MANAGEMENT SYSTEM FOR INFRASTRUCTURE CONSTRUCTION

A New movement for Improving Construction Management Education System in Asia

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The new ODA (Official Development Assistance) charter announced by Japanese government in year 2003 says that the object of Japanese ODA was to contribute to the peace and development of the international community and thereby to help ensure Japan's own security and prosperity. The key activity of ODA for developing countries shall be supporting activities of infrastructure development. However, it can be said that the most important issue is the human resource development through which a developing country can deal with economic and humanitarian issues like poverty, global issues, conflicts and terrorism. Construction management can be one of considerable areas when you think about the human resource development. Based on this understanding, International Construction Management Forum in Asia (ICMFA) was established by faculties of universities in Asia in November 2008. This paper will discuss about the human resource development program for infrastructure development and role and functions of the ICMFA to create favorable environment for technology transfer among Asian countries.

Key words : International construction management, civil engineer, project management, engineering education

1. INTRODUCTION

The Japanese construction industry was engaged in building massive as well as unique infrastructures in the period of time starting the post war rehabilitation until the burst of bubble economy that was happened in early 1990s.

The industry has already shown its ability by building world renowned and highly advanced structures such as long span bridges, tunnels under sea and in soft ground areas, etc. Technological research and innovation in universities, institute of technologies and industries made possible to realize such unique structures. Similarly, the civil engineering taught in universities and institutes of technologies were engaged in the pure elemental technology developments, such as, technology of making strong concrete beams, bonding systems in between reinforcement bar and concrete. Consequently the human resources that were trained in the specialized engineering fields, however, did not incorporate the appropriate management education in the field of engineering.

As a result, the industry could not realize and incorporate the feasibility of social facilities and possible changes in social structure and public needs while developing infrastructures in the past. Many local governments are now facing financial difficulties to maintain the previously built social facilities.

Such environments have further exacerbated the decline in the public trust with the construction industry. What are the reasons that the Japanese construction industry and civil engineering had such problems?

One of the main reasons that could be considerable is the recognition and understanding of infrastructures. Most of people who work in the Japanese construction industry and civil engineering field understand that infrastructures must be structures/facilities that will support and contribute to the public and a nation.

Probably not only Japan but other countries as well the people who work in construction industry and civil engineering field keep this way of understanding of infrastructures.

2. THE MAIN OBJECT OF CIVIL ENGINEERING

What is the main object of civil engineering? It can be said that the main object of civil engineering is to contribute to setting up infrastructure that is required for promoting the public welfare. When you ask a civil engineer regarding the definition of infrastructure, he may answer to you that it means facilities related to the public welfare and development own country. Many people in the present civil engineering field will agree with his answer. However, but it is necessary to reconsider and understand what a nation's welfare is, when you talk about infrastructure. A nation's welfare will be to satisfy public requirement for physical, economical, cultural and environmental aspects.

If you said that infrastructure means facilities related to the public welfare and development of a country, it means that you are seeing a part of infrastructure. Because, it will be understood that you just see the physical aspects of public requirement. It is true we civil engineers have been contributing for making many physical systems that are necessary for the public life, like potable water supply systems, sewages, electricity supply, gas supply, communication, garbage treatment, etc,.

Civil engineers also have been contributing for making many facilities that are necessary for development of a country, like schools, hospitals, roads, rail ways, river banks, irrigation networks, harbors, air ports, bridges, dams, etc,.

However, the way of the contribution for the public and own nation just concentrated on just “to build” for infrastructure development is now creating problems with the public. After all, infrastructure development must be planed and implemented with consciousness of sustainability of societies like maintaining, controlling, managing, demolishing and abandoning, etc. It is also needed to be planned and implemented together with social systems and natural environment.

Judging from this sort of consideration, it is clear that infrastructure development must be done with not only engineering mind but also with the social science mind as well. However, it is hard to say that the present civil engineering observed in the world is to be equipped above mentioned concept. Most of people who are concerned in infrastructure development from engineering field believe that it is essential to explain the situation with quantitative way and they like to use complicated mathematical analysis. They believe that to use complicated mathematical analysis is unavoidable for explaining matters to other people. They also believe that this is the real engineering way. However, this way of explaining does not work well for the public, because it is not easy for them to understand. Therefore in many cases the people who received the explanation would be frustrated with the result.

On the other hand, people who are concerned with infrastructure development from social science fields do not well use quantitative way. They try to explain the situation to other people in a qualitative way by using conceptual approaches. This kind of explanation also dose not work well for the public, because it is difficult for them to make a clear picture regarding the problem. Needless to say, the main stakeholder of infrastructure development is the public. So, it is essential to implement infrastructure development with the way that the public will understand and get satisfaction from the explanations. As mentioned before, it is hard to find an academic area which will provide clear explanations and satisfaction to the public.

We civil engineers need to understand this simple theory and start rebuilding own field. Construction management shall be a key field for executing this kind of challenge.

3. THE NEW CONCEPT OF INFRASTRUCTURE

1) Social activities and those supporting System

As already mentioned above, infrastructure is something that enhances the public welfare and development of a country, and the welfare shall be to satisfy the public requirement for physical, economical, cultural and environmental aspects.

Based on this understanding, the author tried to describe the basic concept of infrastructure as shown on Fig.No.1 and Fig.No.2 in a three dimensional way.

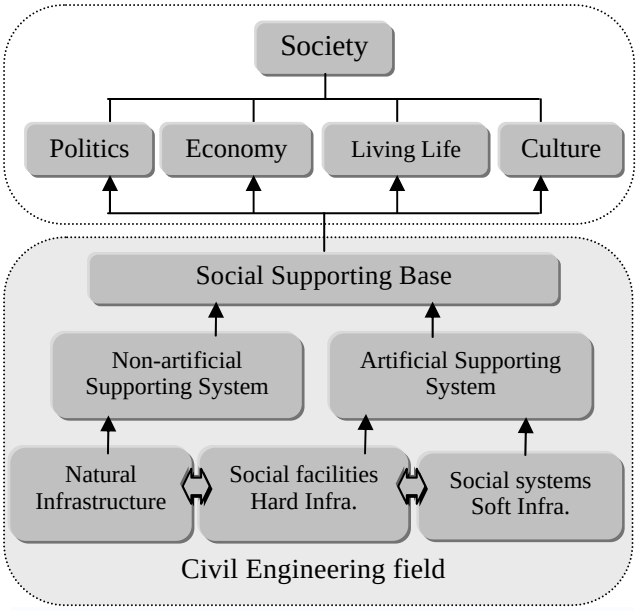

Fig.No.1 Social Activities Supporting Structure

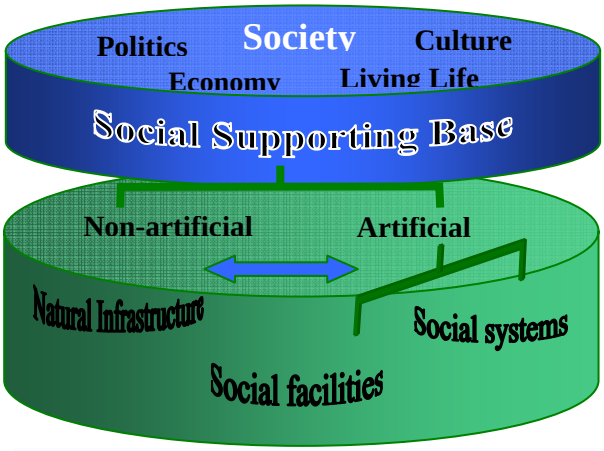

Fig.No.2 Social Activities Supporting Structure

A society will move with several activities such as economical activities, political activities, cultural activities, activities of living things, natural activities, etc. These activities are inter-acting with each other on the base that the author calls 'Social Supporting Base'. This base consists of 2 different kinds of basic systems, one is the artificial supporting system and the other is non-artificial supporting system. Furthermore, the artificial supporting system consists of the social systems that may be called "Soft infrastructure", and the social facilities that may be called "Hard infrastructure". Non-artificial supporting system, on the other hand, can be described as "Natural infrastructures". This concept says that a society is supported by the Social Supporting Base and its base is supported by 3 different kinds of infrastructures.

What described on the Fig.No.1 will be the real meaning and concept of infrastructure that civil engineers need to see. More over, the important thing that you need to understand is that these 3 different kinds of infrastructures should not be planned, built and operated individually. They must be handled with the idea of correlativity. For example, when you need to build a school, you need to consider the natural environment and also social systems like education systems, security systems, medical care systems, etc. It also will be basic to understanding the construction management concept as shown in Fig.No.3.

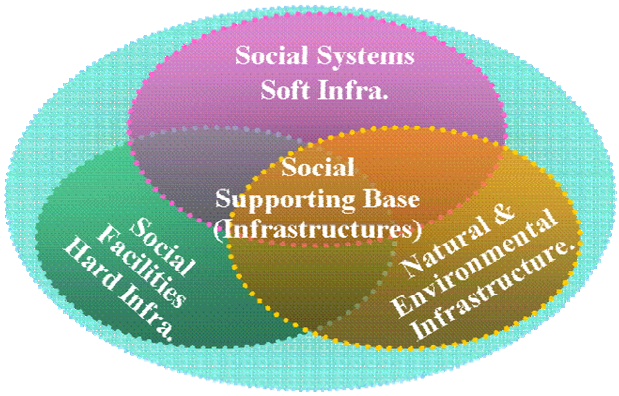

Fig.No.3. A real Shape of Infrastructure

4. CIVIL ENGINEERS' ROLES AND THE RANGE OF ACTIVITIES

No one would wonder when one says that, "I am a social scientist, and therefore I cannot understand the technical matters of civil engineering". However, a civil engineer is never allowed to say that, "I am civil engineer and therefore I cannot understand social matters."

This will be the reason why you need to get and seriously consider the education program of construction management. For establishing an appropriate education system of construction management, what is really needed is to reconsider the situation from civil engineers' roles and functions in the infrastructure, in other words, fundamental social system development. It can be said that basically civil engineers shall be required to do following three different roles. These are;

(i) Mission & Policy:

The function of Mission & Policy is "To find out and to clarify necessary infrastructures for

people and society." It should answer "Why and what shall be made for the people and the society without compromising the capacity for future generation and society?"

(ii) Technical Development & Engineering:
Technical development & Engineering is required "To confirm and to develop the appropriate and effective technologies for making the required infrastructures." It is responsible for "How to make it/them".

(iii) Construction Management:
Construction management is essential "To find out and set up the practical and effective way of implementation of a development project." It provides the ways and techniques required for "How to combine the Mission & Policy and the Technical Development & Engineering practically and effectively."

As shown in Figure 4 the functions of the civil engineers are to integrate Mission & Policy, Technology development & Engineering and Construction Management. Further, the function of construction management is to combine the mission & policy and technology development & engineering for efficient project development.

However, many of the civil engineers like to concentrate in the area of technical development and engineering, and do not seriously consider the mission & policy.

Traditionally universities are executing their activities in academic fields and concentrate in pure elemental technology development. The activities of industries, on the other hand, are mostly to integrate the elemental technology for real project development. The problem is that the activities of universities and industries are not smoothly integrated. This situation must not be maintained. Since civil engineering is responsible for the development of adequate and appropriate infrastructure for the people without comprising the future needs, the civil engineers' role is wider than that has been assumed traditionally.

5. BUILDING UP CONSTRUCTION MANAGEMENT EDUCATION PROGRAM

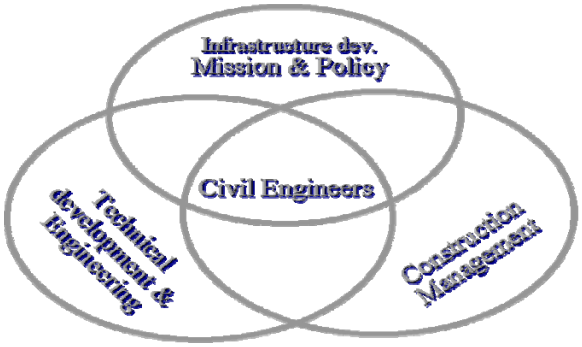

Fig. 4 The functions of the civil engineers

Based on the philosophy described up to here, the author has developed a concept and structure for the practical education program of international construction management. The program has been developed following the five broad headings.

International Construction Management Education program

- 1) Infrastructure project planning & assessment.
  Knowledge and techniques required for Infrastructure development.
- 2) Project mission management.
  Knowledge and techniques required for project implementation.
- 3) Project execution management.
  Management Knowledge and techniques required for project execution.
- 4) Project field management.
  Construction methods and technologies and knowledge required for projects.
- 5) Project operation and maintenance.
  Knowledge and techniques required for project operation and maintenance.

Basically, the knowledge and techniques on these five broad headings shall not be seen and handled individually because as shown on Fig. 5, any social facilities (hard infrastructures) will be set up to go though these five broad headings. However under the situation of where a country or a society is rapidly and continuously developing, the people do not become aware and understand of this basic concept. In order to set up the appropriate and practical education program for construction management, it shall be required to make sure the components of these five broad headings are included.

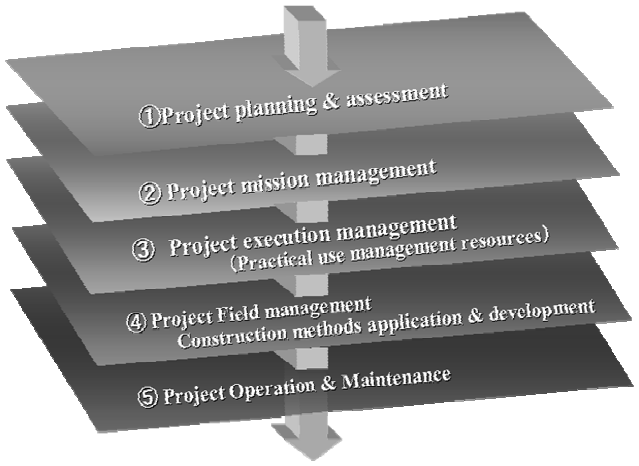

Fig. 5 Five broad headings hard infrastructures

① Planning & assessment of Infra. development
- 1.1. Infrastructure development in the world
- 1.2. Infrastructure development in own country
- 1.3. Planning & Assessment of Infrastructure development
- 1.4. Environment management
- 1.5. Role of Civil engineers

② Project mission management
- 2.1. Law & Regulations related project execution
- 2.2. Standard conditions of construction contract
- 2.3. Feasibility Study & Project Appraisal
- 2.4. Project mission planning
- 2.5. Procurement & Contract

③ **Project execution management**
- 3.1. Project administration
  - 3.1.1. Security, External affaires
  - 3.1.2. Tax & accounting
  - 3.1.3. Financial control
  - 3.1.4. Personnel control
- 3.2. Project management
  - 3.2.1 Schedule control
  - 3.2.2. Cost control
  - 3.2.3. Contract administration
  - 3.2.4. Quality management

④ **Project field management**
- 4.1. Field work execution plan
  - 4.1.1. Permanent works
  - 4.1.2. Temporally facilities
  - 4.1.3. Construction equipment
  - 4.1.4. Material
- 4.2. Field Control
  - 4.2.1. Safety control
  - 4.2.2. Quality control
  - 4.2.3. Productivity improvement

⑤ **Project Operation & Maintenance**
- 5.1. Project Operation
  - 5.1.1. Operation organization
  - 5.1.2. Financial control
- 5.2. Project Maintenance, Monitoring & investigation
  - 5.2.1. Maintenance, Repair & renewal
- 5.3. Social impacts Project assessment
  - 5.3.1. Problems Isolation

This set of components was described by the author based on his experience of educational activities in several universities and over 30 years experience in carrying out construction projects in Japan and overseas. However, he thinks that it is necessary to modify and maintain the program by establishing a network with people who want to work for setting up the practical education program of construction management.

What the author has been trying is to develop a prototype of construction management education program so that each country can adopt the proposed education system with necessary modification to suite their domestic infrastructure development environments.

The details of the curriculum based on the five broad headings for practical construction management incorporating the techniques required for the execution of both domestic and international construction projects are shown in Chart 1.

From year 2001, the author has started to make education materials in accordance with the program described on Chart 1 and implemented the education activities in Department of Infrastructure System Engineering in Kochi University of Technology. One of the curriculums related to contract administration that author made with a consulting company was selected by JIBC (Japan Bank for International Corporation) in 2007.

The author and his collogues are now expanding the supporting activities for setting up the construction management education programs for universities in Asian countries like Mongolian University of Science of Technologies, Institute of Technologies Cambodia, etc.

Chart-1. The structure of Construction Management Education Program

Education Levels: 1 = Basic knowledge & Technique 2 = Practical knowledge & Technique 3 = Professional knowledge & Technique			University 1,2 grade	University 3,4 grade	Master course	Advance course
1. Planning & assessment of Infrastructure development			Education Levels			
1.1.	Infrastructure development in the world	Infrastructure Development	1		2	3
		International Construction Industry	1		2	3
		Globalization. regulations , standards	1		2	3
1.2.	Infrastructure development in own country	Infrastructure Development in own country	1		2	3
		Situation of Construction industry	1		2	3
		Mission of Construction Industry	1		2	3
1.3.	Planning & Assessment of Infrastructure development	Mission & Ppolicy		1	2	3
		Grand Deign & Master Planning		1	2	3
		District & Regional planning		1	2	3
		F/S; Feasibility Studies		1	2	3
1.4.	Environment management	Environment issue		1	2	3
		Environment assessment		1	2	3
1.5.	Role of Civil engineers	Engineer's Mission	1	2		
		Engineer's Ethics	1	2		
2. Project mission management						
2.1.	Law & Regulations related project execution	Construction Law, Audit		1	2	3
		Environmental law & regulations		1	2	3
		Other related Law & Regulations		1	2	3
2.2.	Standard conditions of construction contract	Standard conditions of contract		1	2	3
		Int. standard conditions of contract		1	2	3
		CM standard conditions of contract		1	2	3
2.3.	Feasibility Study Project Appraisal	Risk evaluation & management		1	2	3
		Detail Environment assessment		1	2	3
		Feasibility study assessment		1	2	3
2.4.	Project mission planning	Project formation		1	2	3
		Basic design & Construction plan		1	2	3
		Estimation & Budgeting		1	2	3
		Financial planning		1	2	3
2.5.	Procurement & Contract	Project mission Organization		1	2	3
		Contract formation		1	2	3
		Tendering, evaluation & contract		1	2	3
3. Project execution management						
3.1.	Project administration	Security, External affaires		1	2	3
		Tax & accounting		1	2	3
		Financial control		1	2	3
		Personnel control		1	2	3
3.2.	Project management	Schedule control	1	2	3	
		Cost control	1	2	3	
		Contract administration	1	2	3	
		Quality management	1	2	3	
4. Project field management						
4.1.	Field work execution plan	Permanent works	1	2		
		Temporally facilities	1	2		
		Construction equipment	1	2		
		Material	1	2		
4.2.	Field Control	Safety control	1	2	3	
		Quality control	1	2	3	
		Productivity improvement		1	2	3
5. Project Operation & Maintenance						
5.1.	Project Operation	Operation organization		1	2	3
		Financial control		1	2	3
5.2.	Project Maintenance	Monitoring & investigation		1	2	3
		Maintenance, Repair & renewal		1	2	3
5.3.	Project assessment	Social impacts		1	2	3
		Problems Isolation		1	2	3

6. NEW MOVEMENT FOR CONSTRUCTION MANAGEMENT EDUCATION IN ASIA

The activities implemented by the author and his collogues has made an effect on the movement related to construction management education activities in Asia. A group of faculties in Asian universities specialized in the construction management had a meeting in Taipei and established International Construction Management Forum in Asia (ICMFA) in November 2008. The homepage of this forum says that the mission of ICMFA is “to promote education, research, training and professional development on Construction and Project Management in Asia.” It also explains as follows:

1) Objective:

- Develop and recommend appropriate education and training program on Construction and Project management suitable for Asian environment.
- Introduce contemporary research and practice in Construction and Project Management in member countries.
- Enhance university and institution capacity for developing competent human resources on Construction and Project Management in member countries.
- Share expertise among member countries in research, teaching and other development initiatives.

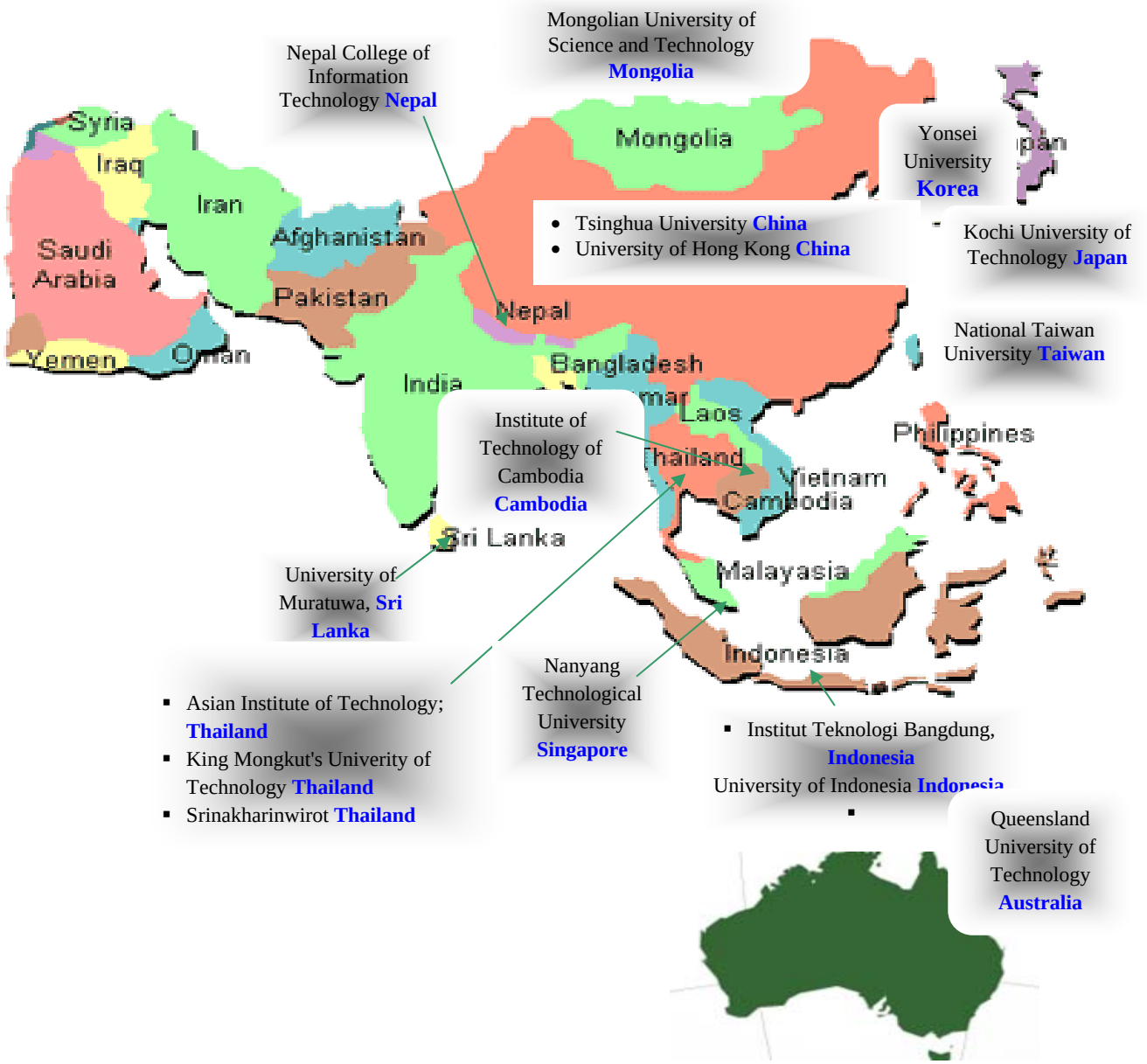

Fig. 6 : Member organizations of the ICMFA

2) Methodology:

- Form a core group of faculties and professionals having relevant expertise.
- Develop network among related program and department of universities and professional societies in Asian countries.
- Organize seminar, conference, training in member countries.
- Carry out research on Construction and Project management and related fields.

ICMFA will assist the member organizations in Asia, which have not yet developed appropriate construction and project management education, to enhance the capacity and establish center of excellence on construction and project management so that the research, development and expertise on the concerned areas will be flowed to the concerned organizations, industries for capacity building and efficient infrastructure development and management. The ICMFA will provide a platform for academics, researchers, practitioners for sharing the resources and experiences accumulated to the individuals and organizations and collaborating among different entities such as Universities, Governmental organizations, Non-governmental organizations, Private sector, Donor agencies, etc.

3) Areas of Expertise to be included under ICMFA

The ICMFA at the beginning of its operation will cover but not limited to the following areas for research, training and professional development in member organizations and countries:

- Planning and assessment of Infrastructure development.
- Mission and policy in Infrastructure development and management.
- Project administration and management.
- Project field management.
- Project operation and maintenance.
- Project dispute resolution.
- Project Financing.

The ICMFA at the first stage of its operation will focus on enhancing the capacity of member organizations and other interested organizations from member countries on Contract Administration and developing appropriate education, training curricula on Construction and Project Management to be introduced in universities and in industry. The other areas will be incorporated after integrating the resources from the members and member organizations.

7. CONCLUSIONS

A concept for realizing construction management for the welfare of people and development of a country is described. It is observed that one of the biggest and most serious problems that developing countries are now facing is corruption/malpractice on infrastructure development projects. The author believes that one of the essential ways for improving such situation is to introduce the systems and techniques deployed in international construction market place to the domestic construction industry. The construction management education program descried in this paper would be appropriate for human development and enable civil engineers able to realize the holistic approach in infrastructure development and consequently improving the infrastructure development environment.

5. REFERENCES

1) Kusayanagi S. [Study on Upgrading Transparency in Construction Industry - Transition from Two-Actors System Into Three-Actors System], No. 716/VI-56, PP221-232, 2002.9. (Written in Japanese)
2) Kusayanagi S. [Enriching Construction Management Education And Its Concrete Measures - Future School Education and Civil Engineers Education], 57th Annual Lectures of Civil Engineering Association Common Session Dept. (Sept. 2002) CS3-015 (Accepted 15.5.2003) (Written in Japanese)
3) Kusayanagi S. [Looking again at the mission of Civil engineering and Civil engineers in Japan], Keynote Lecture on 6th International Summer Symposium, Proceeding of the Symposium, JSCE, 2004, pp 1-7.
4) Kusayanagi S. [Developing appropriate construction management education for infrastructure development and management] 4th CECAR Taipei 2007 T3D-1 pp 129.