Comparison of Job-Shop Scheduling Methods for Micro-Enterprise

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This study aims to investigate characteristics of job-shop scheduling methods for micro-enterprise. Many scheduling methods have been proposed and evaluated. However, most of evaluations are not focused on application for micro-enterprise. In order to figure out an appropriate scheduling method for micro-enterprise, job-shop scheduling methods are evaluated from the view of applicability for micro-enterprise. Basic approach and preliminary evaluations for case study are explained in this paper.

Introduction

Micro-enterprise is a small business that employs a small number of employees. Micro-enterprises are usually operated with fewer than 10 people and started with a small amount of capital. Because of their agility and variety, micro-enterprises are expected to play important roles as the supporting industry in dynamic and/or innovative product development.

Regarding the micro-enterprise related topics, finance, labor-management, accounting problem, legal issue, marketing and technology introduction are mainly discussed. Supporting actual production management is rarely discussed because most owners of micro-enterprise are industrious playing manager who accept long working hours. However, in order to widen the base of micro-enterprise, improvement of labor environment with rational management method is eagerly desired.

On the other hand, scheduling researches mainly focused on from large sized enterprise to small and medium sized enterprise (SME). Compare to the micro-enterprise, these scale enterprises have larger lot-size of products which indicate predictable orders, enough manufacturing facilities, and richer human resource. These tendencies indicate conventional scheduling knowledge is not enough validated to adapt the scheduling methods to micro-enterprises. The objective of this research is to clarify and evaluate characteristics of job-shop scheduling method from the view of applicability for micro-enterprise.

Characteristic of Micro-enterprise

From the aspect of definition of micro-enterprises, most of them have three major difficulties.

The first is small level of capitalization. This limitation results in low redundancy of manufacturing facilities and delay of technology introduction. Furthermore, lot-size of production tend to be small.

The second is limited recruiting activity. Considerable number of micro-enterprises are self-employment, family business, or based on closed personal relationship. This means liquidity of human resource is not high enough and employing talented worker is not easy. Therefore, workers skills and performances may vary very much.

The last is vulnerable position of negotiation. In the actual economic activity, micro-enterprises often accept informal transaction such as personal contact with no written agreement. This kind of transaction sometimes leads to emergent order and/or uncertain order. These order make it difficult to predict future order.

The above mentioned characteristics of micro-enterprises indicate that further considerations are necessary to evaluate job-shop scheduling methods when we apply the scheduling methods to micro-enterprise.

For the formalization of job-shop scheduling problem, above mentioned characteristics of micro-enterprises result in the following features of scheduling problem.

- Redundancy and alternate of production facilities are not enough prepared.
- Investment for information system is limited. Therefore, storing and utilization of operation records are also limited.
- Lot-sizes of production are small, kinds of products vary, and number of order is rather large.
- Workers performances differ very much.
- Emergent jobs and order changes often occur.

Scheduling in Micro-enterprise

As the job-shop scheduling method, many techniques have been proposed to generate, for a given problem, a unique schedule satisfying the shop constrains and providing optimal or near optimal performance [1][2]. In the scheduling of SME to large-sized enterprise, information system such as ERP (Enterprise resource planning) and APS system (Advanced Planning and Scheduling) are operated by information specialist who manage the information systems. Furthermore, SME to Large-sized enterprise are ordered rather large lot-size production, they can forecast the production plan, make master scheduling, and when nearing production they can fix planning. By using the information system, various optimization technique are introduced. Moreover, alternative job-shop management concept such as lean manufacturing and TOC (Theory of Constraints) are also proposed and utilized.

On the contrary, micro-enterprise usually execution day-to-day operation and also lag information. Therefore the micro-enterprise is easily to using Job-Shop schedule by use scheduling methods like a dispatch rule scheduling methods such First in First out (FIFO), Shortest Processing Time (SPT), Earliest Due Date (EDD), and Fewest Operations (FO) etc.

Evaluation of Scheduling Method for Micro-enterprise

It is often said that introducing modern scheduling method will improve the production functionalities i micro-enterprise. In other words, queue time, lead times, work-in-process inventory will be reduced and job visibility and cash-flow will be improved by introducing forecast based global optimized oriented management [3].

In order to evaluate the applicability of modern scheduling methods to micro-enterprise, representative scheduling methods should be investigated with considering the characteristics of micro-enterprise.

In order to compare the different scheduling methods, definition of appropriate example case is essentially important. Therefore, preliminary job-shop simulation

system is developed and job-shop scheduling cases are simulated to clarify the influence of example case. The characteristics of micro-enterprise will be reflect to the example case.

Example of scheduling for Micro-enterprise

By refereeing published research articles [4]-[7], the following example problem is defined: There are five jobs and three machines. Each job-type must be processed in a specific machine sequence. Each job visits each machine once at most. Only one job can be processed on each machine at a given period of time. Furthermore, transportation times between different machines are neglected. The setup times for different jobs are neglected or added to processing time. Details of scheduling problem is listed in Table 1.

By applying a FIFO criteria as dispatch rule, the example is easily simulated and the result of scheduling can be summarized in Figure 1. Furthermore, cases of machine breakdown are also simulated. The result of the case of machine B breakdown is summarized in Figure 2.

From the simulation of dispatch rule scheduling, the total process time in each jobs and the total process time after breakdown are summarized in Figure 3.

Table 1 : Job-shop scheduling example

Job	Machine (process time ; hour)		
	Process 1	Process 2	Process 3
1	A (3)	B (5)	C (2)
2	B (5)	A (4)	C (4)
3	A (4)	C (3)	B (2)
4	C (5)	A (4)	B (1)
5	C (2)	B (1)	A (2)

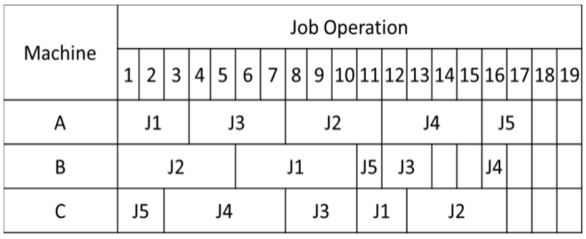

Figure 1 : Gantt-chart for FIFO scheduling

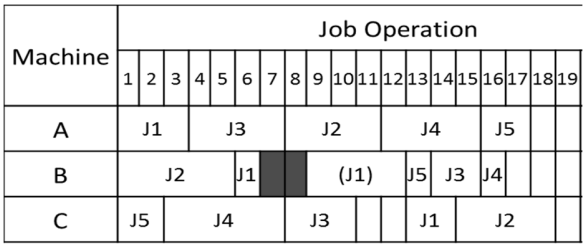

Figure 2 : Gantt-chart FIFO when have machine breakdown at machine B from 7-8 case study

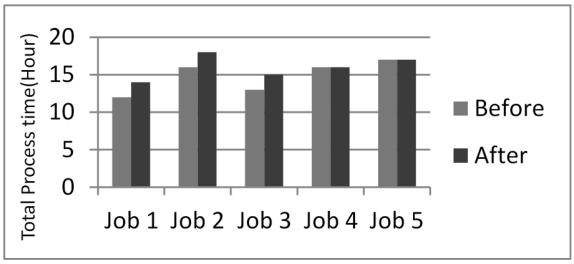

Figure 3 : Comparison of total process time before/after machine breakdown at machine B from 7-8.

From the result of simulations, efficiency and robustness of scheduling plan can be visualized. Furthermore, it becomes clear that setting realistic working rates to machines is an important factor to evaluate the scheduling methods. Introducing the performance variation which reflect the influence of workers variation and evaluations of other scheduling methods are future works of this research.

Summary

In order to figure out an appropriate scheduling method for micro-enterprise, characteristics of micro-enterprise are summarized. Preliminary evaluations to define the example case are also explained.

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