Management Model for Nuclear Power Station Project in Vietnam

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Abstract. Vietnam’s economy has been increasing quickly since 1986 to increase for several times. This leads to an increase in energy demands to satisfy for actual requests. To overcome future shortages of electricity, the Government of Vietnam has been preparing for its nuclear power plants during the past 20 years with many issues and matters must be considered seriously. One of them is which management model is mostly suitable and how to select best models. Good selection can help the Government of Vietnam goes straight forward to final completion of the project on time, cost and quality as well as specific requirements of safe issues, country security, economic enhancement, etc. This paper has an objective to discuss several common management models for construction projects applied in both Vietnam and the world. Later, it will propose a most suitable model of construction management for the first nuclear power plants in Vietnam. The Government of Vietnam can use in considering on its selection process of its nuclear power plants planned to build in the future.

1. Introduction
Following the management level of construction project, the management today is just the beginning to combine design, bidding and construction of a common process in Vietnam. Management of construction should be ready to face and solve unforeseeable problems such as inflation, energy shortages, the world changes, new technology and natural disasters. The thoughtful planning and the constant control of needed human and material resources are more necessary ever to accomplish construction projects that gradually become larger and more complex. It is the most difficult requirement and mission of construction management at present and in future. Requirements for the nuclear power plants involve very high safety so selection of management model for the construction project must be considered carefully. In this research, the authors are going to explore management models for construction projects in the world and Vietnam, analyze the needed requirements of project management for the nuclear power plants, concrete conditions in Vietnam and select suitable management model for the first nuclear power plant of Vietnam.

2. Overview on Construction Project Management
The concept “project management” was first applied in the United States about 30 years ago for defense contractors and construction companies. The project management has developed in many different fields in the world, including construction. Best exemplified by the foundation international
project management institute (PMI), it consists of about 250,000 members and hundreds of sub-institute in many countries in the world: USA, UK, France, Canada, China, Japan, South Africa ... Members around the world have made contact with each countries to exchange experience in project management, participation in training and application new knowledge of project management to reality. A concrete example was the invention of project management model the following Critical Path Method (CPM) at De Pond Company of America and a popular method worldwide. In addition to operation of the international project management institute PMI, the civil association in each country also has got many useful activities in research and application of new knowledge of project management into practice, typically American Society of Civil Engineers (ASCE), England Society of Civil Engineers and Japanese Society of Civil Engineers (JSCE). These organizations greatly have contributed to strengthen and make project management high practical, remarkable effects. Many standards and guideline on project management were designed to help engineers and managers who could operate projects mostly effective.

3. Research Methodology
This research is carried out in accordance with steps shown on Figure 1 as:

Research Objectives: The nuclear power plant is firstly built in Vietnam while the management skills of construction investment projects are not good, the management model has not applied flexibly and research objectives are clearly defined:
1. Studying the management models in detail
2. Selection a suitable management model for the first nuclear power plant in Vietnam

Overview: Research overview will learn about the development of construction management in the world, the situation of construction management in Vietnam, difficulties in the management of construction investment projects.

Research Method: According to internet, books, etc to learn about project management, the life cycle of a construction project. Study the specific characteristics of the nuclear power plants that affect the selection of construction management model to be suitable for practical conditions of Vietnam.

Studying Management Models: The management models are studied in detail. Analyzing specific characteristics of each management model. That is the basis for the selection of a best management model for the project.

Selection of Management Model: Evaluate the management models that are studied in detail. The selection of suitable management model for the first nuclear power plant in Vietnam.

Conclusion: The research is summarized and makes specific comments. The success of the research focus author’s selection of construction management model for the first nuclear power plant in Vietnam on the basis of study specific characteristics of the applied management models and characteristics of nuclear power plants.
4. Nuclear Power Plants

There are currently 463 nuclear power plants in the world accounting for 15% of power. Nuclear power of 187 plants that are being built and are going to build is going to provide by 196,623 MW, increase 53% comparing with today. The world's first nuclear power plant became operational in Obninsk, outside of Moscow in 1954, an output of 5,000 KW. Generation I reactor used gas to cool - GCR (Gas cooled reactor). Generation I reactors were inaugurated in 1956 in Britain and France. Generation II reactor was Pressurized Water Reactor (PWR) or boiling water reactor (BWR), commonly known as light water reactors (LWR). The first generation II reactor was inaugurated in American in 1957, production 60 MW. Comparing with generation I reactors, generation II reactors produced electricity at a lower cost from 20 to 30% and less area, more compact volume. Generation III reactor was European Pressured Water Reactor (EPWR). It was built in 2005 in Finland. Nuclear power plants in the world are now type of generation II reactors. Some countries have built or are planning to replace expired reactors to generation III reactors and the countries are cooperating to research preeminent generation IV reactor (safer, less radioactive waste, more economical, reduce the risk of nuclear proliferation). The working principle of nuclear power plants is not more different than thermo-eclectic plants. Nuclear reactors where supply thermal energy to create steam to run generators. A nuclear power plant normally consists of four parts: (1) Nuclear reactor where take place nuclear fission, provide energy to produce steam; (2) Generator uses steam; (3) Turbine, steam turns it to run generation; and (4) Condense part: cooling steam, transfer it back into the liquid phase. Flue in nuclear reactors is often Urani-235, Urani-233 or Plutoni-239. Nuclear reactors currently use UO2 containing 5% of uranium-235.

5. Management Models

There are numerous alternative contractual approaches to bringing together a team for the design and construction of a project. The principal categories address-ed in this section includes the traditional approach, the owner-builder, turnkey (design construct or design-manage), professional construction management, and program management. Each has its advantages and disadvantages for a particular application.
5.1. The Traditional Model
Members of the Associated General Contractors of America (AGC) have generally advocated and operated under the traditional method (Figure 2). Here the owner employs a designer (architect, architect/engineer, or engineer) who first prepares the plans and specifications, then exercises some degree of inspection, monitoring, or control during construction. Construction itself is the responsibility of a single general contractor under contract to the owner. Much of the work may actually be performed by individual trade contractors under subcontract to the general contractor. Although the subcontractors normally bid upon a portion of the owner's plans and specifications, their legal contractual relationships are directly with the general contractor; the latter, in turn, is responsible to the owner for all the work, including that which is subcontracted. Types of Contracts: The traditional approach can be implemented using the single fixed-price or lump-sum contract, a unit-price contract, a negotiated cost-plus-fixed-fee contract, or a guaranteed maximum-price arrangement. Other variations or combinations, of course, are also utilized.

Figure 2. Traditional Model

5.2. The Owner-Builder Model
Historically, many city, county, and state public works departments, federal government agencies such as the Tennessee Valley Authority, and private companies such as DuPont and Coors have performed both their own design work and some or all of the actual construction with their own forces. This approach is often referred to as “force account”. Other owners (or owners' representatives), such as the Army Corps of Engineers, the Bureau of Reclamation, the Public Building Service of the General Services Administration, and Proctor & Gamble in the private sector, while retaining many of the management and conceptual design responsibilities, have utilized consultants for some or all of the detail design, and have depended upon construction contractors for the actual hiring and supervision of the labor force (Figure 3).

Figure 3. Owner – Builder Model

5.3. The Design-Construct or Design-Manage (Turnkey) Model
Some authorities differentiate between “design-construct” and “turnkey”. General usage, however, treats them interchangeably. In this method, all phases of a project, from concept through design and construction, are handled by the same organization (Figure 4). In the case of design-construct, the constructor acts as a general contractor with single-firm control of all subcontractors. Usually, but not always, there is some form of negotiated contract between design constructor and owner. In the case of
design-manage, construction is performed by a number of independent contractors in a manner similar to the professional construction management concept. Under either design-construct or design-manage, construction can readily be performed under a phased construction program to minimize project duration. This form of completing projects has been used for the majority of process-oriented heavy industrial projects constructed in the United States in the last few decades. Reference to Engineering News Record's annual list of the 500 largest designers shows that the design-constructors are heavily represented in the top 20. Background and Evolution in the 1950s, the typical design-construct or engineer-contractor organization was organized along functional lines. Design, procurement and construction departments were coordinated by a project engineer who was responsible for the overall project with little or no authority to direct the functional groups. The real responsibility initially rested with the design group and shifted to the construction group as the design neared completion. As projects became more complicated and early completion became increasingly important, clients began to demand that one person be placed in charge that could speak for all departments and be accountable to the owner for the overall performance.

**Figure 4.** (a) Design – Build Model and (b) Design – Manage Model

### 5.4. The Professional Construction Management Model
Professional construction management treats the project planning, design, and construction phases as integrated tasks. This approach unites a three-party team consisting of owner, designer, and construction manager in a non-adversary relationship, and it provides the owner with an opportunity to participate fully in the construction process. A prime construction contractor or funding agency may also be part of the team. The team works together from the beginning of design to project completion, with the common objective of best serving the owner's interests. Contractual relationships among members of the team are intended to minimize adversary relationships and contribute to greater responsiveness within the management group. Interactions relating to construction cost, environmental impact, quality, and completion schedule are carefully examined by the team so that a project of maximum value to the owner is realized in the most economical time frame (Figure 5).

**Figure 5.** (a) Construction Manager Model and (b) General Contractor Model
5.5. The Program Management Model
Program management (sometimes called project management) is an emerging concept being used on some of the very largest projects. Program management services may include no design or direct construction but the program manager could handle overall management of a number of individual projects related to an overall program. Program management has been applied on several major projects where the owner has participated heavily in managing the program in an integrated program management team utilizing owner top management personnel and management and specialized personnel from a construction management (CM) firm, architect/engineer, or other consultant (Figure 6).

![Diagram of Program Management Models](image)

**Figure 6.** (a) Program consultant Model and (b) Integrated Project Team Model

6. Applying Management Models for the Nuclear Power Plant in Vietnam
6.1 Assessing Suitable Limit of Management Models for the Nuclear Power Plant in Vietnam
Management models are analyzed in detail. Advantages and disadvantages of each model show the suitability of each model is not high to apply to the nuclear power plant in Vietnam. The selection should be considered following reasons:

1. The nuclear power plant is special national project, firstly considered to build in Vietnam, invested and implemented by Vietnam’s government. The plant is designed and engineered by special standard, best safety, security; studying and evaluating the impact of geologic faults, climate change, sea level in region where the project formulated; writing a report for assessment of environmental impact of the project. Contractor, who is selected, has got much experience in designing, building, operating nuclear power plants, from the countries that have high potential of technology in this field. They have achieved many nuclear power plants. They are also able to arrange financing and invest reasonable.

2. Domestic construction contractors have no much experience to build nuclear power plants. If domestic contractors are selected, the process of project implementation will face many problems. Six basic phases are analyzed above, 3 phases of them are engineering and design, procurement and construction have to be built by foreign contractors who have got much experience and technology to ensure the project's goal: quality, time and cost. Other contractors can be implemented by domestic contractors.

6.2 Selection of EPC Management Model for the Nuclear Power Plant in Vietnam
**Why chooses EPC for the nuclear power plant?** EPC model (engineering, design-procurement-construction) is formed on the basic of solving particular requirement of the nuclear power project and the limitations of construction management models.
The nuclear power plant is a special national project. It requires very high safety, modern technology. Domestic contractors have no experience in the field of nuclear power. EPC model ensures three main phases (engineering and design, procurement, construction) are implemented by experienced foreign contractors and they have fully financial potential and technology. According to EPC model foreign contractors is key contractor also participating in the role of construction management.

**Introduction EPC model.** EPC model selects foreign constructor to ensure requirements:
- Have got much experience in designing, building, and operating nuclear power plants
- There is the potential of science and technology in the field of nuclear power.
- There are large financial resources and investment efficiency.
- Foreign constructor implements key phases of the project: engineering and design, procurement and construction.
- Other phases: concept and feasibility studies, start-up and implementation, operation or unitization can be implemented by domestic constructors.

![Figure 7. Construction Management Model](image)

- Owner and general constructor acting as a construction manager.
- General constructor implements directly: engineering and design, procurement and construction
- Construction manager may act as owner’s agent to extend delegated
- Fixed price or negotiated individual construction contracts with owner
- Negotiated professional fee for construction management and design services
- Owner and general constructor acting as a construction manager.
- Subcontractors contract fixed price or negotiated with general constructor
- Construction manager usually acting as agent for owner
- Negotiated professional fee for construction management and design services

![Figure 8. General Constructor Model](image)
Suitability of EPC model. EPC model keeps advantages of professional construction management model and professional requirements of the nuclear power plant.
- Independent evaluation of costs, schedules and quality of changes or modifications, helps assure decision in the best interest of the owner
- Full-time coordination between each constructor and other constructors
- Minimum design-construction time can be achieved through use of phase construction
- Many opportunities are provided for value engineering in the design, bidding and award phases
- Engineering and design, procurement and construction are implemented to achieve high quality and safety
- Domestic constructors have much experience in building nuclear power plants.

7. Conclusions and Recommendations
In the research the authors study the life cycle of a project and construction management models in detail in the world and in Vietnam. EPC model is formed to apply the most suitable to the first nuclear power plant of Vietnam. Vietnam firstly builds the nuclear power plant; domestic contractors are not able and not also enough condition to achieve the desired quality. General constructor of EPC model is foreign contractor who directly implement three key phases of the project: engineering and design, procurement and construction. Other phases can be implemented by domestic contractors. Owner and general contractor acting as agent a construction manager to reach the consistent implementation of the project.

EPC model resolves requirements of construction for the nuclear power plant in Vietnam completely: quality, technology and good safety. Basically, EPC model is much like the professional construction management. In the reality conditions when domestic constructors are not able to meet high requirements of the project, EPC model is feasible and is the best choice for the project.

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