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Prediction on Human Resource Supply/Demand in Nuclear Industry Using Markov Chains Model and Job Coefficient

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1. Introduction

According to the recent report by the OECD/NEA, there is a large imbalance between supply and demand of human resource in nuclear field [1]. In the U.S., according to survey of Nuclear Engineering Department Heads Organization (NEDHO), 174 graduates in B.S or M.S degree were fed to nuclear industry in year 2004. Meanwhile, the total amount of demand in nuclear industry was about 642 engineers, which was approximately three times of the supply [2]. In case of other developed western nations, the OECD/NEA report stated that the level of imbalance is similar to that of the U.S. However, nations having nuclear power development programs such as Korea, Japan and France seem to be in a different environment of supply and demand from that of the U.S.

In this study, the difference of manpower status between the U.S and Korea has been investigated and the nuclear manpower required for the future in Korea is predicted. To investigate the factors making difference between the U.S. and NPP developing countries including Korea, a quantitative manpower planning model, Markov chains model [3], is applied. Since the Markov chains model has the strength of analyzing an inflow or push structure, the model fits the system governed by the inflow of manpower.

A macroscopic status of manpower demand on nuclear industry is calculated up to 2015 using the Job coefficient (JC) and GDP, which are derived from the Survey for Roadmap of Electric Power Industry Manpower Planning [4]. Furthermore, the total numbers of required manpower and supplied manpower up to 2030 were predicted by JC and Markov Chains model, respectively. Whereas the employee status of nuclear industries has been annually investigated by KAIF since 1995, the following data from the 10th survey [5] and nuclear energy yearbooks [6] from 1998 to 2005 are applied; (a) the status of the manpower demand of industry, (b) number of students entering, graduating and getting job in nuclear engineering.

2. Prediction of Human Resource Supply/Demand

2.1. Manpower Supply Prediction using Markov Chains

Markov Chains is defined as the sequential events that the incidence probability are affected only by just advance event. The chain has the characteristics that the event of just advance time step is recognized but not remembered, therefore; Markov Chains has the hierarchical structure that only the just advance probability affects only the next time step of incidence probability.

Human resource balance equation implementing Markov chains is expressed as Eq. (1). The matrix and vector in Eq. (1) are derived from nuclear energy yearbooks and surveys on the status of nuclear industries.

$$N_j(T) = \sum_{i=1}^{k} N_i(T-1)P_{ij} + r(T)R_j \quad (1)$$

where,

$N_j(T)$: Human resource at time T (year)

P_{ij}: Transition matrix including promotion and retirement

$r(T)R_j$: Recruitment vector

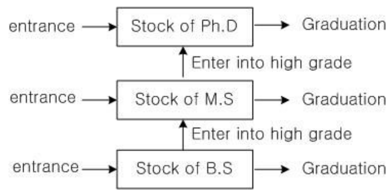

Figure 1. Manpower flowchart in nuclear degree

Manpower planning model by Lee [3] is slightly modified to apply to the present study. Figure 1 shows the manpower flowchart of students in nuclear degree to evaluate the transition matrix adopting Markov chains. The transition matrix is derived under the assumption that the present structure of the manpower is not abruptly changed owing to the stabilized manpower structure

2.2. Macroscopic Prediction of Human Resource Demand Using Job Coefficient

Job coefficient in relation to GDP is used to predict the macroscopic demand of human resource. The coefficient is defined by the manpower per 10^8 won in GDP. The JC for total electric power industry [4] is evaluated to yield the JC for nuclear industry under several assumptions. Modified JC and regression equation is expressed as Eq. (2).

$$\text{Job coefficient} = 0.548 - 0.121\ln(\text{Year} - 1995 + 1) \quad (2)$$

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The coefficient is a conservative value because of considering only the electric power field.

3. Results and Discussion

Macroscopic manpower demand is calculated using Job coefficient as shown in Fig. 2. GDP data to predict the manpower are originated from IEO 2006 [7] and 10th survey on the status of nuclear industry [5]. Calculated results have the error range between maximum value of 6900 persons and minimum 68. The increasing rates of manpower demand investigated between 2002 and 2005 are about 150 to 200 %. The rate is a value considering the project of nuclear hydrogen and SMART. Under the circumference, 35000 people will be required in 2010 according to the result.

However, the prediction using JC presents the saturation state of manpower with the level of 25000 persons in 2010. The saturation phase results from considering only the contribution to nuclear industry by the present operating and planned power reactors.

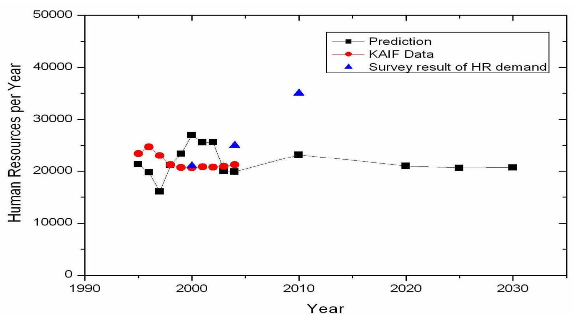

Figure 2 Transition of human resource in nuclear industry

Manpower supply predicted by Markov chains is shown in Fig. 3. The prediction depicts the stable supply structure such as 150 graduates in B.S, 30 in M.S and 18 in Ph.D. The 200 nuclear engineers can be considered as annual inflow into the nuclear society.

The employment rate of nuclear engineer is merely 4 % of total recruitment in nuclear industry. The percentage means that 120 nuclear engineers are merely employed out of the total recruitment of 2800 engineers per year in nuclear industry. The imbalance of the manpower supply and demand in Korea will be in opposition to the situation of U.S. The excess supply scenario is supported by the saturated state of demand predicted using the Job-coefficient.

Depending on the survey results, the reverse imbalance could occur and be more serious owing to 200 excess engineers in demanding. The scenario describes that human resource structure in Korea is going to be resembled with the structure of U.S.

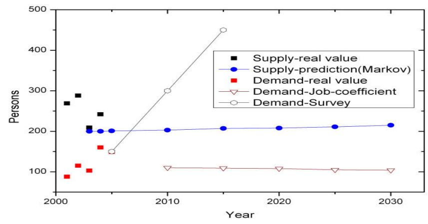

Figure 3 Transition of supply and demand of manpower in nuclear field until 2030

4. Conclusion

Human resource structure in Korea is different from that of U.S in the sense that the former has an excess of supply in nuclear manpower. The imbalance is partly caused by the low rate (4%) of employment of nuclear engineer out of the total recruitment in nuclear industry.

Through the Markov Chains manpower planning model, it is found that Korea has a structure of manpower consisted of 150 graduates in B.S, 30 in M.S, 18 in Ph. D of total 200 graduates every year under the assumption that the present structure is stable. Human resource and manpower demand are investigated up to 2030 by means of public survey and prediction using Job-coefficient.

The quantitative analysis indicates that the Korean nuclear society should provide alternative solutions to the imbalance in manpower as follows; nuclear industry which was restricted in only power industry will make up the employment rate of nuclear engineer to 8% at least. In the growth phase of nuclear industry, the economy index of the present nuclear industry has the low growth rate so that new generation of employment is difficult. To create the recruitment in accordance with the survey results, new growth engine in nuclear society is required such as Nuclear Hydrogen project and SMART.

In future study, the systematic analysis based on scenario will be required to confirm the present results and suggestions. Additionally, to overcome the limitation of the study, considering of only the nuclear power industry, extensive statistics will be required including the related radiation industry and health physics.

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