CASE STUDY: PROPOSED APPLICATION OF PROJECT MANAGEMENT TECHNIQUES FOR CONSTRUCTION OF NUCLEAR POWER PLANT IN MALAYSIA

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ABSTRACT

This study discusses the techniques of project management for the construction of nuclear power plants that can be used in Malaysia. Nuclear power reactors category Gen III + reactor are expected to be use where it is safer and more modern than the first generation of reactors built in the 1970s. The objective of this study is to ensure the construction of this reactor to be completed by the stipulated time and not exceed the cost estimates. In addition, project management is also able to meet all the specifications and achieve the quality standard. In this study, the techniques used in project management are Gantt Chart, Critical Path Method (CPM)/Program Evaluation and Review Technique (PERT) and Microsoft Project. From the study, found that these techniques can assist in facilitating the management of the project to ensure that the estimated time, cost and quality can be managed more effectively.

ABSTRAK

Kajian ini membincangkan tentang teknik-teknik pengurusan projek bagi pembinaan loji kuasa nuklear yang boleh digunapakai di Malaysia. Reaktor kuasa nuklear yang dijangka akan digunakan adalah reaktor kategori Gen III+ di mana ia lebih selamat dan moden berbanding reaktor generasi pertama yang dibina pada tahun 1970-an. Objektif kajian ini dijalankan adalah supaya pembinaan reaktor ini dapat disiapkan mengikut masa yang ditetapkan serta tidak melebihi kos anggaran. Selain itu, pengurusan projek juga dapat memenuhi semua spesifikasi dan mencapai piawian kualiti yang telah ditetapkan. Dalam kajian ini, teknik-teknik yang digunakan dalam pengurusan projek ialah seperti carta Gantt, "Critical Path Method (CPM)/Program Evaluation and Review Technique (PERT)" dan perisian Microsoft Project. Daripada kajian, teknik-teknik ini didapati dapat membantu dalam melicinkan pengurusan projek untuk memastikan masa, kos dan kualiti dapat diuruskan dengan lebih efektif.

Keywords/Katakunci: Project Management, Nuclear Power Plant Gen III+, Gantt chart, Critical Path Method (CPM)/Program Evaluation and Review Technique (PERT), Microsoft Project.

INTRODUCTION

Nuclear energy is one of the possible alternative energy to meet the increasing energy demand in Malaysia. Unlike coal and gas, nuclear power can considered green in other words where it's clean from pollution, the greenhouse effect and so on. It is because only small amount of carbon dioxide released into the atmosphere compared to coal and gas. It is similar to the use of solar energy, wind, geothermal power and water which are all do not depend on burning fossil fuels.

According to *World Nuclear Association*, about 17% of the world's power supply was contributed by nuclear energy. This can be identified based on the construction of nuclear power reactor in 30 countries around the world where it has the capacity of different energy. **Table 1** below shows the

main user of nuclear power in the world. About 348 units of reactor have been operating in the major countries in the world with a total power of over 315 GWe

Study from *World Nuclear Association* also shows, until March 2008, 439 were completed nuclear power reactor in operation and 35 more are still at the construction stages. According to *International Atomic Energy Agency* (IAEA), 20 out of 35 reactors under construction stage are located in Asian countries. This shows that nuclear energy is growing rapidly in Asian. The Asian countries are India, China, Japan and Korea. For countries such as Indonesia, Vietnam and Thailand, they have started early efforts towards the same.

Table 1: The main user of nuclear power in the world

Countries	Reactor	Power (MWe)
United States of America (U.S.A)	104	99 049
France	59	63 473
Japan	55	47 577
Germany	17	20 339
Russia	31	21 743
Canada	18	12 652
Ukraine	15	13 168
United Kingdom	19	11 035
Sweden	10	9 016
Korea	20	17 533
Total	348	315 585

(Source: *World Nuclear Association, 2008*)

Therefore, in developing a nuclear power program especially in Malaysia, the following steps need to be taken, taking into account several major carefully evaluated factors:

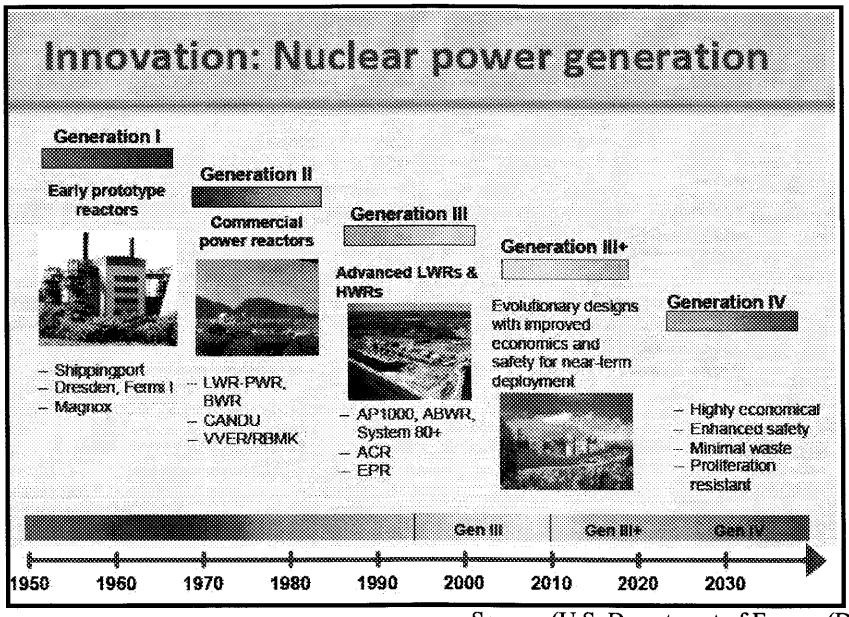
1. ***Preliminary assessment of potential sites,*** with reference to population density, meteorology, grid interconnections, soil seismic conditions, accessibility for large, heavy components, cooling water availability, etc. Even though in-depth site investigations are costly and time consuming, a large enough number of sites should be considered in advance, in order to avoid future conflict with other industrial site usage and population growth. This point should be stress especially for highly populated and rapidly industrializing countries.

2. ***Preliminary assessment of proven reactors,*** in terms of capital and operating cost, fuel cycle analysis and its supply prospect, their construction and operating performance, and the training of Malaysian personnel. At this stage, national policy objectives are to be taken into consideration to select a reactor type from the point of view of assuring an economical and stable fuel cycle and minimum foreign exchange payments. Most often, the results of techno-economic analysis would turn out to be in contradiction with the national policy objective. In such a case, the national policy objective should be pursued at a little sacrifice of economics.

The nuclear power industry has been developing and improving reactor technology for more than five decades and is beginning to build the next generation of nuclear power reactors to meet rapidly growing demand globally.

Several generations of reactors are commonly distinguished. Generation I reactors were developed in 1950-70s. Generation II reactors are typified by the present US fleet and most in operation elsewhere. Generation III (and III+) are the advanced reactors where it expected to be constructed in Malaysia. The first Generation III (and III+) are in operation in Japan and others are under

construction or on offer. Generation IV designs are still on the drawing board and will not be operational before 2020 at the earliest.



Source: (U.S. Department of Energy (DOE), 2003)

Figure 1: Evolution of Nuclear Power System (Gen I to Gen IV)

Reactor suppliers in North America, Japan, Europe, Russia and elsewhere have a dozen new nuclear reactor designs in the advanced level of planning, while others are at the level of research and development.

The Generation III (and III+) reactors have advance features such as:

- A standardised design for each type to expedite licensing, reduce capital cost and reduce construction time,
- A simpler and more rugged design, making them easier to operate and less vulnerable to operational upsets,
- Higher availability and longer operating life - typically 60 years,
- Further reduced possibility of core melt accidents,
- Resistance to serious damage that would allow radiological release from an aircraft impact,
- Higher burn-up to reduce fuel use and the amount of waste,
- Burnable absorbers ("poisons") to extend fuel life.

NUCLEAR POWER PLANT PLANNING AND IMPLEMENTATION STAGES

The Nuclear Power Plant (NPP) project planning and implementation is made up of several long duration activities which can be categorized as:

a) ***Conceptual and preparatory activities*** that squeeze all investigations on technical economic, safety and regulatory aspects required for the justifications of a NPP project;

b) ***Preparatory activities*** to create the national infrastructure necessary to support the launching of the NPP project and the decision to go forward with the project;

c) ***Project oriented activities leading*** to the successful design, construction, commissioning, start-up, warranty tests and acceptance of the first NPP and potentially to subsequent ones;

d) ***Performance oriented activities leading*** to the safe and reliable operation and life management of the NPP and;

e) ***Post operation activities leading*** to decommissioning of the NPP.

When combined with all the information above, it is the generic implementation stages of a NPP project plan shown in **Table 2**. All these activities are usually performed by several different private and public (government controlled) organizations. Each organization is responsible with specific activities and a common goal, e.g. to reach the NPP objective.

Table 2: Generic implementation stages of a nuclear power plant project.

STAGE ACTIVITIES	TIME (YEARS)
1 - PRE-PROJECT	**1-3 years**
Power system planning	
Legal and organizational framework	
National infrastructure survey	
National participation plan	
Site survey & environmental assessment	
Manpower survey and development program	
2 - PROJECT DECISION-MAKING	**3-7 years**
Pre-investment (feasibility) study	
Site selection & evaluation	
Bid specifications/Reception offers	
Bid evaluation	
Contract negotiation and closure	
Initiation long lead procurement item	
3 - PLANTCONSTRUCTION	**3-6 years**
Preparation of site infrastructure	
Detailed design engineering	
Equipment and components manufacture	
Construction, erection and installation	
Commissioning and plant acceptance	
4 - PLANT OPERATION	**30-60 years**
Operation and maintenance	
5 – PLANT DECOMMISSIONING	**5-50 + years**
Decontamination	→ after plant closure
Dismantling	
Waste processing, storage and disposal	

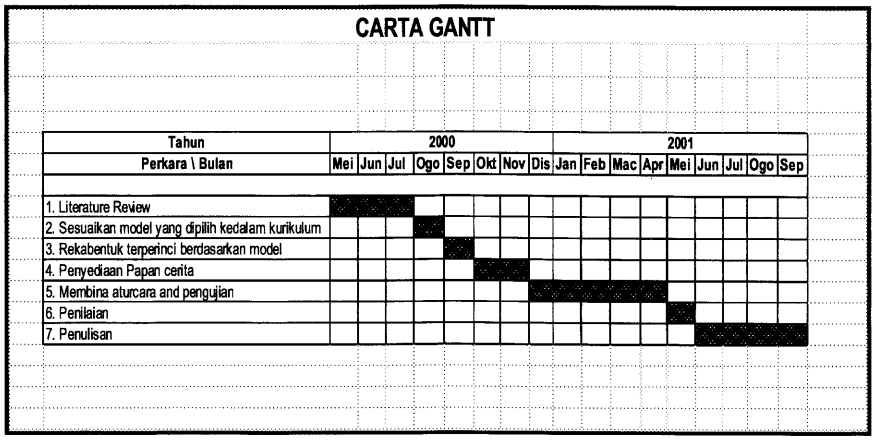
(Source: *Managing the First Nuclear Power Plant Project (IAEA-TECDOC-1555), May 2007*)

THE TECHNIQUES USED IN PROJECT MANAGEMENT

In few years back, there were several methods of project management i.e. Gantt chart and Critical Path Method (CPM)/Program Evaluation and Review Technique (PERT). The used of these tools was to ensure every projects can be delivered smoothly and within the period given. These methods however, will presents a lots of lack and shortcoming when its been applied in larger construction or development.

In practically, the Gantt chart method was developed by Henry Gantt and it is more specific in scheduling and allowed project manager to set the timeline of a project's progress. While the CPM/ PERT was developed by US Army at 1958. The main focused are planning, scheduling and controlling where it is better compared to Gantt chart. This method are normally used in Research and Development (R*n*D) for new product, construction of factory, building, highway, slope, handling heavy equipment, and design and built new system. The samples of the methods were shown in **Figure 2 and 3** below.

In order to satisfy all needs in project management, the Microsoft Project has been created in 1984 to assist project managers in developing plans, assigning resources to tasks, tracking progress, managing budgets and analyzing workloads (**Figure 4**). This tool is commonly used nowadays and it is proven in order to help us in management of time, resources, cost and quality.



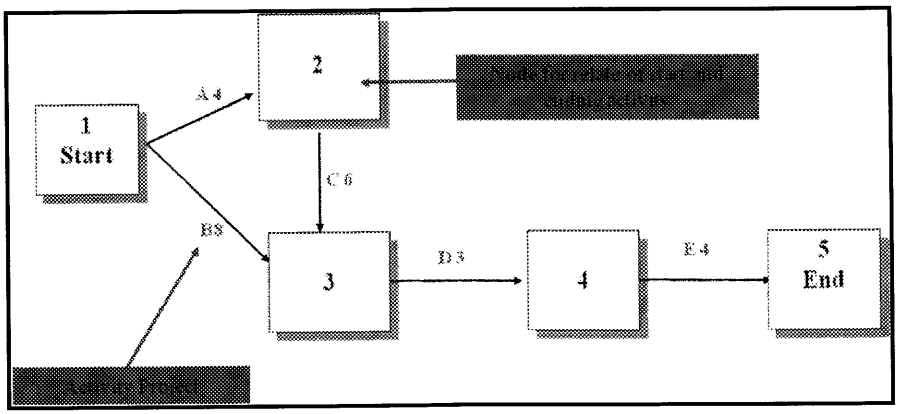
Source: (Pengurusan Projek, 2008)

Figure 2: Sample of Gantt chart Method

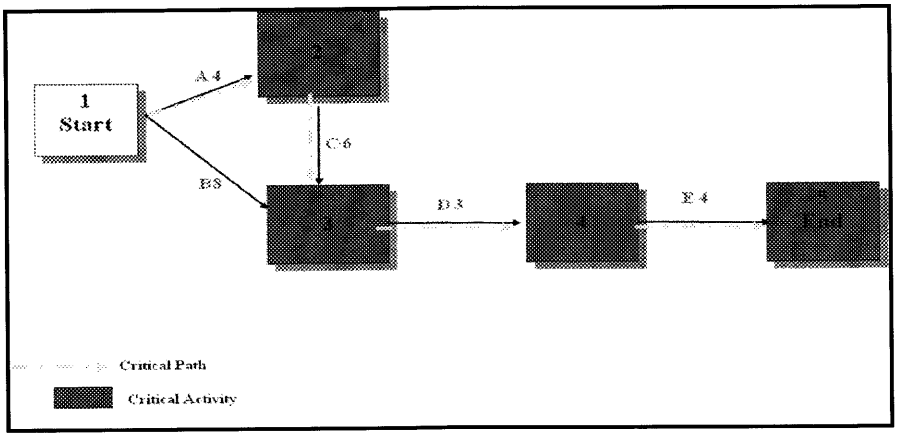
Activity	Immediate Predecessor*	Time
A	-	4
B	-	8
C	A	6
D	B,C	3
E	D	4

*P/S: *Immediate predecessors for some activity is : Last activity must Finish first before new activity started*

(a)



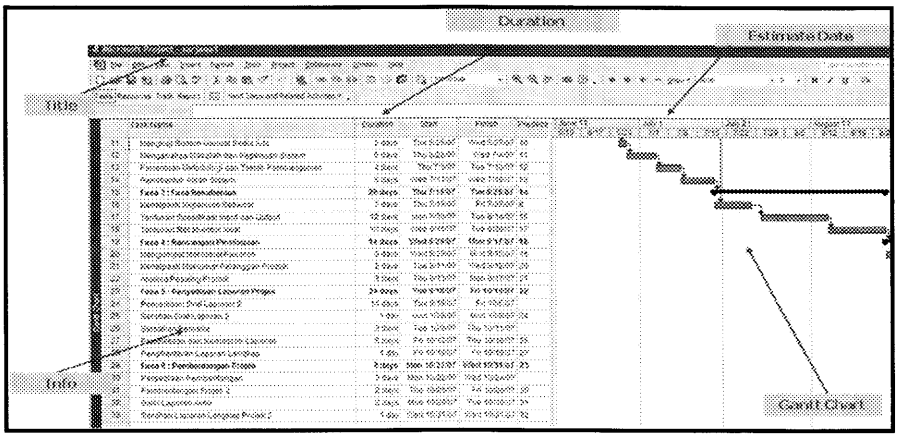
(b)



(c)

Source: (Pengurusan Projek, 2008)

Figure 3: (a)-(c) Sample of CPM / PERT Method



Source: (Pengurusan Projek, 2008)

Figure 4: Screenshot of Microsoft Project

SUMMARY

In a planned of building the NPP, there are hundreds or thousands of functions and tasks. A proper management plan should apply to ensure the project is within the budget, meet deadlines and effective used of resources. In order to monitor all of the goals achieve, Microsoft Projects will helps to manage more efficiently and effectively. Below are several overviews on how Microsoft Projects will helps on the project management.

- **Plan, control and oversee all phases of a project**
  The Work Breakdown Structure (WBS) can be create in order to establish the relationship between tasks and project manager will easily control if there any constraints and deadlines.

- **Avoid major problems**
  Every plans or tasks are saving under 'Baseline'. This 'Baseline' will then be compared with actual progress reports that come pouring in during the life of the project. It will attention to any creeping tasks and allows dealing with these problems appropriately.

- **Avoid miscommunication**
  The Microsoft Projects can be connected with Microsoft Outlook to keep in contact with the team. It will allow Internet tracking and management of the projects and provides more communication.

RECOMMENDATION

Based on the information/data and experience from other NPP development, the following improvements contribute to reach the main goals are:

- The project management team should be given full authority to successfully complete the project within the project budget and schedule;

- Use of Integrated Management System Tools from detail design to material management and documentation control system (computer-controlled fabrication equipment, modelling of complete plant with as much details as possible including piping etc.);

- Good communication which can be aided by implementation of a common electronic network available to all project participants;

- Ensure that suppliers meet to the level of quality requirements;

- Training in scheduling techniques, management system and procedures writing, etc. is a essential part of project management responsibilities;

- There is a strong benefit in finishing design before start of construction and integrating procurement, construction and commissioning requirements with upfront design;

- In general, small incremental design upgrades usually ends up costing more than they save. It is recommended to implement design changes in planned stages rather than as they become available or even better, to freeze design as early as possible;

- Pre-qualification of contractors including design audits should be explained and agreed to beforehand;

- Separation of contracts into functional blocks where possible, rather than by disciplines (civil, mechanical, electrical);

- Making available modern facilities and infrastructures on the site as early as possible; and

- Work (detail engineering, procurement of long delivery material, civil works) should be initiated to the extent possible before the signature of contract.

REFERENCES

INTERNATIONAL ATOMIC ENERGY AGENCY(IAEA). (2007). *Managing the First Nuclear Power Plan Project, IAEA-TECDOC-1555.* Vienna: IAEA,.

Lee, D. B. Korea s Experiences in Implementing a Nuclear Power Programme. *18th IAEA General Conference.* (p. 39 pages). Republic of Korea: Atomic Energy Bureau, Ministry of Science and Technology.

World Nuclear Association. (2010, August). *Advanced Nuclear Power Reactors*. Retrieved from http://www.world-nuclear.org/info/inf08.html.

Pengurusan Projek. (2008, September 3). Retrieved from www.scribd.com/doc/2241301/Pengurusan-Projek-bab-1.