000	18,672,000	18,672,000	18,672,000	3,734,400	1,867,200	1,867,200
Educational Exchange Expert 2	68,040,000	7,560,000	7,560,000	7,560,000	7,560,000	7,560,000	7,560,000	7,560,000	6,048,000	6,048,000	3,024,000
Educational Exchange Expert 3	115,699,200	7,545,600	13,833,600	13,833,600	13,833,600	13,833,600	13,833,600	13,833,600	11,318,400	10,060,800	3,772,800
Equipment planner 1	19,605,600	8,402,400	4,668,000	6,535,200	0	0	0	0	0	0	0
Equipment planner 2	19,605,600	0	13,070,400	0	6,535,200	0	0	0	0	0	0
Equipment planner 3	19,605,600	0	0	8,402,400	4,668,000	6,535,200	0	0	0	0	0
- Remuneration : Local Consultant											
Expert 1	21,400,000	1,200,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	1,000,000
Expert 2	16,800,000	1,200,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	1,200,000	0	0
Expert 3	16,800,000	1,200,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	1,200,000	0	0
Expert 4	14,400,000	1,200,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	1,200,000	0	0	0
Secretary	10,700,000	600,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	500,000
Sub-total	505,132,800	44,680,800	75,040,800	72,240,000	68,505,600	63,837,600	57,302,400	56,102,400	31,392,000	23,721,600	12,309,600
- Other Cost											
International Transportation	11,700,000	1,200,000	1,650,000	1,500,000	1,350,000	1,200,000	1,050,000	1,050,000	1,050,000	1,050,000	600,000
Domestic Transportation	2,340,000	300,000	310,000	320,000	300,000	250,000	220,000	220,000	220,000	120,000	80,000
Insurance	1,402,500	127,500	255,000	232,500	210,000	187,500	165,000	165,000	25,000	25,000	10,000
Accomodation (a)	16,050,000	900,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	750,000
Accomodation (b)	9,780,000	1,620,000	2,520,000	1,980,000	1,440,000	900,000	360,000	360,000	240,000	240,000	120,000
Per-diem	14,025,000	1,275,000	2,550,000	2,325,000	2,100,000	1,875,000	1,650,000	1,650,000	250,000	250,000	100,000
Office & Miscellaneous Cost											
in Mongolia	37,450,000	2,100,000	4,200,000	4,200,000	4,200,000	4,200,000	4,200,000	4,200,000	4,200,000	4,200,000	1,750,000
in Japan	42,800,000	2,400,000	4,800,000	4,800,000	4,800,000	4,800,000	4,800,000	4,800,000	4,800,000	4,800,000	2,000,000
Sub-total	135,547,500	9,922,500	18,085,000	17,157,500	16,200,000	15,212,500	14,245,000	14,245,000	12,585,000	12,485,000	5,410,000
Total	640,680,300	54,603,300	93,125,800	89,397,500	84,705,600	79,050,100	71,547,400	70,347,400	43,977,000	36,206,600	17,719,600

Attachment 21 Overall project implementation schedule



Attachment 22 Current condition of facilities at National University of Mongolia (NUM) and Mongolian University of Science and Technology (MUST)

Circumstances of the Project Sites

Mongolia has a total land area of 1,564,000 km^2 (approx. four times the total land area of Japan) and a population of 2,810,000 (2011 figures). It is located in the eastern part of Central Asia between Russia and the Xinjiang Uyghur Autonomous Region of China.

1) City of Ulaanbaatar

The project sites are located in the City of Ulaanbaatar (hereinafter UB), the capital of Mongolia, located at 47º55'N and 106 º55'12" E. The city has a total land area of 4,704.4 km^2. It is located a little north of the center of the country in a basin surrounded by mountains with an altitude of approx. 2000 m.

2) Population

The population of UB is approx. 1,220,000 (2012 figures), which is nearly twice as many as 650,000 in 1998. There is a continuing influx of population from rural areas to the city.

3) Climate

UB has a typical continental climate characterized by dry weather throughout the year, the existence of four seasons and extremely large diurnal and annual temperature ranges. While the maximum temperature in summer exceeds 30 ºC, the minimum temperature in winter is below -30 ºC. The average diurnal temperature range is between 25 ºC and 30 ºC. The average annual temperature is below 0 ºC. Heating is required from mid-September to mid-May. The annual precipitation is only approx. 250 mm. Approximately 70 % of the rainfall occurs in the summer months of June, July and August. The air is dry throughout the year with relative humidity ranging between 40 and 75 %. Static electricity is generated in winter because of the dry weather. Strong gusts characteristic of the continental climate are recorded throughout the year, but mainly in spring and fall. Strong winds also cause tornadoes, sandstorms and large Asian dust storms.

Table: Climates in Ulaanbaatar
(Average Temperature and Precipitation by Month)

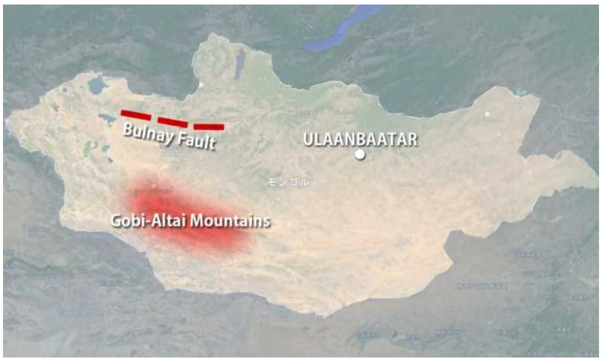
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly Average / Total
Average Temperature	℃	-22.3	-17.2	-9.0	0.9	9.4	14.4	16.9	15.1	8.3	-0.3	-12.2	-19.9	-1.3
Average Low Temperature	℃	-33.2	-30.1	-23.7	-14.3	-6.3	1.3	5.3	3.2	-5.1	-14.9	-25.1	-31.5	-14.4
Average High Temperature	℃	-7.3	-1.0	9.9	20.1	27.9	30.4	30.9	29.3	25.0	18.4	5.9	-4.9	15.5
Precipitation	mm	2.0	2.0	3.3	8.4	13.4	50.9	65.7	76.3	32.1	8.3	4.9	3.2	270.5
Number of Rainy Days	days	4.1	2.9	3.8	5.1	5.8	11.9	15.6	14.3	7.9	4.7	5.1	5.5	86.7

Source: World Meteorological Organization, averages over the 31-year period between 1971 and 2001

4) Earthquakes and Ground

The record of earthquakes in Mongolia includes such mega quakes as the Tsetserleg (Mw 8.1) and Bulnay Earthquakes (Mw 8.3) caused by active faulting in northwestern Mongolia in July 1905, and the Gobi-Altai Earthquake (Mw 8.3) in December 1957. The earthquake hazard map of UB shows that the city area is classified into areas of degree VI - VIII on the MSK (Medvedev-Sponheuer-Karnik) 64 scale, which correspond to a seismic intensity of four to five on the Japanese seismic intensity scale.

Recent studies revealed a slight increase in the number of unfelt earthquakes, which could be interpreted as a sign of a period of high seismic activity, and the existence of four active faults within 30 km of UB. On the basis of these findings, the possibility of the occurrence of an M7 earthquake has been raised. As many buildings have inadequate seismic performance, such an earthquake can be expected to cause suffering to many people.



Past seismic activities in Mongolia

Source http://www.bcj.or.jp/c20_international/cooperation/src/Presentation1.pdf

Earthquake hazard map of UB

5) Roads (Urban Planning)

Chronic road congestion has been a problem in UB. The congestion is caused by the poor road network design in the city: *i.e.* there is only one trunk road in the city which runs east-west, and all the main roads in the city run through the city center. The increase in the number of vehicles brought about by rapid economic growth is another cause of the congestion. Since there are few parking lots in the city, many people park their vehicles on the road.

Roads are in poor condition even in some areas of the city center. In order to avoid the damaged sections, many drivers drive outside the traffic lanes. This behavior causes traffic chaos. Work to alleviate this problem is in progress. However, since it is impossible to implement road works in winter because of the cold weather and frozen ground, all road works must be implemented simultaneously during the summer. This simultaneous implementation of road works is another cause of congestion.

Study of the Current State of the Facilities (in NUM, MUST and MUST-ME)

1) Sites, Location and Layout of the Campuses

The campus of NUM and the main campus of MUST, where there are the project sites, are located in Sükhbaatar District of UB, within a 3 km radius of Sükhbaatar Square in the center of the city.

Figure. Locations of the National University of Mongolia and the Mongolian University of Science and Technology

The main campuses of the two universities are located within 1 km of the city center. There are student dormitories on the campus of NUM. While the campus of the School of Mechanical Engineering in MUST (MUST-ME) is not located near the city center, it takes only a 10 to 30 minute drive to reach the campus from the city center. As the student dormitories are on campus, students have good access to the campus.

2) Current State of the Facilities

The buildings on the campuses of NUM and MUST were constructed in 1946, during the Soviet era. In these buildings, there is a hallway in the middle of each floor with classrooms on both sides of the hallway. Although the buildings were originally lecture room buildings, some of the classrooms have been refurbished into laboratories because of the shortage of laboratories.

① Buildings

- Most of the buildings on the campuses are of reinforced concrete structure. The exterior walls are of thick brick masonry construction with a thickness of approx. 650 – 700 mm for thermal insulation.
- Wood-patterned vinyl sheets were laid over the original floor slabs. The floor has been repaired by overlaying vinyl flooring sheets on damaged parts of the wooden flooring, without repairing the damage.
- Windows in the buildings have been renovated with a combination of double glazing and resin sashes, for thermal insulation in cold weather.
- Some buildings still have their original windows with wooden sashes and single glazing. As these windows have no thermal insulation function in their glass sections, they are ineffective in protecting the interior of the buildings from the cold.

Photograph: A renovated window (2nd Building, MUST)

Photograph: A window which has not been renovated (6th Building, NUM)

- Most of the rooms used as laboratories used to be lecture rooms (classrooms). Therefore, they are not equipped with the water supply, sewerage or ventilation systems appropriate for carrying out experiments and research.

- Some laboratories are equipped with water and sewer piping, which is assumed to have been extended from the toilets.

② Water Supply and Domestic Hot Water Supply

- Water is supplied to the campuses directly from the city water system. As the campuses are large, water pressure is low in some parts of the campuses. In order to compensate for the fall in pressure and to supply water to every building, booster pumps with tanks have been installed directly onto the city water extension mains.
- The booster pumps are installed underground beneath buildings, as is also the case with the hot water supply plants for heating. There is allegedly no problem in the system. However, as the low cistern toilets and urinals with flush valves are stained with rusty water, there seems to be a problem with water quality or with degradation of the piping materials. As the buildings have also deteriorated due to age and use, the water supply is cut off approx. once a month for maintenance work.
- Domestic hot water is supplied to designated sinks and washbasins in the buildings. The domestic hot water on the campuses is generated by heat exchange between the hot water supply for heating and the city water, by means of tube heat exchangers. There is no supply of domestic hot water to the campuses in summer, because the supply of hot water for heating is suspended during the summer.
- Buildings on the campuses of NUM and MUST are equipped with indoor fire hydrants and fire extinguishers. The water supply pipes for the indoor fire hydrants are connected directly to the water supply system.

③ Sewerage

- Sewage and greywater generated in facilities on the campuses are combined and discharged directly into the municipal sewer main installed beneath the roads around the campuses.
- Wastewater from experiments is discharged into the municipal sewer mains directly, without treatment. However, since the establishment of environmental standards, highly concentrated acids, alkaline solutions and organic solvents have been placed in separate containers and their disposal outsourced to companies specializing in the treatment of such substances.
- Rainwater from the buildings on the campuses is discharged directly onto the campus ground. Therefore, water puddles form at times of heavy rain.

④ Hot Water Supply System for Heating, Air-conditioning and Ventilation

- Hot water supply system for heating is supplied from the hot water supply system for district heating to the hot water supply plant for heating (installed with city water supply and domestic hot water supply equipment) installed beneath each building on the campuses. In order to prevent freezing of the city water in winter, in most places the extension mains of hot water for heating and city water are installed side-by-side.
- The temperature of the hot water for heating is approx. 100 – 120 ºC. The temperature varies to a certain extent according to the season. The hot water for heating supplied to the buildings on the campuses goes through plate heat exchangers and is pumped up to different parts of the buildings for heating. The hot water supply plant is equipped with a thermometer, pressure gauge, temperature control valve, and flow meter. These receiving facilities and pumps are operated automatically.
- Each room and staircase in the facilities is heated with hot water radiators. The temperature in heated rooms is approx. 17 – 20 ºC. In principle, air-conditioning is not used in the buildings. However, certain rooms without windows and those for specific use are equipped with air-cooled air conditioners. Laboratories are equipped with draft chambers, and exhaust ducts are connected to exhaust fans installed on each floor or on the roof. However, the ducts and exhaust fans are old and rusted, and some of them do not function. As a small vent located on the wall on the hallway side is the only source of air supply to a laboratory, the draft chamber cannot exert its full exhaust capacity.

⑤ Waste

- Waste generated on each campus is gathered at a single location, and the gathered waste is collected every day by the municipal waste collection corporation. The waste is transported to the municipal waste collection sites at three locations in the city and disposed of by being piled up in the open. Certain special laboratory waste is disposed of as industrial waste in the new municipal incinerator.

The figure below shows a simple flow diagram of the supply of water, domestic hot water and hot water supply system for district heating on campus.

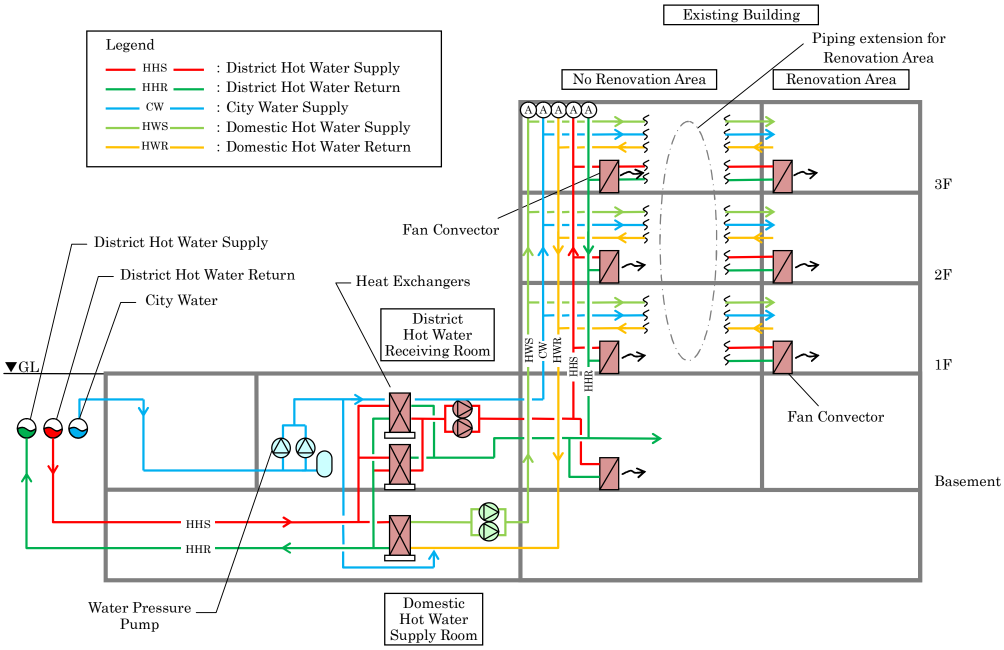


Figure: Flow of the supply of water, domestic hot water and district heating

A drawing of the infrastructure on each campus is attached to the description of the current state of each building.

⑥ Electricity

- Buildings in UB receive low-voltage power from a local substation of the power company. The capacity of each local substation is only on the order of hundreds of kVA. Therefore, power is supplied to large-demand consumers via extensions from multiple local substations or from a substation dedicated to the consumer concerned.
- None of the three campuses has a dedicated substation. Each campus is provided with low-voltage power via extensions from more than one local substation.
- Voltage is somewhat unstable, possibly due to poor maintenance of the power distribution system or due to the imbalance between supply and demand. Application of emergency generators is limited to few laboratories with small-capacity generators, used only for experimental equipment.
- The electrical installations in the buildings on the three campuses are for use at low voltages (380V/220V). There are buildings in which the original installation are still in use, buildings in which only the wiring devices including circuit breakers have been replaced, and buildings in which the entire switchboard has been replaced. Regardless of the differences in the current status of the installations between the buildings, the capacity of the extension lines is not adequate, and the buildings do not

have extra wiring or circuit breakers to supply power for the installation expansion. Therefore, the installation of additional large-scale experimental facilities is considered difficult.

3) National University of Mongolia (NUM)

- NUM was established in 1942. Its campus is located to the northeast of Sükhbaatar Square which is in the center of the city. The university has 16 faculties, which are accommodated in a number of buildings. The existing buildings were constructed in the 1946. The 1st, 2nd and 6th Buildings, which accommodate science laboratories, will be extended/renovated in this project.
- The 1st Building is a three-storied (partially five-storied) building. It houses the Office of the President, administrative departments, the Faculties of Physics, Electronics and Chemistry.
- The 2nd Building is a four-storied building. It houses the Faculty of Biology and the Faculty of Biotechnology.
- The 6th Building is a two-storied building. University operations occupy the southern part of the first floor. The building also houses part of the Faculty of Chemistry.
- Part of the first floor of a student dormitory was renovated into laboratories of the School of Biotechnology.

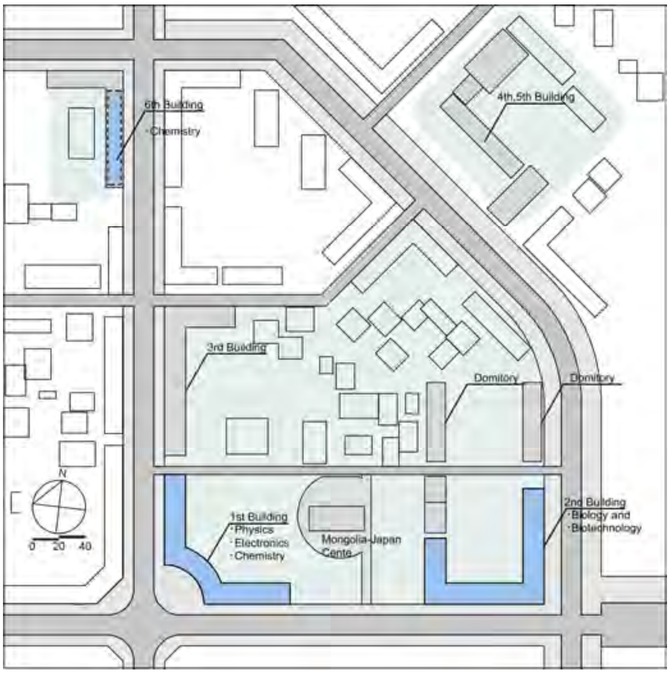
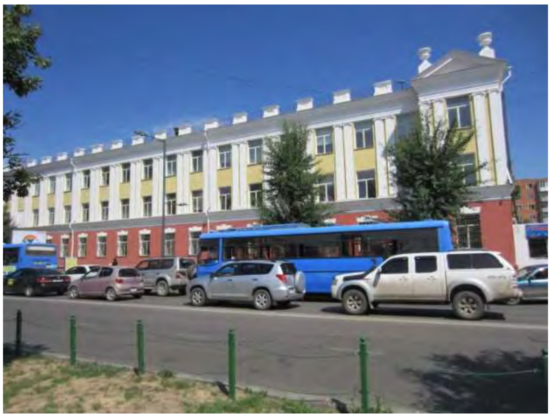


Figure: Building Layout on the NUM campus

Photograph: Façade of the 1st Building



Photograph: 1st The Building viewed from the road to the south

Photograph: The southern side of the 2nd Building viewed from the road to the south

Photograph: The 6th Building viewed from the intersection to the north.

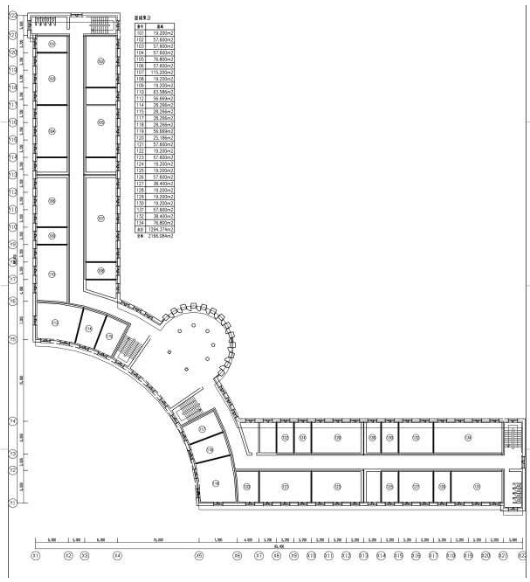


Figure: Floor plan of the first floor of the 1st Building

Figure: Floor plan of the first floor of the 2nd Building

① Building

- Relatively frequent repainting has slowed down the degradation of the exterior of the old 1st and 2nd Buildings. These two buildings were constructed with almost identical specifications, which include a floor plan with a corridor running through the middle of the building and classrooms and laboratories on either side of the corridor.
- The 6th Building is located a little distance away from the rest of the university buildings. Part of the building, which was formerly used for a different purpose (as a vocational school) is used by the university. The interview survey revealed that the 6th Building had been constructed before the 1st and 2nd Buildings. Its appearance, with partially collapsed walls and warped doors, also gives the impression of a building that is quite old.
- The floor sags and feels soft in places when walked on. Benches are unstable because the floors on which they stand are warped. Vibration from people walking in the corridor reaches the nearby laboratories and sometimes affects the results of experiments.
- New chemical-resistant and abrasion-resistant PVC sheets have been laid over the floor of some laboratories. However, as these sheets are simply laid over the existing floor sheets, these sheets have not provided any fundamental solution to the problems.

Photograph: A flooring sheet laid over the old floor

Photograph: A large gap under a door created by warping of the floor

② Water Supply and Sewerage System

- Water is supplied to the NUM campus directly from the city water system. As the water pressure of the water supply system drops within the campus because of the large land area, a booster pump with large tank has been installed and is used for supplying water to every building on the campus. The city water receiving station and the pump station are located in the basement of the dormitory in the western part of the campus. A relay water supply base is located to the east of the 1st Building.
- Some laboratories are equipped with sinks and research equipment. Exposed piping along

the ceiling or piping across the walls is used to supply water to them. A water main is installed on the ceiling of the corridor on each floor. Pipes supplying water to the sinks and equipment branch off from the main pipe. Drain pipes from the sinks and equipment are presumably connected to a sewer main installed on the ceiling of the corridor of the floor below after running through the floor, making a 90º turn at the ceiling of the room below and running across the ceiling to the main.

③ Hot Water Supply System for Heating, Air-conditioning and Ventilation

- Hot water supply system for heating is supplied from the hot water supply system for district heating to the heating hot water supply plant (installed together with the facilities for the city water supply and domestic hot water supply) located in the basement of a dormitory in the western part of the campus. To supply hot water to the 1st Building, a heating hot water supply sub-plant is installed to the east of the building.
- Because of the lack of installation space, cylinders of specialty gases, *e.g.* oxygen, nitrogen, carbon dioxide, nitrous oxide, hydrogen, argon and pure air, are installed in what seems a dangerous manner in the chemistry laboratories.
- Each room is equipped with hot-water radiators. Hot water is supplied to the radiators through piping which branches off from the hot water main on the ceiling of the nearest corridor or from the exposed vertical hot water pipe.

The figure below shows the locations of the infrastructure and its extensions on and around the NUM campus.

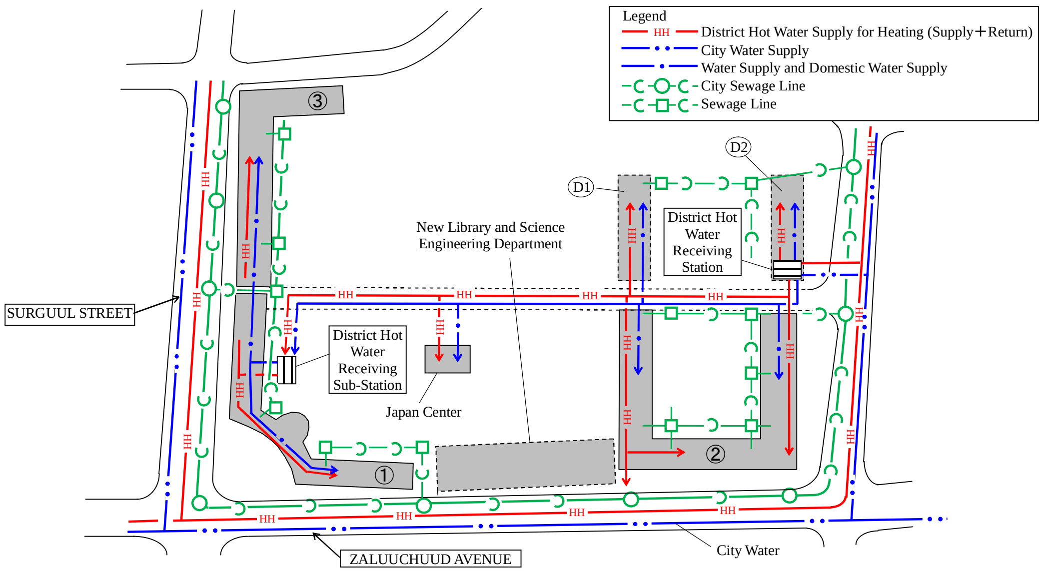


Figure: Locations of the infrastructure and its extensions on and around the NUM campus

④ Electricity and Communications

- One or more low-voltage (380/220V) power lines extend from nearby local substations of the power company to the campus. With the exception of small buildings, no building on the campus has a central power control system. Instead, a distribution panel installed at a service entrance point is used to distribute power to distribution panels on each floor or in the laboratories.
- Wiring that penetrates walls and floors and is embedded in the framework throughout the original construction of the building makes it difficult to carry out comprehensive rewiring to increase the power supply capacity in the buildings.
- In renovated areas wiring are either in exposed conduits and simple laid above the false ceiling.
- Wall-embedded wiring devices, such as switches and breakers, are found in areas where apparatus installed in the original construction is still in use, while exposed flush mount wiring devices on walls and ceilings are found in renovated areas.
- In some of the switchboards installed in the original construction work and still in use, breakers and wiring have been replaced with more recent products, while others still have the old-type wiring apparatus, breakers and fuses that were installed at the time of the original construction. The use of such old apparatus prevents any significant increase in the power supply capacity through renovation. In fact, the users of some of the laboratories report the inadequate capacity of the power supply.
- Fluorescent lights are the main light source. The resulting illuminance is more or less equivalent to or slightly less than the illuminance standard in Japan. The light control system in use is a local control with rocker switches on the wall. There is no use of light control timers or a central lighting control system. Type A, C or O wall sockets are installed in the buildings so that electric equipment fitted with the different types of plugs available in Mongolia can be used.
- In some buildings, each school has its own telephone lines installed, while others have extension telephone networks and local area networks, with telephone switchboards and network equipment.

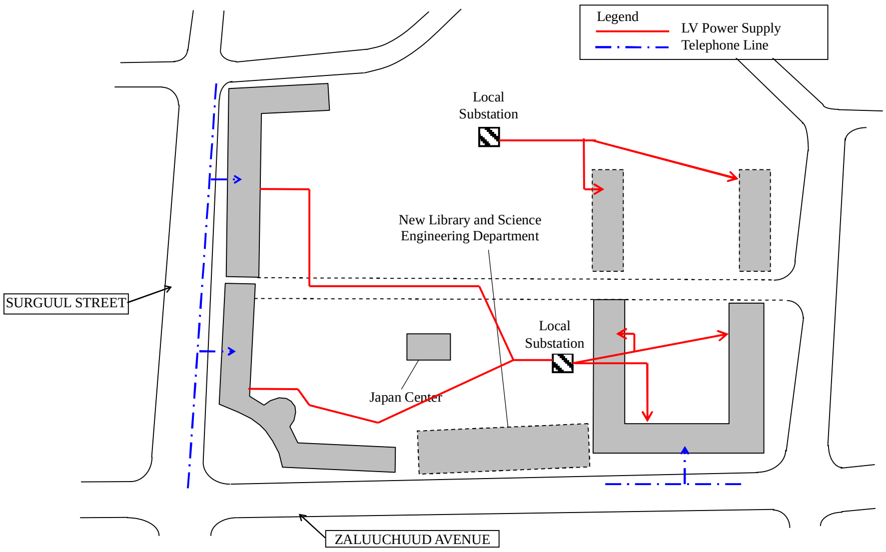


Figure: Diagram of the extensions of the power supply and telephone lines on and around the NUM campus

4) Mongolian University of Science and Technology (MUST)

- MUST was established in 1959. It is located in a city block diagonally across from where the NUM campus is located. The 1st – 3rd Buildings, T-Building and the Library Building are on the MUST campus. As a result of repeated extensions to these buildings, the building layout on the campus has become very complex. The 2nd Building and T-Building are to be extended/renovated in this project. (Figure 00)
- The 1st Building is a four-storied building. It houses the Office of the President of MUST, major administrative departments and the Department of xxx.
- The 2nd Building is a seven-storied building, with one basement floor and six floors above ground level. It is occupied mainly by the Department of Civil Engineering and the Department of Electrical Engineering.
- The 3rd Building is a four-storied building. It houses a lecture hall and the Department of xxx.
- T-Building is a six-storied building with one basement floor and five floors above ground level. The building has a room shaped like a quarter-circular hall. There is a bridge connecting the second floor of the building to the second floor of the 2nd Building.
- The Library Building is a new building, constructed in 2007. It has one basement floor and six floors above ground level. It has an excellent network environment in addition to its library functions. It houses information/communications facilities and an auditorium.

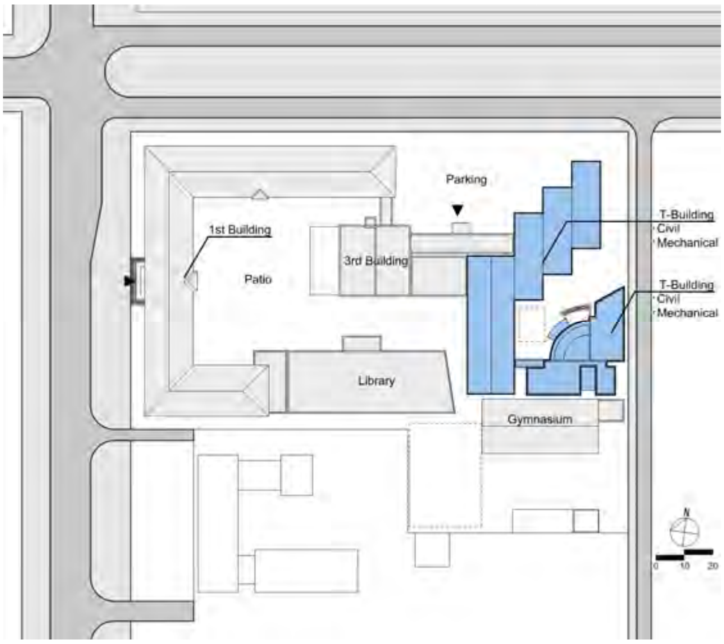


Figure: Building layout on the MUST campus

Photograph: The 1st Building
(viewed from the patio)

Photograph: The 2nd Building
(viewed from the parking lot)

Photograph: T-Building (in the foreground)

Photograph: Library Building (viewed from the patio)

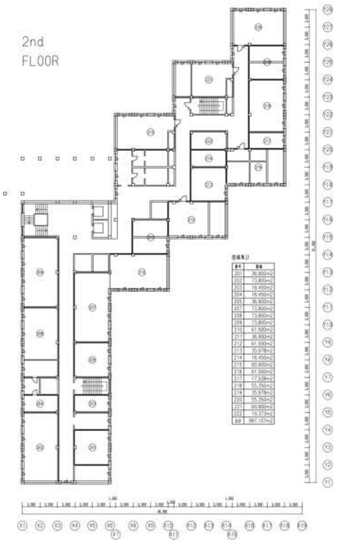


Figure: Floor plan of the second floor of the 2nd Building

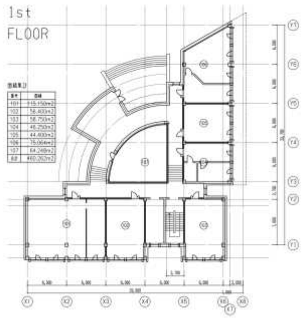


Figure: Floor plan of the first floor of T-Building

① Buildings

- The 2nd Building has a visibly perceptible lean. The leaning has been caused by a combination of factors, including poorly executed construction work, the relationship between the depth of the building foundations and the depth of frost penetration, and land subsidence.
- These factors have also caused warping in an elevator shaft and made the elevator in it unusable.
- The building was originally constructed with five floors above ground, and an additional floor was later added onto the roof of the original building. This additional floor has created problems relating to traffic lines as well as functional problems.
- The ceiling height of approx. 3.2 m in this building is lower than in the other buildings. This low ceiling height makes further extension of the water supply and sewerage systems difficult.

Photograph: A leaning pillar in the elevator hall

Photograph: An elevator made unusable due to leaning of the framework

- T-Building was constructed in the 1980's. It is the only building in the university which has an exterior curtain wall finished with bricks.
- There is a step in the middle of the corridor, presumably to adjust the level. However, because the building is newer than the 2nd Building, there is little leaning observed in the corridors and walls of T-Building.
- There is a plan to construct a pre-fabricated laboratory building with a floor area of 110 m^2 on a vacant lot between T-Building and the 2nd Building. However, as the person in charge of the construction plan was not available at the time of the survey, there has been no confirmation of the outline of the facility or of any request for assistance.

Photograph: Laboratory on the first floor of T-Building

Photograph: Planned site of new laboratory building

② Water Supply and Sewage System

- An underground city water main runs across the campus. Water used on the campus is drawn from the main at three locations on the campus to the three receiving stations (to the north of the 1st Building, the Library Building and the 3rd Building). As the water pressure in the water supply system drops on the campus because of the large land area, small booster pumps are installed directly onto the extension mains at several locations.

- Laboratories are equipped with sinks and research equipment. Exposed piping on the ceiling or wall is used to supply water to the sinks and equipment. A water main is installed on the ceiling of the corridor on each floor. Pipes supplying water to the sinks and equipment branch off from this main. Drain pipes from the sinks and equipment are presumably connected to a sewer main installed on the ceiling of the corridor of the floor below after running through the floor, making a 90º turn onto the ceiling of the room below and running across the ceiling to the main.

③ Hot Water Supply System for Heating, Air-Conditioning and Ventilation

- Hot water for heating is supplied from the main of the hot water for district heating which runs across the campus to the heating hot water supply plants (installed together with the facilities for the city water supply and domestic hot water supply) on the campus, in the same way as the city water. The plants are installed in the northern side of the 1st Building, the Library Building and the basements of the 3rd Building, as is the case with the city water system.
- Each room is equipped with hot-water radiators. Hot water is supplied to the radiators through piping which branches off from the hot water main on the ceiling of the nearest corridor or exposed vertical hot water pipe.

The figure below shows the locations of the infrastructure and its extensions on and around the MUST campus.

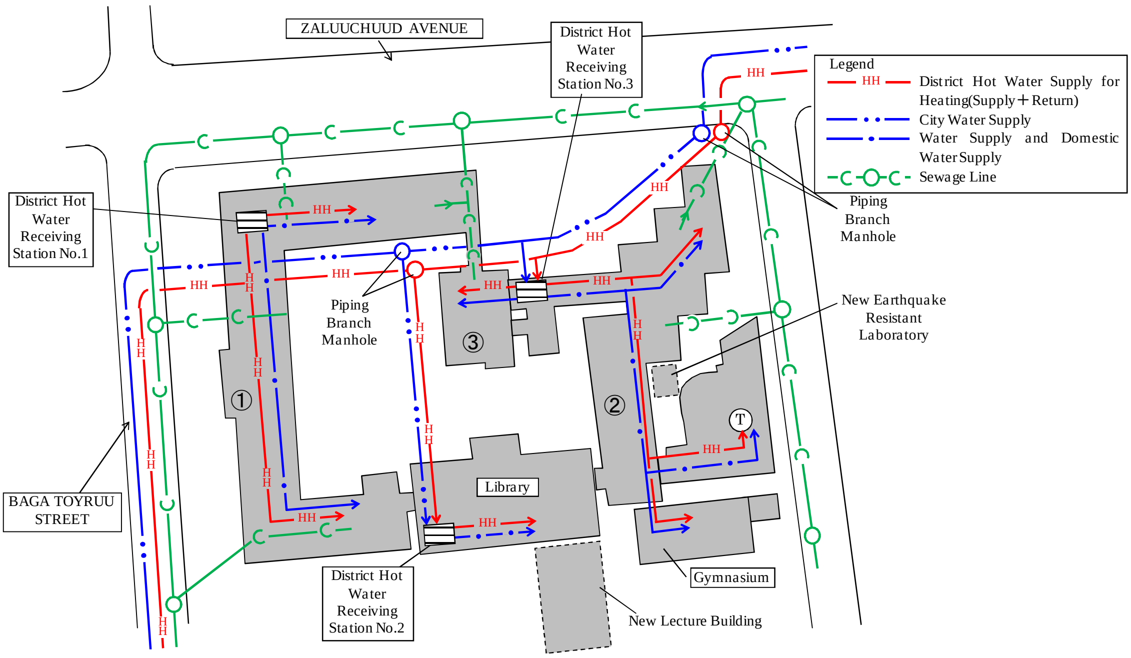


Figure: Locations of the infrastructure and its extensions on and around the MUST campus

④ Electricity and Communications

- Underground low voltage (380/220V 50Hz) 3φ4W power lines extend from a nearby local substation of the power supply company to the electric room on the campus. Metering is done at the switchboard at the service entry point. Power is distributed from the switchboard to local panels in individual rooms (only where heavy-load equipment/facilities are installed) and in each zone of the campus.
- Wiring method is either by conduits or simple laid wiring on false ceiling space. Conduits and wiring embedded in walls and ceilings are also used in some places. In addition, exposed flush mount wiring and wiring apparatus on the walls and ceilings are found in renovated areas. The embedded wiring and wiring apparatus pose a difficulty in replacement or renovation.
- Because of the buildings are relatively new, the existing wiring and wiring apparatus seem to be in a condition that will allow their continued use. However, there are concerns over the capacity of the power distribution system on the campus, which may not be sufficient to meet the demands of modern experimental equipment. Voltage drops occasionally cause the lights to flicker (several times a week) and power outages occur with a frequency of once a month to once every few months. The increasing demand for power and the limited capacity of the power supply distribution network are seen as the cause of these problems. Only small emergency generators for use by individual departments or for specific purposes are found on the campus. There is no emergency generator large

enough to meet the demands of the entire campus. Each room containing heavy-load equipment is equipped with a local switchboard to supply power in the room.

- Fluorescent lights are the main light source. The effective illuminance is equivalent to or slightly less than the illuminance standard in Japan. The light control method is a local control with rocker switches on the wall. There is no use of light control timers or a central light control system. Type A, C or O wall sockets are installed in the buildings so that electric equipment fitted with the different types of plugs available in Mongolia can be used.
- Telephone company communications lines extend underground to terminal boards in the buildings on the campus and extend from there to locations where telephone connections are required. Wiring in conduits and simple laid above the false ceiling are the main wiring methods used for the telephone lines, while conduits and wiring embedded in walls and ceilings are found in some places. In addition, exposed wiring and wiring apparatus attached directly to walls and ceilings are found in renovated areas.
- The Library Building has a server room from where the campus LAN facilities are controlled.

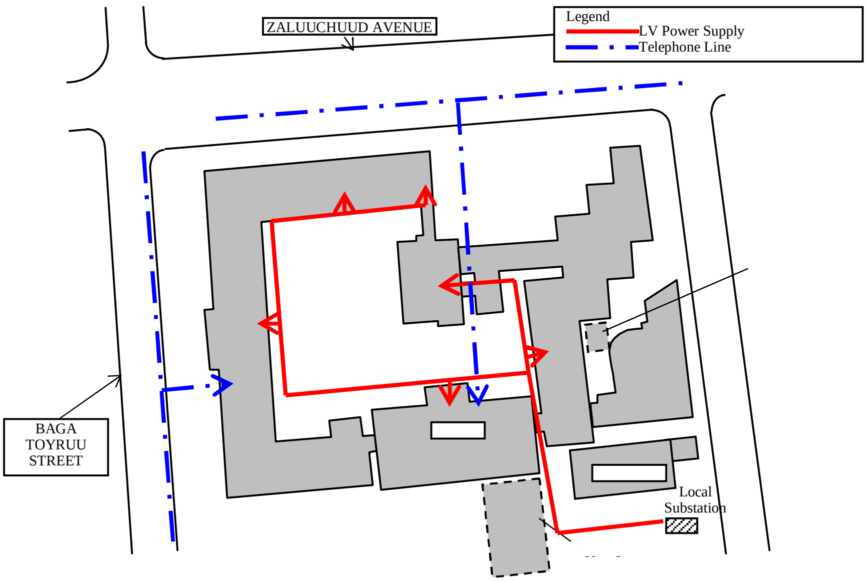


Figure: Diagram of the extensions of the power supply and communications lines on and around the MUST campus

5) School of Mechanical Engineering, MUST (MUST-ME)

The campus of MUST-ME is located 2km southwest of the city center. All the facilities on the campus are to be extended/renovated in this project. (Figure)

- The buildings on the campus were constructed in 1962 during the Soviet era, as buildings for a vocational training school. There are three buildings and a bridge building on the campus. The buildings are characterized by a brick masonry structure, which gives them an appearance that is different from that of the buildings on the MUST main campus.
- The 1st Building is a two-storied building. It houses the Office of the Director, administrative departments and lecture rooms for students.
- The 2nd Building is a three-storied building. It houses lecture rooms and training rooms.
- The Bridge Building connecting the 1st and 3rd Buildings is a one-storied building. It is mostly occupied by laboratories in which are installed machines which require foundations for their installation and need to be coupled with other machines for their operation.
- The 3rd Building is a two-storied building. Its first floor is mostly occupied by laboratories in which are installed machines which require foundations for their installation and need to be coupled with other machines for their operation. There is a space with a high ceiling clearance where large mechanical equipment can be installed. Lecture rooms and training facilities are housed on the second floor.
- An auto repair shop and an automobile inspection station occupy most of the space in the Garage Building. Some of the automobile inspections carried out in UB take place in this building.

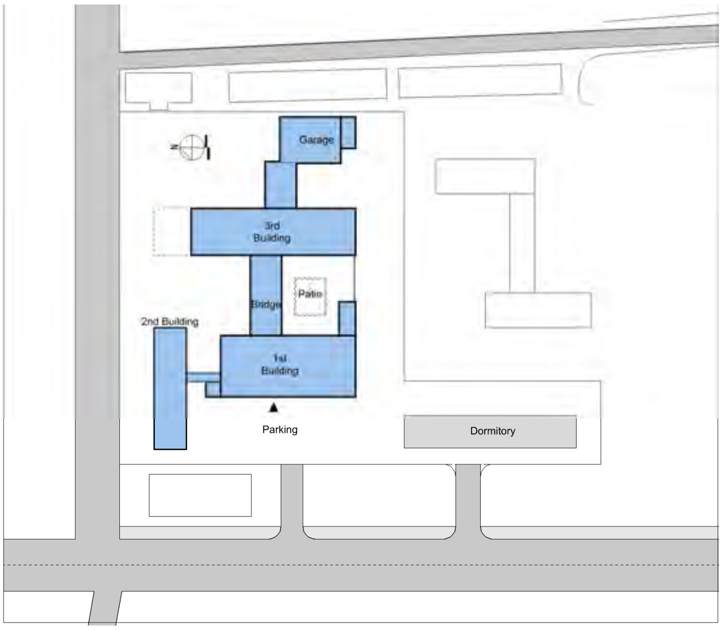


Figure: Building layout on the MUST-ME campus

Photograph: The 1st Building (viewed from the parking lot, with the student dormitory in the background)

Photograph: The 2nd Building (viewed from the parking lot)

Photograph: Patio, Bridge Building (background) and the 3rd Building (right)

Photograph: Garage Building

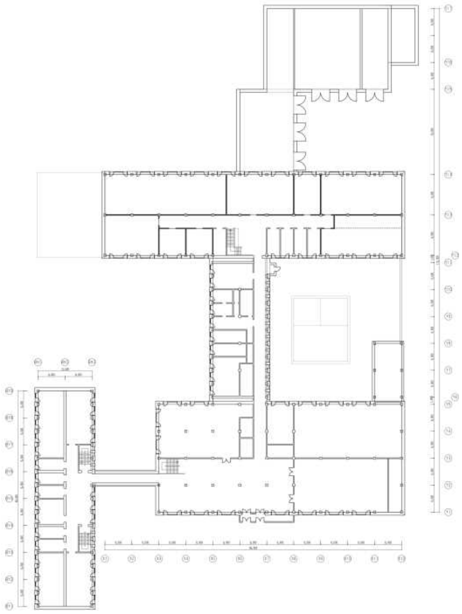


Figure: Floor plan of the first floor of the buildings of MUST-ME

① Buildings

- The buildings have strong frameworks with thick pillars and beams.
- Some of the windows of the laboratories in the 3rd Building have not been renovated and still have the original wooden sashes and single glazing. Broken glass in some of these windows has been left unrepaired and poses a problem on cold days.

Photograph: A machine room

Photograph: A window which has not been renovated

② Water Supply and Sewerage System

- A 50 mm-diameter city main serves the MUST-ME campus. As the water in the main is sufficiently pressurized, water is supplied directly from the main to laboratories, kitchens and toilets. The city water supply is stable. The water supply is suspended approx. once a month for inspection. As the water supply system has no receiving tanks, low-cistern Japanese-style squat-type toilet bowls are installed in the toilets. The sanitary ware is stained slightly with rusty water and some has suffered damage over the more than 50 years that the buildings have been in use.
- Indoor fire hydrants are not installed in these old buildings, presumably because their installation was not mandatory at the time of construction. Instead, fire extinguishers are placed at key locations in the buildings.
- Laboratories and engine rooms are equipped with sinks and research equipment. Exposed piping along the ceilings or piping across the walls is used to supply water to the sinks and equipment. A water main is installed on the ceiling of the corridor on each floor. Pipes supplying water to the sinks and equipment branch off from the main. Drain pipes from the sinks and equipment are presumably connected to a sewer main installed on the ceiling of the corridor of the floor below after running through the floor, making a 90º turn onto the ceiling of the room below and running across the ceiling to the main.

③ Hot Water Supply System for Heating, Air-Conditioning and Ventilation

- Hot water supply system for heating is provided from the hot water supply system for district heating (located on the opposite side of the road in front of the campus) to the hot water supply plant (installed together with the facilities for the city water supply and domestic hot water supply) on the campus. The plant is installed in an underground space between the 1st and 2nd Buildings.

- Each room in the buildings has a simple vent hole. Mechanical ventilation with exhaust fans and ducts is used in the laboratories. However, some of those fans and ducts are not used because they are not in working order. The ventilators and ducts installed in the attic space in the 2nd Building are not in use because of dilapidation. No measures have been taken to deal with the odor or noise generated in the engine laboratories.
- Each room is equipped with hot-water radiators. Hot water is supplied to the radiators through piping which branches off from the hot water main on the ceiling of the nearest corridor or exposed vertical hot water piping.

The figure below shows the locations of the infrastructure and its extensions on and around the MUST-ME campus.

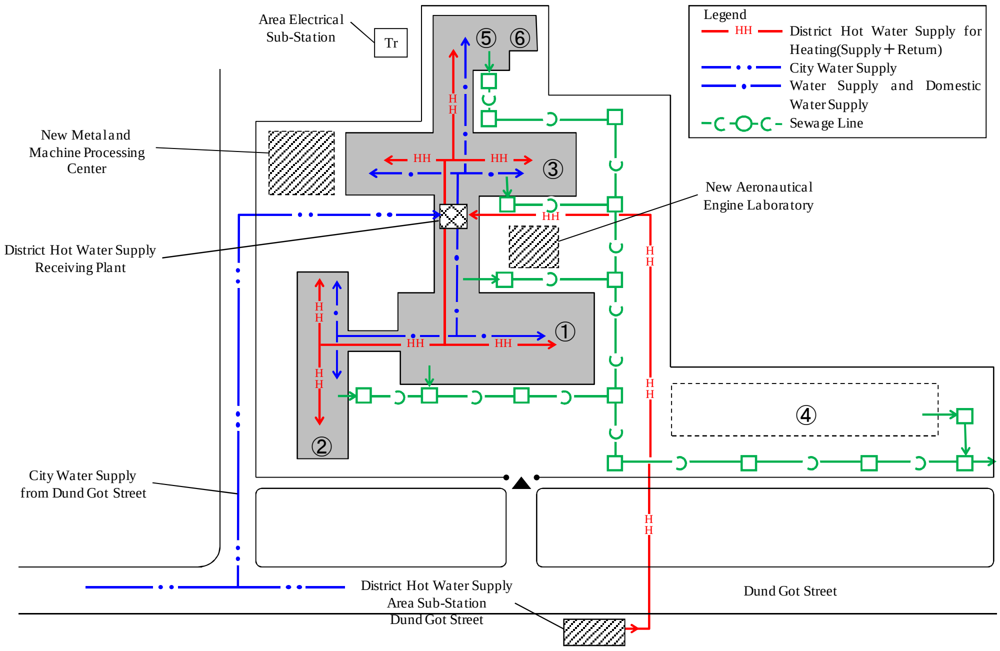


Figure: Locations of the infrastructure and its extensions on and around the MUST-ME campus

④ Electricity and Communications

- Underground low voltage (380/220V 50Hz) 3φ4W power lines extend from the nearby local substation of the power company to the electric room on the campus. Metering is done at the switchboard at the service entry point, *i.e.* the electric room.
- Power is provided from the switchboard to local distribution panels in individual rooms (only rooms where heavy-load equipment/facilities are installed) and each zone on the campus.

  Wiring in conduits and simple laid above the false ceiling are used as the main wiring methods for the power supply. Conduits and wiring embedded in walls and ceilings are used in some places. In addition, exposed flush mount wiring and wiring apparatus on the walls and ceilings are found in renovated areas. EPS for exclusive use of electrical installation was not observed. Voltage drops occasionally cause the lights to flicker (several times a week) and power outages occur with a frequency of once a month to once every few months. The increasing demand for electricity and the limited capacity of the power distribution network are considered as the cause of these problems. Only small emergency generators for use by individual departments or for specific purposes are found on the campus. There is no emergency generator large enough to meet the demands of the entire campus. Each laboratory containing heavy-load equipment is equipped with a switchboard to supply power in the laboratory.

- In some of the switchboards installed in the original construction work and still in use, breakers and wiring have been replaced with more recent products, while others still have the old-type wiring apparatus, breakers and fuses that were installed at the time of the original construction. For the rooms mainly intended for research, users report the inadequate capacity of the power supply.
- Fluorescent lights are the main light source. The luminance is equivalent to or slightly less than the illumination standards in Japan. The light control system in use is a local control with rocker switches on the wall. There is no use of light control timers or a central light control system. Type A, C or O wall sockets are installed in the buildings so that electric equipment fitted with the different types of plugs available in Mongolia can be used.
- Telephone company communications lines extend underground to terminal boards in the buildings on the campus and extend from there to locations where telephone connections are required. Connection to the information communications network has been established independently by each department requiring a connection. Wiring in conduits and simple laid on the false ceiling are used as the main wiring methods for the telephone lines, while conduits and wiring embedded in walls and ceilings are found in some places. In addition, exposed flush mount wiring and wiring apparatus on walls and ceilings are found in renovated areas.

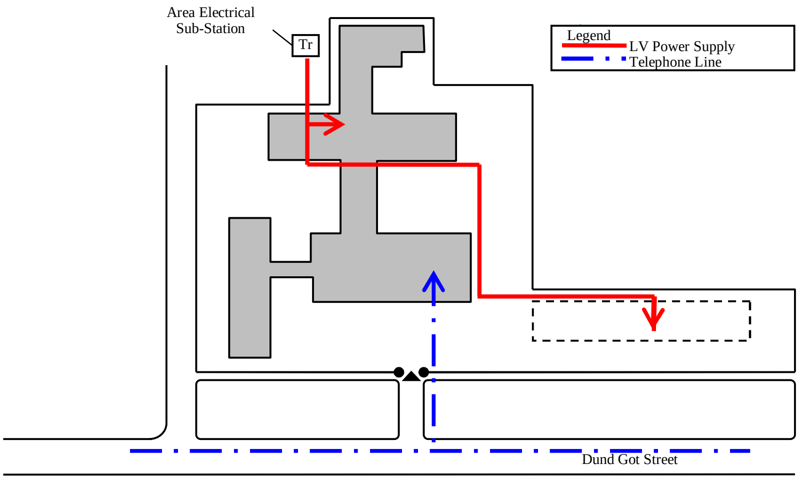


Figure: Diagram of the extensions of the power supply and communications lines on and around the MUST-ME campus

⑤ Construction of New Laboratories and Extension of the Lecture Building

MUST-ME has requested the construction of laboratories to accommodate new experimental equipment and the extension of an existing building to accommodate an increased number of students.

1) Construction

The requested laboratories are for experiments with aircraft engines. MUST-ME originally planned to construct a temporary structure in the space between the 2nd and 1st Buildings. However, they later learned that a city ordinance does not allow the felling of the trees in the space in question, and that taking into consideration the noise generated in the laboratories and the safety of experiments, a facility only a quarter of the size of the original plan could be constructed. Therefore, they are planning to construct the facility over the patio in front of the Bridge Building.

- Table - Request for a new laboratory building

Department		Functions	Scale
Mechanical	Construction	Laboratory-1, Aircraft Engine Laboratory Building ・ Wind Tunnel Laboratory ・ Laboratory with sound-proof and explosion-proof specifications for experiments with engines (Turbo Engine Laboratory) ・ Assembly Room	Approx. 170 m^2 12 m x 14 m Required ceiling height: 3.5 m

2) Extension

An extension of the 2nd Building is requested so that the number of lecture rooms can be increased in order to accommodate the increasing number of students. The 2nd Building has four stories. It is currently being used up to the third floor. When the building first came into use, the space on the fourth floor was used as a Machine Room. However, the machines on the fourth floor are no longer in use and the space is being used for storage. The plan is to renovate this space to create new lecture rooms. The field study revealed that the pillars and beams were sound and that the structure was strong enough to withstand the load that would be applied when the space was used for lectures. However, the low ceiling, only 1.7 m at its lowest point, means that this space cannot be used for lecture rooms.

MUST-ME explained that they intended to solve the ceiling height problem by removing the ceiling and roof of the area concerned and constructing a new roof so as to ensure a sufficient interior ceiling height. Because parapets have already been erected on the roof and there are pillars and beams around the exterior walls, the renovation work itself is not considered difficult.

MUST-ME has already begun consultation on the renovation with a local consultant and the estimate of the cost has been completed.

-Table- Outline of the laboratories and the extension

Department		Function	Scale
Mechanical	Extension	Lecture rooms Construction of new lecture rooms on the fourth floor ・At present, a storeroom with low ceiling. ・A new roof is to be constructed after removal of the existing ceiling and roof.	Approx. 560 m^2 Ceiling height: at least 2.7 m

MUST-ME was also planning to construct a four-storied building with a total floor area of approx. 1,200 m^2 on a plot next to the 3rd Building. However, at the time of this survey, the specific of construction had not been released.

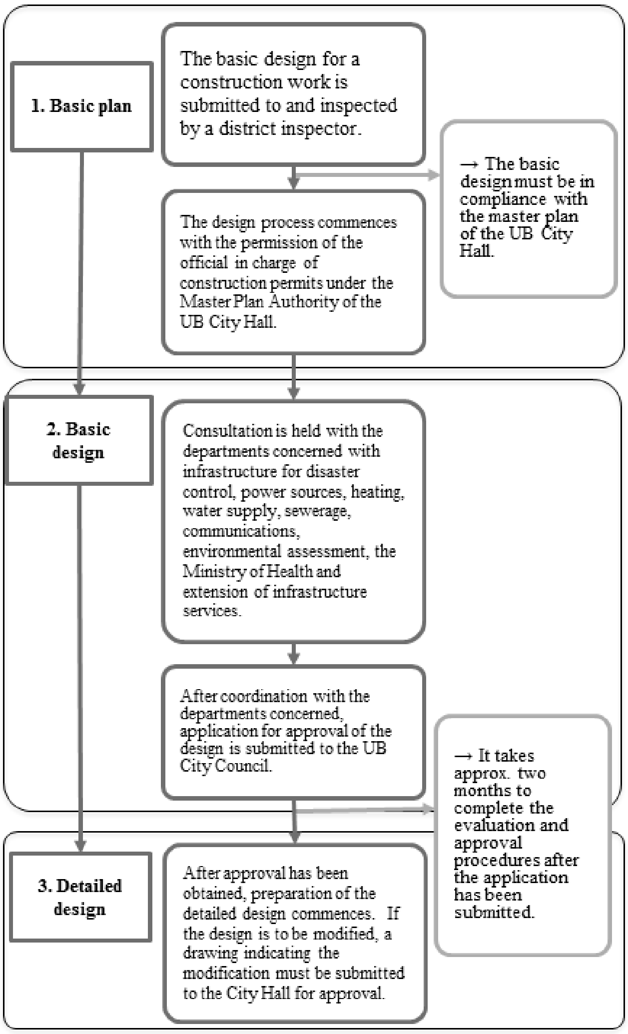
Attachment 23 Process of application to the UB city hall for construction approval

1) Workflow of the Application for Construction Approval

The latest survey has revealed that the UB City Hall accepts and processes applications for construction approval in accordance to the workflow shown in the diagram on the right. The city hall approves the implementation of construction work after all the departments concerned have approved the application.

Application documents have to be written in Mongolian and the application must be submitted by a Mongolian consultant. In addition, as the evaluation standards stipulate areas in which approval for architecture, structure and MEP may be obtained, an appropriate consultant will have to be selected.

Table. Workflow of application for construction approval



2) Evaluation Procedures

The table below shows the infrastructure-related departments mentioned in the Construction Application 2.

Table. Departments of the UB City Hall involved in the evaluation of an application for construction approval

No.	
1	Master Plan Authority (City Hall)
2	Water Supply and Sewerage Authority (City Hall)
3	Heating Network Company
4	Fire Fighting Department in the National Emergency Management Agency
5	Solid Waste Collection Department, City Accomplishment Department
6	National Agency of Meteorology and Environmental Monitoring in the Ministry of Environment and Green Development
7	Environment and Green Development Department (City Hall)
8	Electrical Supply Network Company
9	Telecommunications Department, Information Communications Technology and Post Authority

Attachment 24 Study of the condition of the infrastructure of UB

1) City Water Supply and Sewerage System

The Water Supply and Sewerage Authority of Ulaanbaatar City (USUG) was established in 1959. It operates and maintains water sources, water transmission facilities, water supply pipelines, sewer network and wastewater treatment facilities. The water supply system includes four water sources, ten relay pump stations and water wells at a total of 175 locations. In areas where people live in gers, small pumps for water wells have been installed at 560 locations and, where there is no water source, water tanks have been constructed to receive water transported in water trucks. The current water supply capacity of USUG, which has been increased to 240,000 m^3, is currently sufficient as the average daily water demand of the city is approx. 150,000 m^3. However, as the water demand is expected to double by 2020, USUG is working on the improvement of the water transmission stations and pipelines including a study of water leaks, groundwater development and utilization of water from the Tuul River. As there is a sufficient supply of water to the campuses of the universities where the project sites are located and the surrounding area, water supply will not be a problem following the extension and renovation.

The sewer network in the city has a total length of 150 km and covers almost the entire business and residential areas of the city. There are two large-scale sewage treatment plants in the city. However, the use of an old-style biochemical treatment system in these plants has given rise to problems. The UB City Hall is planning to construct a state-of-the-art sewage treatment plant in the near future. There are five small-scale sewage treatment plants in townships in the suburbs of the city. As the central sewer main runs near the university campuses, sewage treatment will not pose a problem following the extension and renovation.

2) Waste Disposal

Five hundred and fifty tons of waste are produced in the city every day. Not all the waste that is produced is collected. While the waste disposal plants are operated by a municipal corporation, the waste is collected for a fee by a waste collection corporation. The waste is transported to final waste disposal plants at three locations in the city and piled up out in the open (dumping). These plants are in an unhygienic condition because of the lack of incinerators. An incinerator was constructed specifically for the disposal of industrial waste three years ago, but problems have prevented its full operation.

The master plan of UB includes plans for the collection of waste according to type, a reduction in the volume of waste, the promotion of recycling and the implementation of a project for the improvement of hygiene at the waste disposal plants.

3) Power Supply Facilities

There are four coal-fired power plants, Coal-fired Power Plants 1-4, in UB. Plant 1 is no longer in operation. Plants 2 and 3 have outputs of 24 MW and 148 MW, respectively. The implementation of a project for the improvement of Plant 4 contributed to energy saving and the prevention of air pollution by reducing NOx and SOx exhausts, and increased the power supply capacity to 540 MW. However, power shortage has been observed because of the growth of the mining and construction industries. Therefore, Plant 5 is under construction. Partial power generation at Plant No. 5 is expected to begin in 2015.

4) Hot Water Supply System for District Heating

A state-owned company called Ulaanbaatar Heating Network Company supplies hot water for heating and maintains the hot water distribution pipelines in the city. The company generates hot water for heating using the heat generated in Coal-fired Power Plants 2, 3 and 4, and supplies approx. 1,552 Gkal/H of hot water through a 375 km-long pipeline network. As is the case with the power supply, hot water for heating is in short supply. Therefore, projects are being implemented for the construction of Power Plant No. 5, the improvement of the hot water pipeline network for heating and the upgrading of the relay pump stations; policies for the saving of hot water for heating are also being put into effect.

Attachment 25 Plans for the relocation of the universities and projects for the construction of new university buildings

1) University Relocation Plan and Science Building Project

This survey revealed the existence of a plan to relocate the schools in the scientific disciplines of NUM and MUST from UB to Baganuur, a coal mining town located three-hours' drive east from UB, and of a committee charged with implementing the plan.

The plan was to facilitate relocation by establishing restrictions on the construction of university buildings in UB.

However, an estimate of the cost of the relocation plan revealed that implementation of this plan would require a huge budget – equivalent to the annual budget of Mongolia. In addition, a soil survey conducted in Baganuur revealed soil pollution at the planned relocation site. A new government came to power following the election in 2012. As a result of the combination of the above-mentioned events, the activities of the committee have been suspended and the status of the plan itself is unclear.

In addition, there used to be a plan for the construction of a building in which the NUM and MUST scientific schools would be integrated with financial assistance from two private companies, Rio Tinto and Oyu Tolgoi. However, this plan is at a standstill for political reasons.

Under these circumstances, both NUM and MUST are preparing projects for the construction of buildings on their respective campuses.

2) Projects for the Construction of University Buildings

NUM is planning to construct a four-storied building with a total floor area of 10,000 m^2 and a library (Library Block) on the plot in front of the Mongolia-Japan Center. The aim of the construction is to establish a facility for efficient research by consolidating in the new building research facilities currently located in a number of different buildings. The vice president of NUM says that the university intends to construct a facility that will resolve the problem of dilapidation and lack of facilities, that can be used to integrate the existing 16 departments and faculties into a simple and rational organization, and that will make students and scholars proud of studying at NUM.

The UB City Hall has already granted construction approval for the project. The preparation of the construction site has been completed (figure below). The university and the central government are to finance 40% and 30% of the project cost, respectively. NUM is looking for investors to finance the rest of the cost.

Meanwhile, MUST has an outline design of a 12-storied building with a total floor area of approx. 10,000 m^2 on the campus where land is more limited. The UB City Hall has granted construction approval for this project also. The preparation of the construction site has already been completed. The president mentioned the dilapidation of existing facilities and a shortage of laboratories as the reasons for the construction of the new building. The original plan was to construct a six-storied building. However the number of floors in the building has been increased to 12 in order to accommodate requests from various departments. MUST is studying the possibility of increasing the number of the floors to thirteen.

MUST has already submitted to the Parliament a budget request for the project. If it is approved, 50 % of the construction cost will be included in the national budget for the next fiscal year. MUST is looking for investors to finance the rest of the cost.

- Table - Outline of the new buildings

	National University of Mongolia (NUM)	Mongolian University of Science and Technology (MUST)
Facilities in the building	Library and laboratory building	Laboratory building, auditorium and conference hall
Total floor area	Approx. 10,000 m^2	Approx. 10,000 m^2
Number of floors	4	12
Features	A library in the building	A conference hall and an auditorium on the top floor

Figure: Location of the site of the new NUM building

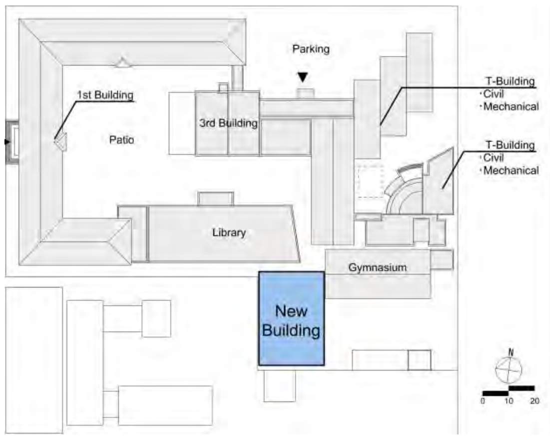


Figure: Location of the site of the new MUST building

Photograph: Planned building construction site on the NUM campus

Photograph: Planned building construction site on the MUST campus