Cost Estimation Framework for SMART(SMR)

Jinsam Cho [a], Jeeyoung Kim [a*]
[a]*Korea Atomic Energy Research Institute, 1045 Daeduk-daero, Yoseong-gu, Daejeon, Korea*
[*]*Corresponding author: kimjy@kaeri.re.kr*

1. Introduction

KAERI(Korea Atomic Energy Research Institute) has carried on development of its SMR(Small and Middle Sized Reactor), *SMART*. To evaluate its economic efficiency, conceptual framework of economic evaluation was built up in the previous study. Following that whole framework, sub-framework for cost estimation is studied in this work. In this early stage of an advanced reactor development, its cost evaluation framework has been studied recently. Generally, the definition of cost itself could be different among various evaluation purposes. So, we focused to set up hierarchy and categories of it, and later broken down their sub structure and suitable methodology to avoid any kind of missing and overlapping cost in cost estimation.

2. Methods and Results

According to the papers related in this cost topic, cost breakdown structure, cost range.

Here in this study, we suggested properties cost estimation framework of SMRs should consider. Generally, the definition of cost itself varies among various evaluation purposes. So, to avoid any kind of missing or overlapping cost in estimation, we focused to set up hierarchy and categories of it, broke them down into sub structure and designated suitable measuring methodologies respectively.

2.1 Consistency & Comprehensiveness in Hierarchy

When cost estimation begins, cost categories should be defined where all kind of cost would be allocated and summarized. Generally, the categories is divided into 4 level and presented in Fig. 2. In many cases the lowest level, *Infrastructure-Opportunity Cost*, is apt to be omitted because opportunity cost is not directly calculated but hidden between the alternatives. However, this level cost should be considered especially in the case that SMRs is competing with other types of reactors. So, if we omit this level of cost, decision of selecting an optimal reactor type could be made wrong.

Moreover, relation of each level in the hierarchy is upward dependent: The status quo of the lower is deterministic to the upper level deterministic. For example, if there is a nation of which power grid system is not completed nationwide, SMRs could be more competent than LRs considering this kind of infrastructure cost. To take this effect into account, we prepare two kinds of cost estimation models: Stand-Alone Model and Comprehensive Model. The former is for calculating generic cost estimation of SMART, and total cost is almost fixed regardless of a customer, but the latter is for calculating every relevant cost at a view point of a customer, and total cost differs with regard to a customer. Table I shows this.

Generally, a nuclear power plant's life cycle cost at overnight basis is divided into 4 categories. Fig. 1 shows this hierarchical structure of nuclear power plant cost estimation. To estimate cost of SMART in details, every cost in each level is made into a spread sheet module such as Microsoft Excel. This leads to calculate a category's cost separately and sum up totally at the end of estimation.

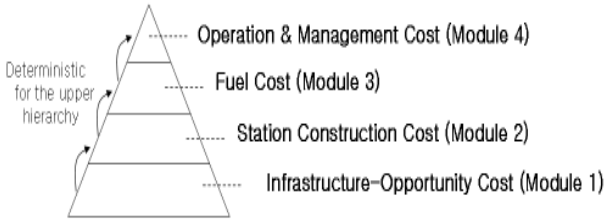

Fig. 1. Consistency in cost hierarchy

Table I: Type of Cost Estimation Model

Cost	Stand-Alone model	Comprehensive model
O & M	○	○
Fuel	○	○
Station Cons.	○	○
Infra-Opp.	-	○

2.2 Structural Cost breakdown

Cost guideline for Gen IV shows total capital investment cost comes through four steps: Total Direct Cost, Base Construction Cost, Total Overnight Construction Cost, Total Capitalized Investment Cost[1].

In a well-defined project planning, WBS(Work Breakdown Structure) can be built up in details. After defining WBS, each item's requiring resource should be calculated. This procedure makes RBS(Resource Breakdown Structure) for Station Construction Cost. And also, in a life cycle cost calculation, Fuel and O&M cost should be included. For this breakdown, SMART uses 8 major accounts. This is described in Table II[2].

Table II: Breakdown of SMART Overnight Cost

Category	Account Description
Direct Cost	A/E
	Equipment cost

	Execution cost
	Fuel cost
Indirect Cost	Project management cost
	License cost
	Commissioning cost
	Contingency

2.3 Risk Consideration

In the early stage of a project such as FOAK, top-down approach is useful for cost estimation. However, as development evolves, bottom-up approach is getting more necessary. Because it is amid SMART development at the moment, it must include cost risk factor both type of approach. To produce risk related information, suitable probability function is allocated in every spreadsheet module. Finally, through a random sampling method such as monte-carlo simulation, SMART cost estimation model could produce cost risk related information.

2.4 Relevance with object

In optimal selection on the basis of management accounting, sunken cost should be excluded and only relevant cost such as incremental cost be considered. This concept should get though the cost hierarchy from the bottom to the top.

3. Future work

In this work, cost estimation framework is studied. As a part of the whole economic evaluation of SMART, the framework is going to be used cost estimation. Conclusively, putting cost module and benefit module together, SMART economic evaluation will be completed.

REFERENCES

[1] The Economy Modeling Working Group of the Generation IV International Forum, Cost Estimating Guidelines For Generation IV Nuclear Energy Systems, p. 79, 2007
[2] KAERI, Estimation of SMART Cost and Its Economics, p. 16, 2009