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Analysis of Workshop Production Scheduling Considering Risk Factors

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Abstract. In the process of workshop production scheduling, many risk factors can affect the reliability of production. The factors influencing the production scheduling include time, quality, equipment failure and so on. The stability is critical in the flow shop, so the risk factors related to the production scheduling should be considered in the workshop production. Workshop scheduling is taken as the research object in this paper. Along with the rapid development of database technology, the process of workshop production scheduling also involves the record and statistics of many historical production data. So data analysis technology will be used to analyze the risk factors in the process of workshop scheduling firstly inthis paper. Secondly, the simulation model for production scheduling integrated with the risk factors will be built. The aim of the model is to balance the flow shop plan and improve the production efficiency. Finally, an example is given to show that the risk factors selected in this paper and the model are effective for solving the risk problem of workshop production scheduling.

Keywords. production scheduling, flow shop, risk factor, simulation

Introduction

The production scheduling regulates the activities of production, preventes the possible deviations during production, adjusts the activities which are away from the original production process, ensure effective regulation, the number of products and the production progress to reach the production target successfully. Production scheduling is complex, and there are risk factors in it. With the development of production technology, more and more enterprises have introduced advanced production organization method by information technology. A large amount of historical data in the database of production, so the useful information can be found from these data to assist decision making effectively.

Ensuring the reliability of production effectively in the production scheduling is an urgent problem. Finding the risk factors which affects the production scheduling from the historical data to improve efficiency of production plan is a strong support for the completion of the production plan successful.

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1. Literature review

Workshop production scheduling is concerned frequently. In the aspects of using traditonal method to solve production scheduling problem, Youichi Nonaka et al. [1] use the method combined with mathematical programming and tabu search to find the best workshop production scheduling machine allocation rules and process routes. Chen H X et al. [2] select Lagrange relaxation algorithm to study the job shop scheduling problem. In the aspects of using artificial intelligence method to solve production scheduling problem, Rui Zhang et al. [3] proposed a genetic algorithm based on local search module to solve the production scheduling problem. Xueni Qiu, Henry Y.K. Lau [4] establish a model for multi-objective problems, and use hybrid artificial intelligence method of artificial immune system (AIS) and priority scheduling rules (PDRs) to solve it. S.H. Chung et al. [5] proposed a modified genetic algorithm to solve the DS model. In the aspects of using data mining to study workshop scheduling, some researchers [6-12] use the fuzzy set theory and genetic algorithms, use multivariate analysis of variance method based on adaptive network fuzzy inference system, and use the scheduling rules whinch are gotten by data mining to solve these problems.

From these research, we can not find solving the workshop production scheduling from the view of risk. This paper will study the problem considering risk factors which gotten by using the method of data mining.

2. Study framework

In order to consider the risk factors in the production scheduling, we need to find the main risk factors in the production process, and it can adopt the method of data mining. In this paper, we will use the method of cluster analysis to find out the main risk factors from the historical data. On the basis of the classical production scheduling model, the simulation model is used to simulate the production, and the risk factors are applied to the simulation model to optimize the production scheduling. The main framework is shown in Figure 1.

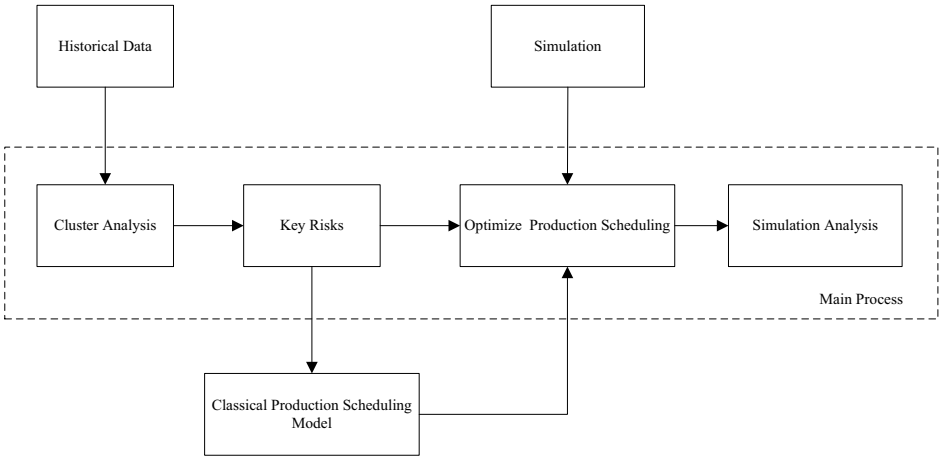

Figure 1. Diagram of study framework.

3. Risk factor study based on association analysis

3.1. Data selection

The risk factors in production scheduling need to use the method of data mining, so the data tables which is relating to the production scheduling should be found from the database. Different companies have different databases, so the main data items should be found through the analysis of the process of production. The special data tables need to be rebuilt which are connected with the original database. The main tables which are used in the next analysis is shown in Figure 2. According to the clustering index selection as well as the structure of the data tables, the SQL statement is used to statistical summary for association analysis.

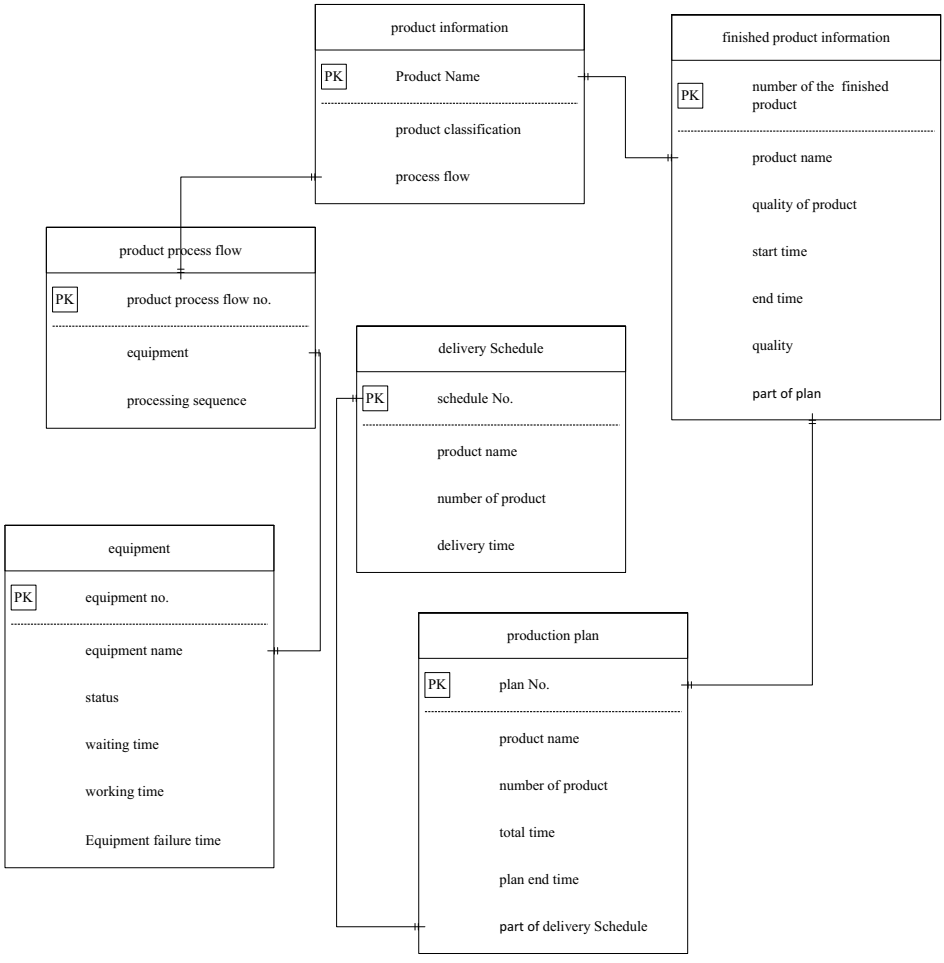

Figure 2. Diagram of data tables.

The data in the database can not be used for analysis directly because some data is irregularities and anomal. So some advanced processing of data should be made before using. The main flow is shown in Figure 3.

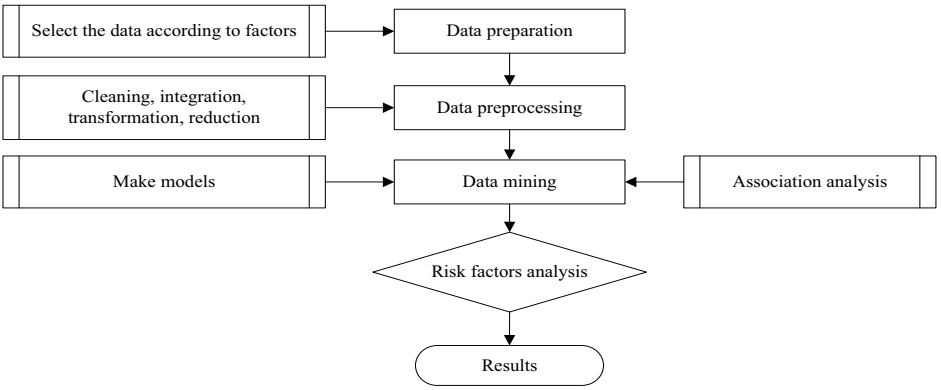

Figure 3. Process of data selection.

3.2. Association analysis

Through the cluster analysis of the data items to get the factors which influence the production scheduling, we can get the key risk factors. Considering the advantages and disadvantages of various algorithms for association analysis, fuzzy C-means clustering is choosed in this paper.

In the fuzzy C-means clustering for the clustering progress of risk factors, we need to find $y_1, \ldots, y_c$ as the center of c clusters. The objective function is defined as follow. Figure 4 shows main flow chart of the fuzzy C-means clustering to search the key risk factors.

$$I_f = \sum_{j=1}^{n}\sum_{i=1}^{c} x_{ij}^{\beta} d_{ij}^2; z_i \in R^n, 1 \le i \le c \tag{1}$$

The meaning of the parameters in the equation (1) is defined as follows.

1. x_{ij}: the value of the membership degree matrix
2. $d_{ij} = \|z_i - x_j\|$: Euclidean distance between the *i-th* cluster center z_i and the *j-th* data point x_j
3. β: fuzzy control parameter

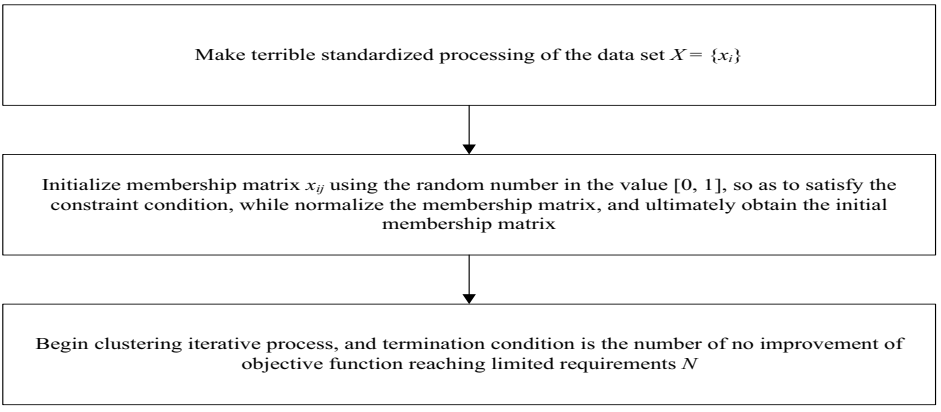

Figure 4. Flow chart of the fuzzy C-means clustering.

Through using the method above and the amount of historical data, the key risk factors inculding risk of time, risk of quality and risk of equipment can be found.

- Risk of time means that production scheduling needs more time for the processing.
- Risk of quality means that the unqualified product needs to repair.
- Risk of equipment means that the failure of equipment affects production.

4. Simulation optimization

The plan is achieved by simulation in this paper, and three key risk factors are constructed in the simulation system. The object of the model is to ensure the completion of production plan, and the risk probability is the basic judgement to resume the plan. The occurrence of the risk is stochastic, and the probability of completion of the original plan will be calculated. The rules below should be used in the simulation.

- *IF* the probability of completion of the original plan is less then or equal to 70%, *THEN* new plan should be created.
- *IF* the probability of completion of the original plan is greater than 70%, *THEN* continue to carry out the original plan.

The flow chart of simulation is shown in Figure 5.

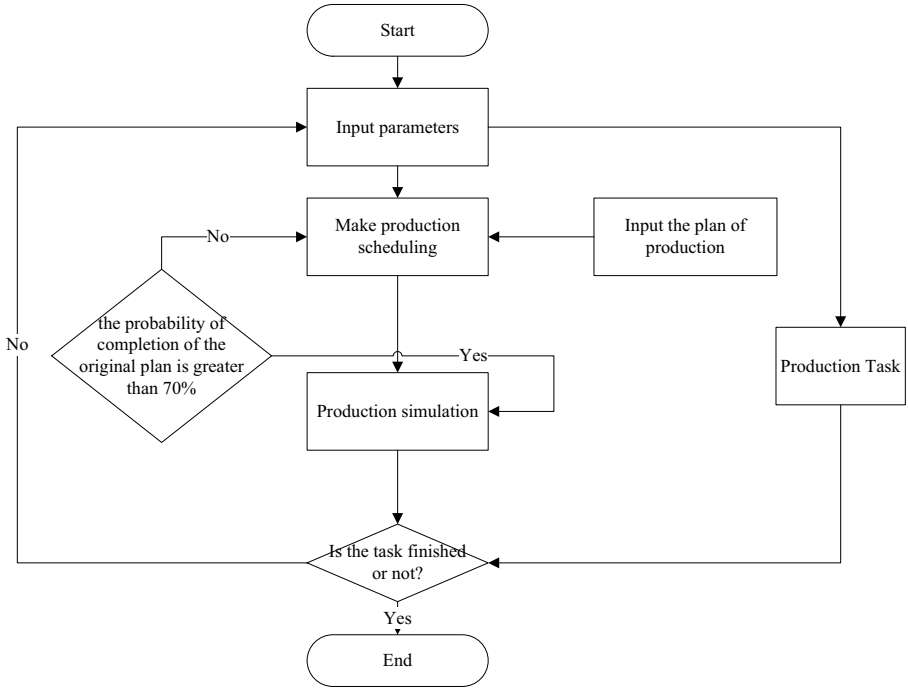

Figure 5. Flow chart of simulation.

5. Case Study

This paper uses the actual data of a workshop as a case study. The simulation model of in this paper is established by eM-Plant8.1, and the simulation model is shown in Figure 6. The initial parameter conclude the production task, equipment status, production process of the product and processing time.

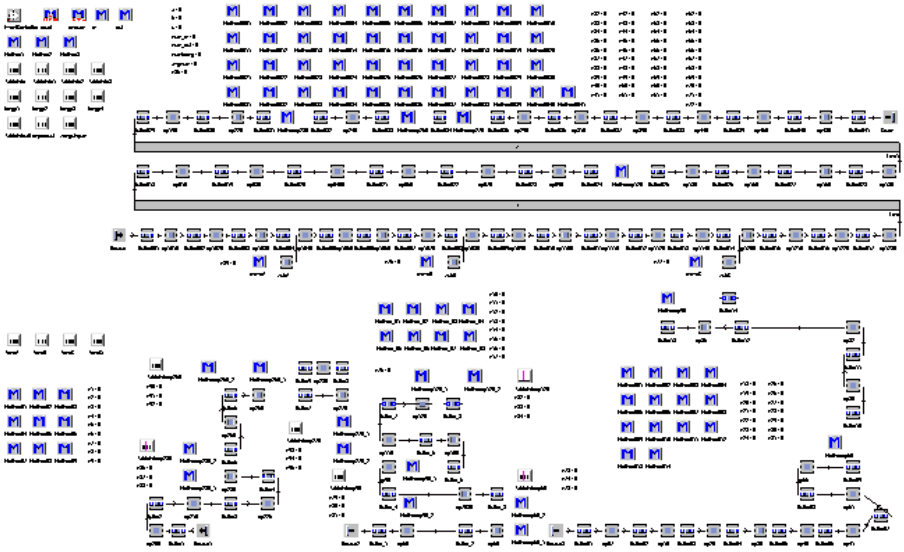

Figure 6. Simulation interface of production system.

The simulation has been run two times. First time, the risk factors is considering in the simulation, and it is not considering in the second time.Through the comparison of twice simulation, the processing efficiency is shown in Figure 7.

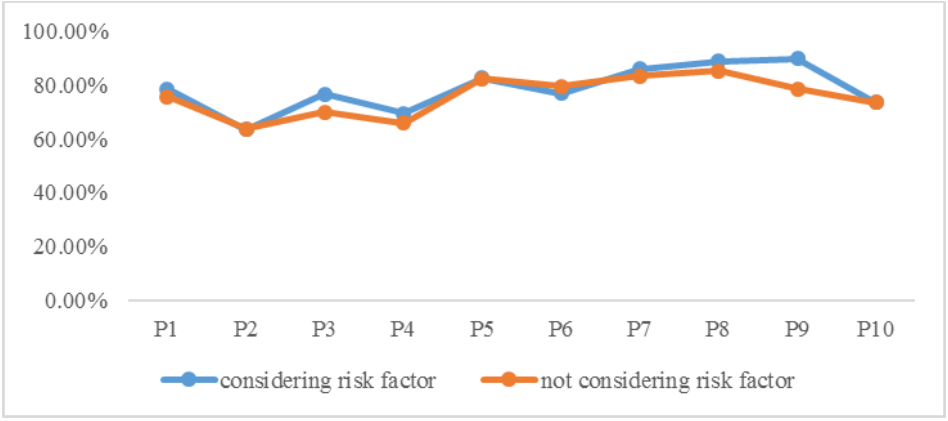

Figure 7. Comparing of simulation results.

It can be seen from Figure 7 that the production efficiency which considering the risk factors is higher than another one, so it is feasible to consider the risk factors in the production scheduling.

6. Conclusion

By using the association analysis, the main risk factors in workshop scheduling have been found, including risk of time, risk of quality and risk of equipment. Simulation is used to model the workshop scheduling considering risk factors in this paper. A typical case is provided to illustrate the risks found in this paper is correct, and the production efficiency can be improved if these risk factors are considered in making the workshop scheduling.

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