Identifying Workers with Low Aptitude toward Assembly Tasks in Production Cells Based on General Aptitude Test Battery Score

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Abstract

Major studies on cell production have placed an emphasis on technical factors such as machine order/layout, family part grouping, work-flow sequence, etc. However, it is still insufficient to investigate how human factors affect the productivity of production cells. Although many companies have introduced cell production systems and realized that productivity of cells varies greatly with workers, there is no effective measure to access workers' aptitude toward to assembly tasks in production cells. In order to assess the impact of workers' aptitude on productivity, we have made a series of experimental studies and clarified that there are about 6% of workers who have very low aptitude and can be considered not suitable to assembly tasks in cell production. Meanwhile, intending to find the worker's aptitude closely relating to her/his productivity, we designed a laboratory experiment, and administered 11 paper-and-pencil tests of the Japanese General Aptitude Test Battery (GATB) to the workers to measure their seven work-related aptitudes. After examining the partial correlations between the workers' GATB scores and their productivity, we have clarified that the GATB scores can't directly measure a worker's aptitude towards the assembly tasks in production cells, but we could apply principal component analysis to obtain a component score that correlates significantly with the workers' productivity in cell production. However, this component score still can't be used to measure workers' aptitude perfectly, in particular it can't be used to identify the workers with very low aptitude.

This paper intends to propose an effective classification model to identify the workers with very low aptitude based on workers' GATB scores. We pay special attention to make several new contributions to cell production research through the following examinations:
 (1) Based on workers' GATB scores, we apply linear discriminant analysis and decision tree to construct several classification models and demonstrate that these models can't identify the workers with very low aptitude with acceptable accurate.
(2) As the number of workers with very low aptitude is much less than the workers else, we treat this identifying problem as a classification problem on class imbalanced datasets. We apply random forest method to construct a classification model and examine its effectiveness, as well as the best choice of the parameters.
(3) We investigate the relationship between the detailed aptitude scores or standard aptitude scores of GATB and the workers' classification, and clarify the aptitude scores that have a heaver impact on the classification.

Keywords
Cell Production, Experimental Study, Workers' Aptitude, General Aptitude Test Battery (GATB), Random forest

Biographies
Yanwen Dong is a professor in the cluster of science and technology at Fukushima University. He received his bachelor degree in 1982 and a master degree in 1984 from University of Science and Technology Beijing, China. He also received PhD in 1996 from the Osaka Prefecture University, Japan. He worked in University of Science and Technology Beijing as a lecture from 1984 to 1995 and in Faculty of Economics, Fukushima University as an associate professor from 1997 to 2004. His current research interests include cell production system, production scheduling, data mining and management information system.
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