Life-cycle Based Risk Evaluation for Ship Project

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ABSTRACT

As ships go through many risks in their life-cycle, in order to supply a reasonable decision-making at the earliest stage of a ship project planning, risk analysis is needed. A risk evaluation methodology, which combining life-cycle assessment with multi-criteria decision-making tool of analysis hierarchy process (AHP), was proposed. In this method, first, risks of ships in the life-cycle were identified, and the life-cycle based risk evaluation criteria system for ships is built. Then the values of evaluating loss of risk indicators and comparison matrices are obtained by experts concerned. From the former, grey clustering analysis is done. Simultaneously, weights of each risk indicator are calculated from the latter. Finally, the value of integrated risk evaluation, which reflect the level of the risk loss, was obtained and a sensitivity analysis is carried out to assess the effect on the final results of uncertainty in the risk values assigned. An example is given to demonstrate the application of the methodology and illustrate the validity and practicality of the proposed method.

KEY WORDS: Ship; life-cycle; risk evaluation criteria system; AHP; grey evaluation; sensitivity analysis.

INTRODUCTION

Ship investment projects have characters of technical complexity, harsh working condition, high costs and long service period. In their life-cycle from projects programming to decommissioning, there are variety of risks and many uncertainty factors which have immediate or indirect effect on whether the project can obtain the expected return or not. So risk assessment is indispensable when ship investment projects start. It is acknowledged that risk is inevitable but may be mitigated. Risk assessment is a very important step for risk management in ship investment project. So far, there are many literatures about risk assessment on ships’ structure, fire, explosion, collision and grounding, capsize, HOE (Human and Organization Error), etc. Kim et al. (2006) conduct the fire risk modeling of machinery space and evaluate the major hazards threatening the engine room. Amrozowica (1997) analyses tanker grounding with probabilistic method. McTaggart (2000) examines capsize risk in a seaway. Collision risk evaluation and risk reduction are discussed (Lehmann and Biehl, 2004; Chen and Moan, 2003). Bea (1996) summarizes how human and organization factors in design, construction, and maintenance of ship structures might be formulated and addressed, and suggests ways to improve the overall efficiency of the system so that initial costs are not increased and long-term costs are decreased. Each study of the above is on given object in ship life-cycle.

In this paper, a ship project is taken as a whole system according to its life-cycle. With the viewpoint of System Engineering Theory, the risk assessment of ship project employs the Grey Clustering and Analysis Hierarchy Process (AHP) method. The assessment steps of the method are as follow:

1) Establish a life-cycle risk indices system of ship project;
2) Determine the value of each risk indicator by the investigation of experts or technical personnel and make a cluster analysis;
3) Determine the weight of each assessment index in the whole assessment system;
4) Use the synthesizing judgment to obtain the final assessment results.

In many circumstances, due to the complexity and uncertainty of objective factors, using a crisp number to represent a judgment proves to be difficult, a sensitivity analysis of the risk values of each indicators is carried out to make certain which indicators have the notable influence on the risk evaluation.

LIFE-CYCLE RISK INDICES SYSTEM OF SHIP

There are so many risks in the ship life-cycle that it is necessary to classify them convenient for risk identification. Decision makers need to know each risk index in the operating process of the ship project, the most important risk in each stage, and the level of risk degree in the whole project. Consequently they can control the crucial risks and reduce the loss. In order to do this, risk identification must be made according to each stage of the ship life-cycle and conceive an evaluation indicator system with the viewpoint of systematization.

Here, ship life-cycle is divided into five stages: programming, design, constructing, service and decommissioning, which are illuminated in Table 1:

1) Programming stage: In this stage, decision makers study the market of construction and charter of ship, shipping, etc; select the scheme; then feasibility analysis is necessary. If the scheme is