PRODUCTION WORKSHOP OPTIMIZATION

Abstract. In this paper, we propose a way to model and optimize the cost of production workshop.

1. Mathematical modeling

sec: model

1.1. Notation and definition. Given a batch of order b, it will contain the size of this batch, a set of production process $S_b = \{s_{b_1}, s_{b_2}, \dots, s_{b_n}\}$ and each prosess has an according standard processing time t_{bs}. Thus, given a set of b as $\mathcal{B}$, we can obtain a set of all the production process S_b as $\mathcal{S} = \bigcup_{b \in \mathcal{B}} S_b = \{s_1, s_2, \dots, s_n\}$.

The first task is to assign these process to the workers fairly. For worker w, he/she can be described with parameters that
(i) The ability to complete the production process $s_i \in \mathcal{S}$ as e_{s_w}.
(ii) The proficiency in completing the production process $s_i \in \mathcal{S}$ as f_{s_w}.
(iii) The limitation of the number of assigned production process as M.

If we denote the production process set of worker w as $S_w = \{s_{w_1}, s_{w_2}, \dots, s_{w_n}\}$ and the according quantity as Q_{s_w}, then the total time cost will be

$$T_w = \sum_{s_w \in S_w} Q_{s_w} * f_{s_w} * t_{s_w}, \tag{1.1}$$ cost_w

subject to

$$\sum_{s_w \in S_w} Q_{s_w} \leq M, \tag{1.2}$$ subject_w

and

$$\sum_{w \in \mathcal{W}} Q_{s_w} = \sum_{b \in \mathcal{B}} n_{bs}. \tag{1.3}$$ subjct_b

Here, n_{bs} is the number of process s contained in batch b.

To assign these process fairly and efficiently, we try to minimize the maximum of the time costs around workers that

$$\min \max_{w \in \mathcal{W}} T_w. \tag{1.4}$$ loss

After this step, the assignment of the batch set $\mathcal{B}$ has been decided. The next step, we will assign the workers to the seru $c \in \mathcal{C}$ (workshop) efficiently. Assume we have the workers in seru c as a set $W_c = \{w_{c_1}, w_{c_2}, \dots, w_{c_n}\}$, then the labor time of seru c will be

$$T_c = \sum_{w_c \in W_c} T_{w_c}, \tag{1.5}$$ cost_c

subject to

$$\|W_c\| \leq N. \tag{1.6}$$ subject_c

And the total labor time will be

$$T_{total} = \sum_{c \in \mathcal{C}} T_c. \tag{1.7}$$ total

1.2. **Integer Programming.** Follow previous definition, we have three variables that
(i) The assignment of process s from the batch b to the worker w as a $0-1$ variable $z^b_{s_w}$.
(ii) The quantity of process s assigned to the worker w as an integer variable Q_{s_w}.
(iii) The assignment of worker w to the seru c as a $0-1$ variable x_{w_c}.
And the first step optimization will be rewriten as

$$\min \max_{w \in \mathcal{W}} \sum_{s_w \in S_w} z^b_{s_w} Q_{s_w} * f_{s_w} * t^b_{s_w}, \tag{1.8}$$

opt_1st

subjects to

$$z^b_{s_w} \leq e_{s_w}, \tag{1.9}$$

$$\sum_{s_w \in S_w} Q_{s_w} \leq M, \tag{1.10}$$

$$\sum_{w \in \mathcal{W}} Q_{s_w} = \sum_{b \in \mathcal{B}} n_{bs}. \tag{1.11}$$

And the second step optimization will be rewriten as

$$\min \sum_{c \in \mathcal{C}} \sum_{w_c \in W_c} x_{w_c} \sum_{s_w \in S_w} z^b_{s_w} Q_{s_w} * f_{s_w} * t^b_{s_w}, \tag{1.12}$$

opt_2nd

subjects to

$$\sum_{w_c \in W_c} x_{w_c} \leq N, \tag{1.13}$$

$$\sum_{c \in C} x_{w_c} = 1. \tag{1.14}$$

References