IMPROVING PERFORMANCE OF THE CONSTRUCTION INDUSTRY IN THE LEAST DEVELOPED COUNTRIES THROUGH ALTERNATIVE PROJECT DELIVERY SYSTEMS

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ABSTRACT: This paper based on the Nepalese and Cambodian construction environment discusses some of the factors which affect the efficiency in project delivery system in the least developed countries. Only several infrastructure development projects were completed within the planned resources in the traditional project delivery system. In addition to the financial problem, lack of bridging the design and construction, inadequate construction management knowledge and skills in the construction engineers, and lack of appropriate human resource development system are the main reasons for poor performance of the Nepalese and Cambodian construction industry. Alternative project delivery systems are discussed and incorporation of the construction management system to improve the situation is proposed.

Key Words *:Traditional project delivery, least developed country, construction industry, construction management*

1. INTRODUCTION

Poor performance of the construction industry in developing countries is due to lack of technological and managerial capabilities[1), 2), 3)]. The construction industry in the least developed countries still remains in a tiny executers' position. Cost overrun, delay and quality not meeting the standards are common in public works in Nepal and Cambodia. The traditional, Design – Bid – Build (D-B-B), project delivery system has been widely used in public infrastructure development. Only several projects were completed within budget and time. Almost all public infrastructure development projects in Nepal and Cambodia have been carried out through the foreign assistance. However, there is no incorporation of other project delivery systems to improve the efficiency in infrastructure development. This paper based on the Nepalese and Cambodian context discusses the factors which affect the efficiency in project delivery system and adaptability of other alternative project delivery systems in the least developed countries to improve the efficiency in infrastructure development and performance of the construction industry. Nepal and Cambodia were selected in this study to represent the least developed Asian countries as Development Assistance Committee (DAC) has classified these countries under the least developed category.

2. DESIGN-BID-BUILD (D-B-B) PROJECT DELIVERY SYSTEM

Design-Bid-Build (DBB), the traditional project delivery system in which the client makes contracts separately with a consultant/designer and general contractor (Figure 1), consists of three linear phases

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of the work. Client creates a project plan and the designer prepares the necessary construction documents. Fixed-price bids are then requested from qualified contractors based on lowest responsive bid through competitive bidding to execute the work. The client then makes a contract with a contractor to execute the work in accordance with the plans and specifications.

Thus client will have a complete construction document and a fixed price for a project before execution, provided there are no changes in plans and design. Another benefit to the client is that the most of construction risks are transferred to the contractor assuming the design risk oneself [4]. This method is fine in many cases where the project is clearly definable, well and completely designed, not necessary to complete in less time than the standard process will take, and unlikely to change during construction. However, owners must determine the type of skills and experiences they would need to handle the contracting systems and should only choose ones they feel comfortable with[5].

(1) Disadvantages of the traditional project delivery (D-B-B) system

a) Longer project implementation period

The traditional Design-Bid-Build system consists of three distinct linear phases of work: design, procurement and construction. Procurement cannot be done until the design and drawing are 100 percent complete, and the set of construction document is fully prepared. Further, construction cannot be started until the contract is awarded to a contractor. Thus, there is no overlapping of the phases which could shorten the project implementation period. However, other project delivery methods like Design and Build, and the Construction Management can provide opportunity to overlap the design, procurement and construction to shorten the project implementation period.

b) No constructability input

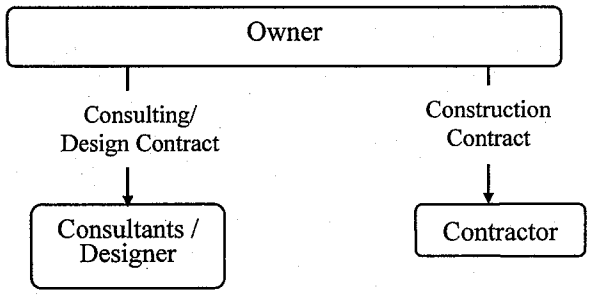

Figure 1: Traditional Project Delivery

Constructability is the integration of construction knowledge and experience in the planning, design, procurement, and construction phases of projects consistent with overall project objectives[6]. A constructability analysis is performed from the construction standpoint, not the design standpoint.

Bidders are not involved in the design and procurement stage so that there is no enough opportunity to review the design and drawings from the construction and contractors perspective, and consultants, if employed, for supervision will have less opportunity to correct any defect in design before construction. Since the contractor is hired for the construction only and not all the legal provisions stipulated for the construction do accept alternative proposals/technology, the D-B-B method does not offer enough opportunity to incorporate input from the construction contractor adequately on construction materials and methods that could improve the design, functionality and cost

c) Client gets involve in more claims and disputes:

One major source of conflicts in a project execution is errors and omissions in the working drawings and specifications prepared by the designers. In the traditional system, a client prepares design, drawing and the complete construction document with the help of the hired consultants and /or in-house staffs. However, as stated earlier, there is less opportunity to identify the error and omissions in the design and drawings from the construction viewpoint. Further, the client is the guarantor of the completeness and accuracy of the designer's work. This draws the clients into disputes between the designer and contractor and frequently subjects the clients to significant liability.

d) Clients need more technical staffs

The traditional Design-Bid-Build project delivery system requires full completion of the set of construction document including the detailed drawings and specification before the bids are requested. Further, it requires considerable supervision and control during construction to ensure quality and timely delivery of the project. Thus, a client may need substantial number of technical manpower to manage larger Design-Bid-Build project which create a long-term financial burden for the client to hold the employees. This characteristic of the traditional project delivery system has created financial burden for the least developed countries to hold larger number of technical manpower and governments of the least developed countries are not able to provide higher salaries to employees.

3. DESIGN-BID-BUILD IN THE LEAST DEVELOPED COUNTRIES

Design-Bid-Build is the principal project delivery system in Nepal and Cambodia. All public

infrastructure development projects in Nepal and Cambodia have been implemented through multiple contracting under DBB system irrespective of the sources of funds and clients' experiences. Despite the long experience of the clients in the Design-Bid-Build project delivery system, only several projects have been completed within stipulated time and budget in Nepal[7]. Efficiency in irrigation development projects in Nepal is shown in the Appendix Table A1.

The history of irrigation and roads development in Nepal showed that only several projects were completed in time and within budget. It was found that the intents of traditional delivery system like complete plan, design and fixed price contract had not been achieved in Nepal. Further, the clients could not prepare complete design drawing and practical schedule and cost before execution, and did not have enough construction management skills to control time, cost and quality. Those clients were typical among infrastructure development organizations and represent the performance of the whole industry as similar organizational structure and contracting methods have been using in other development projects.

The majority of the reasons, for the delays and variations, reported and identified through survey questionnaire and interviews could be grouped under construction management. These were lack of project management, design change, design defect, delay in contract award, lack of coordination, and no trained manpower in constructions. The lack of funds was the dominating factor for delay in internally financed project; however, poor construction management had resulted to delay and variations even in foreign assisted projects.

The authors have investigated the characteristics of the stakeholders involved in project implementation which have influenced the efficiency of project delivery system and performance of the construction industry in the least developed countries. The main stakeholders of infrastructure development in the least developed countries are government (the owner), the construction industry and donor agencies.

(1) The Owner

Government in the least developed country is the largest purchaser of the construction product. All public infrastructures have been implemented through governmental organizations. The clients' performance in a project delivery in Nepal and Cambodia is mainly influenced by the following factors.

a) Weak political and legal environment

Although an implementing agency holds sufficient engineers and support staffs, any change in political environment also affects the key post for project implementation. Political influences in deciding project engineers are common in Nepal and Cambodia. A project manager in such a country, therefore, not only involves in the technical management of a project, but also engages in making favorable political environment. Frequent change in the project personnel during execution and less devotion of the key personnel for the technical management of project had greatly affected the decision-making and the quality control in the implementation of a project.

Moreover, Nepal and Cambodia have not enforced construction and procurement laws. Administrative financial regulations have been following in construction also. Further, these countries have not established their own standards for design and construction of infrastructure. Lack of own national standards and codes for design and construction in Nepal and Cambodia made technical manpower to be familiar with many other countries' standards and codes which has influenced the efficiency in project design. Further, the lack of appropriate laws and regulations in procurements and construction has made difficult to ensure consistency in decision-making and quality control.

b) Lack of motivation for working

Amos and Sarchet (1981) define motivation as "a force or drive causing some action, behavior or result". Further, Maslow's hierarchy of human needs to explain how persons are motivated to an action suggested that the lowest motivational factor is related to physiological needs: food, water, sex, shelter and clothing (the survival needs required to maintain life). The hierarchy goes upwards to safety needs, social needs, esteem needs and self-actualization needs[8]. However, existing incentive system and opportunity provided to the employees in Nepal and Cambodia have not even satisfied the lowest needs of the human beings as categorized by Maslow. The employees, therefore, are naturally not motivated and may not show integrity at work. The human resources involved in project implementation in Nepal and Cambodia are ever seeking other sources to fulfill the cost of livelihood rather than efficient delivery of a project. Lack of motivation to the employees is the major problems in the in the construction as well as service industries of Nepal and Cambodia, which has also affected the efficiency of project delivery system.

c) Lack of appropriate human resource development system

Government is the largest employer of the technical manpower in Nepal and Cambodia. However, human resource development system is not well established

to improve the efficiency of the services it delivers. Governments in Nepal and Cambodia do not have appropriate training system compatible with the job requirements. For instance, an employer does not provide training in administration, design and construction management for fresh-recruited technicians before sending him/her to the construction site. Further, the civil engineering education has not incorporated necessary knowledge area and skills of the construction management. Thus, the performance of a technicians is solely depends upon his own ability and how cooperative and experienced are the other team members. Therefore, involvement of untrained technical and managerial manpower in project implementation is more likely in these countries which is the main reason for inefficiency in infrastructure development and poor performance of the construction industry.

d) Lack of checks and balances

Consultants services are sought only in large, complex project and when donors' guidelines demands for. A client in Nepal and Cambodia often plans, designs and prepares construction documents for small and medium scale infrastructure development project. Further, supervision and inspection are done by the client itself, and the client has full domination in all stages of a project cycle. There is less opportunity for the involvement of the other party to check the performance of the client and, thus, hiding of any faults of the client is more likely in such construction environment.

e) Inefficient decision making system

Responsibility avoiding in decision-making process in bureaucracy is seen in Nepal due to political influence and weak legal environment. The layers of supervision used in the traditional D-B-B project delivery system further influence the decision making in a project execution. A client in Nepal and Cambodia usually sets up design and supervising team for small to medium size project sets under the project manager which consists of engineers and technicians – support staffs. The client usually hire designer for the design of large projects. The Figure 2 shows the decision-making system in the traditional project delivery system where designer is hired for the design and the client himself supervises the project.

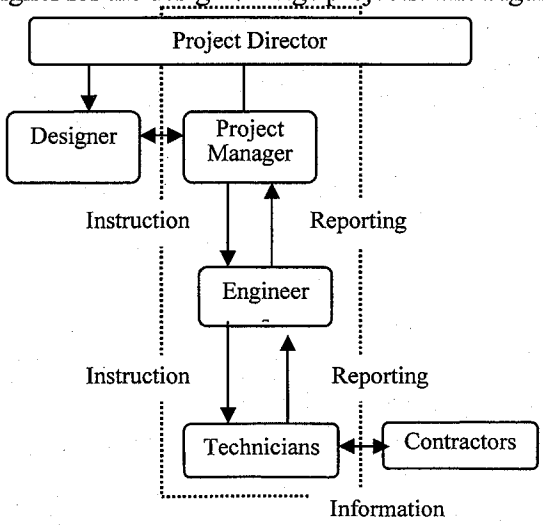

Figure 2: Decision Making in client supervised

Technicians are supposed to oversee the daily work progress of the contractors and visit construction site often, if not stayed at the site. Engineers are engaged in design, in issuing the drawings and solving technical problems. Any problems encountered by the contractor at the site are first reported to the engineer through the technicians who then reported to the project manager. The project manager may consult the designer and instructs the engineers regarding the problems. The engineer further instructs the technicians, and finally the contractors receive the project manager's decision through the technicians. Such reporting from site to project office and decision dissemination from project office to the site usually takes considerable time, and there is more likely for responsibility transferring among the supervising members which slows down the work progress and often create adversarial environment at the construction site.

(2) The Construction Industry

Like in the developed countries, a few large contractors dominate the construction industry of Nepal and Cambodia, and the majority of the construction firms are small to medium class. Contractors are categorized and selected on the basis of their technical and financial capability. However, experienced and qualified manpower is not generally available even with the highest class of contractors. There are four classes of contractors (A, B, C and D) in Nepal and Cambodia. There were 176 'A', 350 'B', 1500 'C' and about 10,000 'D' class contractors in Nepal[9]. Only about 20 percent of the highest 'A' class construction firms are being managed by engineers. The total number of civil engineers and architect working in Nepal as of July 2002 were 2,759. Almost 90 percent of the civil engineers involved in development works in Nepal are one-degree graduates[10]. Further, no university in Cambodia provides a master degree in civil engineering.

Authors' questionnaire survey followed by interviews and field visit identified that most of the contractors from Nepal and Cambodia were not familiar with appropriate time, cost and quality management tools and practice. There were no appropriate training systems for the construction engineers and technicians in the construction industry. Further, no contractors have established and invested for human resource development. The contractors in project execution were dependent on the clients' engineers for technical support, as they

could not hold sufficient engineers themselves. Such client dominated traditional project delivery system could not enhance the performance of the construction industry in Nepal and Cambodia due to no incorporation of professional construction management. Further, the lowest bid principle of the traditional project delivery system forced contractor to bid the lowest possible to get a work. The practice of the lowest bid in the traditional D-B-B system has made contractors to employ inexperienced and untrained technical manpower at low incentive, and to seek shortcuts during construction.

(3) The Donor Agency

Foreign resources were the major sources of fund for infrastructure development in developing countries. For example, more than 50 percent of the expenditures other than salaries and incentives to employees, and regular office expenses in Nepal, and 75 percent of capital investment in infrastructure development in Cambodia had been covered through foreign aids[11), 12)].

Foreign assistances and funding was usually in the form of loan, grant and technical assistance. Donors compel to employ donor's firms and expatriate for the implementation of grant aid projects. Further, the requirements for bidding in the foreign assisted project are beyond the capacity of the local firms which has created favorable environments for foreign firms in Nepal and Cambodia. Moreover, the aid policies of donors were directed to benefit their own economies. It is estimated that up to 75 percent of the value of foreign aided contracts and 60 percent of foreign assistance is pulled back to the donor countries for supply of equipment, materials, personnel, supervision and consultancy of the project[13)].

4. ALTERNATIVE PROJECT DELIVERY SYSTEMS

There are other project delivery systems: Design and Build (DB), construction Management (CM) and Build Operate and Transfer (BOT) which are used for public as well as private infrastructure development in the developed as well as in some developing countries.

(1) Design and Build (DB)

A client contracts with a design-builder firm for the design and construction of a facility as shown in Figure 3. This is the simplest contracting method which offers a single point of responsibility for the owner. DB system allows the client to transfer some or all responsibilities for design and construction onto a third party. Unlike in the traditional project delivery system, the design and construction are integrated in the DB system.

The DB system offers the benefits like more design options, and innovative and cost effective design for the owners. The owner will not need to mediate disputes between the designer and the constructor as the DB firm is contractually accountable and responsible for the entire project. Similarly, there will be no change orders or claims arising from errors and omissions in the drawings since the designer and builder are under one contract. This system also allows fast tracking to shorten the implementation period.

However, the owner will have limited assurance of quality control and there will be no opportunities for checks and balances from the third party in the DB system. Since, the DB contracts mostly are awarded based on qualification and experience, the small contractors will have limited access to the DB system. The DB system, thus, requires contractor's own

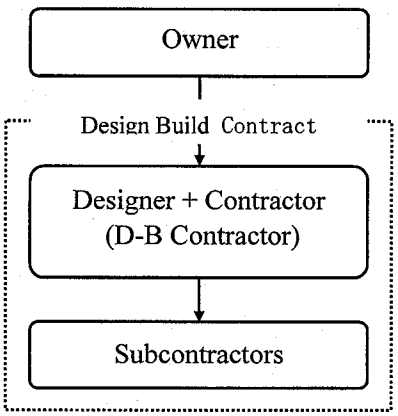

Figure 3: Design-Build (DB)

experience and capacity for the efficient delivery of a project, and the contractor will not have opportunity to receive professional services and advice for efficient delivery of a project as there is no involvement of the other professional party in the execution. Thus, the DB system will not provide opportunity to enhance the capacity of small and less experienced contractors.

(2) Build-Operate-Transfer (BOT)

The build-operate-transfer (BOT) system is an integrated project delivery system in which the private sector is contracted for the design, construction, operation and maintenance of a single facility or a group of assets. BOT system has been widely used in developing and privatizing infrastructure in the developed as well as developing countries.

A builder-contractor in the BOT system requires

enough financial, technological and managerial capability to design, build, operate and maintain a facility. However, the construction industry in Nepal and Cambodia consists of large number of small contractors with low financial, technical and managerial capability. In such environment, if all infrastructure development sectors were opened for BOT, local firms could not compete with foreign firms, and consequently the local construction industry would deprive from work. Further, the local firms may have opportunities to execute small petty works in the BOT projects, but foreign firms' services would not be directed to enhance the capacity of local contractors. Thus, the BOT system does not address the problems of the Nepalese and Cambodian construction industry, and would not provide local industry opportunities for human resource and technology development

(3) Construction Management

Construction Management (CM) is a project delivery where the client contracts individual

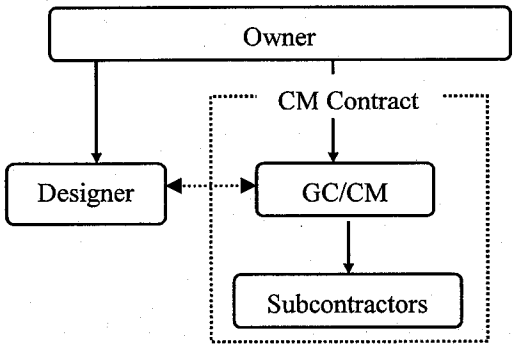

Figure 4: Construction Management (GC/CM)

construction manager or a construction management firm during the design stage of a project. This method was developed to provide significant constructability input during the design stage of a project and help the client supervise the project during the execution. Construction management service normally includes but not limited to design review, constructability input, value engineering, estimating, scheduling, budgeting and cost forecasting, selecting and coordinating contractors, construction supervision, progress reporting, documentation and so forth. Two common variations of the Construction Management: General Contractor/Construction Manager (GC/CM or CM@R) and Construction Manager as Advisor (CM as Advisor) are usually employed.

a) General Contractor/Construction Manager (GC/CM)

In the General Contractor/Construction manager (GC/CM) method, the owner contracts with a design team and simultaneously procures a GC/CM to provide constructability input in design and then to build the facility (Figure 4). The maximum allowable construction cost is negotiated with the GC/CM once the designs are sufficiently complete. The GC/CM then guarantees the final maximum price, the guaranteed maximum price (GMP). The GMP includes construction cost, the CM's fee, and the CM's contingency. Cost overrun except for contractual change orders are the responsibility of the GC/CM. All the construction work is subcontracted in phases as necessary through the GC/CM. The owner typically reimburses subcontractor costs to GC/CM, and the GC/CM pays the subcontractors when paid by the owner. During design stage, the GC/CM becomes a collaborative member of the project team along with the designer to provide constructability input, cost, schedule and specifications reviews. The GC/CM, in the execution stage, continue to provide constructability review of plans and specifications, performs value engineering, coordinate subcontractors, help client supervise work, prepares and updates schedule, reports the work progress and helps client to ensure the quality.

b) Construction Manager as Advisor (CM as Advisor)

Under the CM as Advisor system, the owner contracts with a construction manager, in addition to the designer, to assist in the management of the construction program to control time, cost and quality. Thus, the owner will have three separate contracts with the designer, the construction manager and contractor as shown in Figure 5. In effect, the expertise of the construction manager is intended to enhance the effectiveness of the underlying project delivery system, whether it be the traditional D-B-B or DB. The construction manager is only acting as the owner's advisor or agent, and does not hold the subcontracts. The construction manager usually does not take the responsibility for the design fault but reviews the design and feeds back to the designer. This method was developed to provide significant constructability input during the design stage of a project and help the client make schedule, budget and supervise the project during the execution. The contractors can be selected during the design stage or after the completion of whole design through the competitive bidding.

Similar to GC/CM, the CM as Advisor provides the construction management services but it does not hold trade contracts. The specific role of the CM as Advisor during the pre-construction and construction stages are dependent on the needs for the project as determined by the owner. In addition to the construction management services, the construction manager's services can also be utilized to train the client's employees and contractors, as necessary, to acquire hands on skills during the construction.

The more important advantage of the construction management system is the early introduction of construction knowledge such as constructability assessment, value engineering and so forth while maintaining separate process to procure design and construction parties, thus maintaining a system of checks-and-balances, which does not exist in traditional system. The participation of a construction manager in design stage inputs the perspective of practicing contractors to provide greater accuracy in estimating, budgeting and scheduling. This helps in higher quality of construction documents, a value engineered design, and defects in design can be detected early in the process. The CM method facilitates fast tracking to accelerate a project delivery and more flexibility in scheduling. The construction cost can be determined very early in the GC/CM method since they are based on a guaranteed maximum price. Since the CM as Advisor has similar contractual arrangement to the DBB, the client does not need additional capacity to administer the contract.

The CM method would improve the existing decision making system. The construction manager directly supervises the project and feeds the clients so that project manager can make decisions efficiently with consultation of designer, if necessary. Moreover, the CM system enables the clients to implement the decisions immediately through the construction manager. Thus CM method helps improve quality of supervision and efficiency in decision-making by eliminating layers of supervision in project execution (Figure 6).

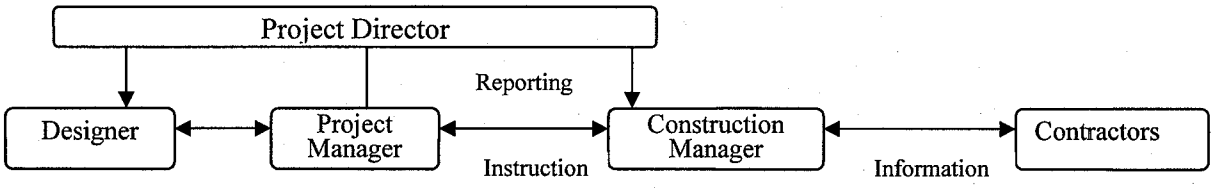

Figure 6: Decision Making in Construction Management Method

The project 1, one of the two projects considered in this study, with the Construction Manager as Advisor showed encouraging performance over the traditional method in the project delivery and human resource development. Salient features of the projects are shown in table 1 below[14].

The project 1 was implemented through the CM method which comprised, in addition to the designer, a construction manager (CMR) having sufficient construction management experience. The CMR was entitled to advise and help client make practical estimate and schedule, select contractors, add necessary constructability in design, perform value engineering (VE) and supervise works. The daily involvement of the CMR and continuous site monitoring and work evaluation made it possible to introduce VE, ensure quality of daily works and check any divergence from the original plan. VE proposed by the CMR in the project 1 for foundation during the construction resulted in foundation size reduction, thus helped decrease the cost. The designer was also consulted to confirm the VE. There was regular progress meeting with clients, contractor and the CMR. The project was completed within the stipulated time and in less than the contracted amount without any difficulties and disputes. Further, the Kochi University of Technology provided students opportunity for the construction supervision which enabled the students to acquire construction management skills from the Construction Manager's services.

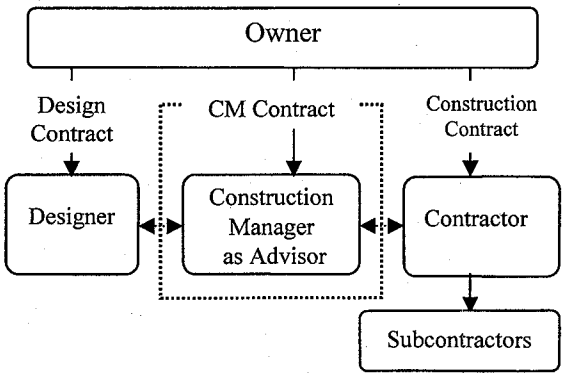

Figure 5: Construction Management

On the other hand the project 2 consisted of a Total Design Manager 'TDMR' and a construction manager for the planning and administration of the project. The TDMR does not exist in the CM contract. Although the project 2 included the construction manager, the actual execution system of the project was similar to the traditional execution system of the Japanese building projects.

The TDMr and CMR could neither add constructability nor envisage the complexity of the design in translating it to the field. The project was continuously revised. As a result, the project has undergone divergence from the original plan and the client was compelled to close the project at 2 storey (initially it was intended for 3 storey) with increased cost (+11.75%) after 5.5 months from the initial intended completion date.

The project 1 showed that the CM contract with the inclusion of true functions of CMR would help complete a project within the planned resources without deviation, and at the same the system would enable the client and contractors to train their human resources through the construction manager's services.

Thus, the CM as Advisor project execution method in Nepal and Cambodia would enable the clients and contractors able to deliver a project efficiently and to train human resources during the execution of the project to improve the performance of the construction industry.

Table 1: Salient features of the projects

Particulars	Project 1	Project 2
Owner	Kochi University of Technology, Kochi prefecture	Miyako Town Office, Miyagi Prefecture
Type of Project	Building Construction	Building Construction
Parties involved	Client, Designer, Construction manager, Contractors	Client, Total Design Manager, Construction manager, Contractors
Total floor area (initial) / number of storey	6196 m2 / 5	6114 m2 / 3
Total floor area (final) / number of storey	6236.3 m2 / 5	5376 m2 / 2
Initial intended Construction period	12.5 months (from February 2003)	12 months (from March 2002)
Actual Construction period	12.5 months	17.5 months
Special feature	Construction manager, VE	Total design manager
Contract amount (initial)	1700 million ¥	1565 million ¥
Contract amount (final)	1550 million ¥	1749 million ¥
Change in cost	-8.8%	+11.75%

5. DISCUSSION

The capacity of an industry depends on its reserve of human resource, fixed capital and technology, and not directly on firms[15]. Generally, delay in project delivery not only leads to cost overrun but also deferred benefits from the projects. The impact of delay in irrigation and roads project delivery are even more serious in agro-based countries like Nepal and Cambodia.

Moreover, the qualified technical manpower is scarce in the Nepalese and Cambodian construction industry. The problems inherent to the D-B-B system and characteristics of the construction industry stakeholders have further affected the project delivery system and performance of the construction industry in Nepal and Cambodia. The Nepalese and Cambodian construction industry, therefore, need to develop quality human capital and appropriate technology for efficient project delivery. Incorporation of project delivery systems which could integrate human resource development to enhance quality of human capital in parallel to the efficient project delivery would help the Nepalese and Cambodian construction industry improve their performance in project delivery.

Although the DB and BOT system are very effective in infrastructure development, these (DB and BOT) systems require high quality and experienced firms to execute a project. Further, the DB and BOT project delivery systems cannot provide design/builder or developer enough opportunity to integrate human resource development activity to enhance the human capital during execution. In addition, the majority of the contractors from Nepal and Cambodia do not have enough financial, technical and managerial capability to execute DB / BOT projects. The DB and BOT project delivery systems are not suitable in the Nepalese and Cambodian construction industry as the DB and BOT systems cannot integrate human resource development and do not provide small and inexperienced contractors enough opportunity to participate in development activities.

Since the construction industry of Nepal, Cambodia and other least developed countries consist of large number of small contractors with limited experience, the local construction industry may not be able to provide GC/CM services but they can be benefited from the construction manager's services as in CM as Advisor. The CM as Advisor project execution method used by the client of project 1 showed that a project can be executed efficiently and human resource development is also possible by incorporating construction management services adequately in the CM contract. The Kochi University of Technology through the CM as Advisor was able to train the students on the construction management during the execution along with the completion of the project within planned resources without difficulty and disputes. In the similar way, a client and/or contractor from Nepal and Cambodia can utilize the CMR services to improve the efficiency in project delivery and at the same time can train their human resources.

The construction manager's services would help

improve project delivery environment in Nepal and Cambodia. The construction management system also helps overcome the weaknesses of the traditional system. Constructability, value engineering and checks-and-balances can be realized and, involvement of motivated trained manpower and efficient decision can be achieved through the involvement of the construction manager. Further, the CM contract can integrate human resource development activities and provide client/contractor opportunities to be trained during the execution. The construction manager can keep the project on track even the project manager and engineers are changed during the project implementation. Thus, the construction manager helps owner to enhance the project delivery performance and human capital development through the construction management services in the pre-construction and construction phases. Since the construction manager is hired for a specific project, the owner will not have any responsibility over the construction manager after the project is finished. The construction management system will also enable owner to keep few permanent technical manpower which would reduce the long-term administrative cost burden for the employer.

Moreover, the opportunity for the local construction industry to participate in work and to enhance the human capital would be expanded if donors used the construction management project delivery system in the least developed countries. The local contractors from the least developed countries could have opportunity to be trained and to acquire modern technology and management skills from international construction manager provided that the construction management system in the donor assisted project. Thus, a construction manager's services would provide better opportunity to enhance human capital in the least developed countries if donors send the construction manager instead of contractors for the implementation of infrastructure development projects.

6. CONCLUSION

The problems of the D-B-B system and the characteristics of the stakeholders in project implementation which have influenced the project delivery and performance of the construction industry in Nepal and Cambodia are discussed here. The construction industry in these countries needs to focus on human capital development in order to enhance the efficiency in project delivery. Alternative project delivery systems which incorporate human resource development would help improve the capacity of the Nepalese, Cambodian as well as other least developed countries' construction industry.

The DB and BOT system are not suitable in Nepal and Cambodia at present because the construction industry in the Nepal and Cambodia consists of large number of small and inexperienced contractors with low financial and technical capability, and the DB and BOT systems require high quality builder/developer with enough financial and technical capability, and the DB and BOT do not integrate human resource development while implementing a project. Further, the local industry in Nepal and Cambodia may not be able to provide the GC/CM services however they can be benefited from the construction manager's services as in CM as Advisor.

The introduction of the Construction Manager's services through the CM as Advisor method in a project delivery would help add constructability, value engineering to make practical estimate and schedule, and make enable the client and contractors to complete a project within prescribed time, budget and quality. On the other hand, the client and contractor could train their human resources through the construction management services of the CMR in similar way to the project 1 discussed above. Thus, the CM system incorporating human resource development would be appropriate to improve the performance of the construction industry through human capital development in Nepal and Cambodia as well as other least developed countries whose infrastructure development environment are similar to these countries.

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APPENDIX

Table A1: Delay and Variations in irrigation development projects in Nepal[16)]

Project Name	Start Date	Target date of Completion	Actual date of completion	Delayed (Yrs)	Estimated Cost (mUS$)	Actual Cost (mUS$)
Sunsari Morang IP						
CCP	Oct-64	Nov-72	Nov-75	3 (37%)	3	7.25 (142%)
SMIP I	Feb-78	Feb-82	Feb-85	3 (75%)	37.5	40 (7%)
SMIP II	Apr-87	Apr-94	Apr-94	-	45	49.9 (11%)
SMHP	Jan-91	Dec-95	Dec-97	2 (41%)	29.68	25.02 (-16%)
P 1	Apr-93	Dec-95	Dec-97	2 (75%)	11.67	16.85 (44%)
P 2	Oct-93	Dec-95	Dec-97	2 (92%)	3.36	3.32 (-1%)
P 3	Feb-93	Oct-95	Jul-96	0.67 (25%)	na	na
Bagmati IP						
CAD 7	May-96	May-98	Jul-99	1.16 (58%)	0.43	0.38 (-12%)
CAD 15	Apr-98	Jul-00	Jul-00	-	0.88	0.93 (6%)
CAD 2	May-96	May-98	Aug-98	0.25 (13%)	0.39	0.38 (-3%)
Rajapur IP						
ICB 1	Feb-96	May-98	May-00	2 (89%)	1.29	1.48 (15%)
ICB 2	Nov-96	Aug-98	Aug-00	2 (114%)	5.37	5.37 (0%)
ICB 3	Jun-97	Jun-00	Jun-00	-	5.51	5.51 (0%)
ICB 4	Sep-97	Sep-99	Sep-99	-	1.15	1.15 (0%)
Chitwon Lift IP	Feb-78	Feb-85	Feb-87	2 (29%)	19.5	24.05 (23%)
BLGWP						
Stage I	Nov-76	Oct-83	Oct-85	2 (29%)	13.7	na
Stage II (ph 1)	Oct-83	Oct-88	Nov-90	2 (40%)	19.4	na
Stage II (ph 2)	Nov-90	Dec-95	Dec-95	-	na	na
Stage III	Feb-91	Dec-98	Jun-95	0.5 (6%)	52.69	59.43 (13%)

na: not available, figure in () shows overrun percentage

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