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OJT Skill Management Procedures and their Characteristics

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Abstract

This paper proposes two prototype OJT (On the Job Training)-based skill management procedures for indirect work processes, *i.e.* Total Skill Maximisation Model (TSMM), and Entire Performance Maximisation Model (EPMM). Main common feature of these procedures is characterised by mathematical programming model with AHP skill measurement for workers. Feasibility and effectiveness of the proposed models are investigated through application to an information processing section of case company that belongs to a typical production management division of a large-scale multi-factory make-to-by process industry. The result obtained from the analysis indicates that proposed procedures provide relevant role for personnel skill and divisional performance management.

1. Introduction

In this decade, many Japanese manufacturers have been struggling with their weaken profitability due to shrunk market with cost increase [4]. Especially, major cause of the swelling of their cost is expanding indirect function such as product development, business planning and information processing. Divisions being in charging of these functions have to involve high quality white colour employees who are cared by good salary, because these functions are critical for successful business [12].

In this situation, they have been making effort to shift the target business processes for improvement from manufacturing function to these indirect functions and started to refine these in terms of business process reengineering [2], [3].

This effort contain various activities such as white colour training, enhancement of information infrastructure, organisational restructuring and, of course, traditional improvement activities. Among these, training is a fundamental and significant way to improve entire organisational performance, because human resource is the principal resource for any business unit, especially for indirect operation division [9], [10].

There are many ways of human resource empowerment developed as educational programmes. These programmes are actually effective in the case that job contents are well defined, structured and need a lot of experience to become an expert on these jobs. However, in the case of general office works, many of them do not satisfy these preconditions. Jobs to be proceeded are often non-repetitive, inadequately specified and the ways of process are difficult to standardise. Therefore, most of these works are usually processed by *ad hoc* manner and evaluation of work performance is often abandoned, which means renunciation of management.

A relevant way to cope with training and/or educational matter being considered by many companies in this tough situation is On the Job Training (OJT) scheme rather than Off the Job Training (Off-JT) [6].

In this context, this paper proposes two prototype OJT-based skill management procedures for indirect operation processes, *i.e.* Total Skill Maximisation Model (TSMM), and Entire Performance Maximisation Model (EPMM), and investigates their feasibility and effectiveness through a case study in an information processing operations in a typical production management stuff division of a large-scale multi-factory make-to-by process industry.

2. Approach

The adopted procedure to cope with the considered problems consists of three steps as shown in Figure 1 [5].

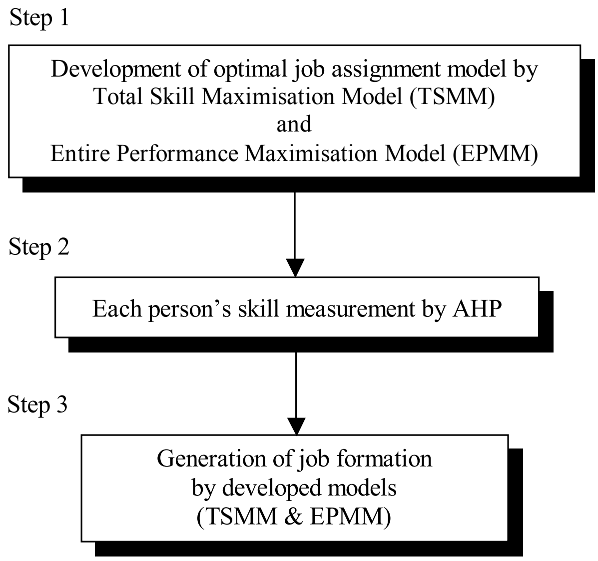

Fig. 1 Flow of the adopted approach

These are 1) Development of optimal job assignment model by 0-1 programming, *i.e.* Total Skill Maximisation Model (TSMM), and Entire Performance Maximisation Model (EPMM), 2) Each person's skill measurement by Analytic Hierarchy Process (AHP) [7], [8], [11] and 3) Generation of job formations by the proposed optimal job assignment models.

In step 1, two 0-1 programming model are proposed for optimal job assignment to each person, one of which aims maximisation of total divisional skill, *i.e.* Total Skill Maximisation Model (TSMM), and the other of which aims maximisation of entire divisional performance, *i.e.* Entire Performance Maximisation Model (EPMM). Namely, in the OJT-based operation, division manager generally pursues improvement of total divisional skill and entire divisional performance simultaneously. Therefore, these two mathematical models are necessary to be developed and investigated simultaneously.

Essential assumption supposed for developing these models is that some general skill measure and performance measure, which has additive property, are exist. That is, total divisional skill level is supposed to be evaluated by summation of each person's skill level belonging to the considered division. For performance of each job, it is supposed to be evaluated by summation of each person's skill level assigned to the job and, therefore, entire divisional performance can be evaluated by weighted summation of each job performance. Where, weighting parameter can be determined by evaluation of its importance or significance for contributing the division.

It is also necessary to introduce the assumption of skill-up mechanism, which gives expected skill level of each person being attainable by OJT activity. In this paper, following simple rule is introduced.

1) The skill level of the person with the highest skill for job j among the group, which has to proceed job j, will be improved half of the difference from ideal expert's skill level.
2) The other persons' skill level in the group for job j will be improved half of the difference from the highest skill level in the group.

The meaning of introducing the above rule is to guide the OJT performance to meet this assumption. By this way, every person involved in OJT will recognise the target level to attain after the training term. Otherwise, the outcomes of OJT will be on the course of nature.

In step 2, AHP is implemented to measure each person's skill level for each job, which has been used in many applications for evaluating non-numerical issues. This measurement is performed, for example, based on pair-wise comparison of persons' degree of expertness, education and preference on each job. Figure 2 shows an AHP hierarchy diagram of person's skill rating.

In step 3, optimal job formations for both criteria, *i.e.* maximisation of total divisional skill and entire divisional performance, are generated by proposed job assignment models. Where, effective software called LINGO [1] non-linear mathematical programming package is used for actual calculation.

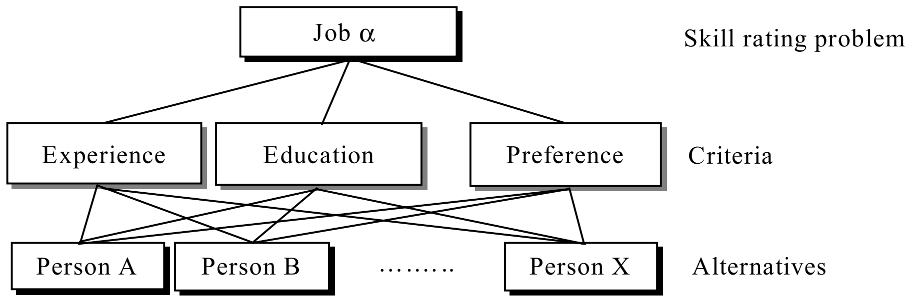

Fig. 2 Hierarchy diagram of person's skill rating (Job category: Information processing)

3. Total Skill Maximisation Model (TSMM): Result of step 1

In the following description, proposed Total Skill Maximisation Model, a kernel of the proposal, is described by focusing on its algorithmic aspect.

<Objective function: Maximising total divisional skill level>

$$Max.\ \sum_{j}^{N} q_j \tag{1}$$

s.t.

<Model for evaluating total divisional skill level for job *j*>

$$q_j = \sum_{i}^{M} s'_{ij} \tag{2}$$

<Model of person's skill-up mechanism>

<<Model of leader *i*'s skill-up mechanism, who has the highest level of skill for job *j* among the persons in charge>>

$$s'_{ij} = \frac{\bar{s}_j + \grave{y}_{i*j}}{2} \tag{3}$$

<<Leader *i*'s skill level, who has the highest level of skill for job *j* among the persons in charge >>

$$\grave{y}_{ij} = \max_{i} \left(\grave{s}_{ij}\, x_{ij} \right) \tag{4}$$

<<Model of person *i*'s skill-up mechanism, who is in charge of job *j* as a supporter>>

$$s'_{ij} = \max\left(\grave{s}_{ij}, \frac{\grave{s}_{ij} + \grave{y}_{i*j}}{2} x_{ij} \right) \tag{5}$$

<Constraint on the number of persons required for job *j*>

$$\underline{n}_j \le \sum_{i}^{M} x_{ij} \le \bar{n}_j \tag{6}$$

<Constraint on the number of jobs assigned to person i>

$$\underline{l}_i \leq \sum_{j}^{N} x_{ij} \leq \bar{l}_i \tag{7}$$

<Decision variable to assign job j to person i>

$$x_{ij} \in \{0,1\} \tag{8}$$

For notation, see section 4.

4. Entire Performance Maximisation Model (EPMM): Result of step 1

In the following description, proposed Entire Performance Maximisation Model, the other kernel of the proposal, is described by focusing on its algorithmic aspect.

<Objective function: Maximising entire divisional performance>

$$Max. \sum_{j}^{N} a_j p_j \tag{9}$$

s.t.

<Model of divisional performance or result of job j realised by job assignment policy>

$$p_j = \sum_{i=1}^{M} \grave{s}_{ij} x_{ij} \tag{10}$$

<Constraint on the number of persons required for job j>

$$\underline{n}_j \leq \sum_{i}^{M} x_{ij} \leq \bar{n}_j \tag{11}$$

<Constraint on the number of jobs assigned to person i>

$$\underline{l}_i \leq \sum_{j}^{N} x_{ij} \leq \bar{l}_i \tag{12}$$

<Decision variable to assign job j to person i>

$$x_{ij} \in \{0,1\} \tag{13}$$

Notation

Pj	: Divisional performance or result of job j
aj	: Significance coefficient of job j on entire divisional performance (weighting function) being obtained by AHP (a score rating method)
x_{ij}	: 0-1 variable denoting that person i is in charge of job j or not (person i is in charge of job j: 1, Otherwise: 0)
q_j	: Total divisional skill level being able to provide for job j
$\grave{s}_{ij}$	: Skill level of person i for job j at the beginning of the considered management term

s'_{ij} : Expected skill level of person i for job j attained after the term, *i.e.* at the end of considered management term

$\bar{s}_j$: Ideal expert's skill level for job j (Maximum skill level evaluated in the past)

$\grave{y}_{i^*j}$: Maximum skill level for job j among assigned persons at the beginning of considered management term, which is offered by person i^*

$\underline{n}_j$: Minimum number of persons engaged in job j

$\bar{n}_j$: Maximum number of persons engaged in job j

$\underline{l}_i$: Minimum number of jobs that are assigned to person i

$\bar{l}_i$: Maximum number of jobs that can be assigned to person i

i : Subscript denoting person i (i=1,..., M)

i^* : Subscript denoting person i^*, who has the highest skill level among persons assigned to the same job

j : Subscript denoting job j (j=1,..., N)

5. Skill data measurement: Result of step 2

In this section, for application of the proposed procedure to a skill management problem in a case company, profile of the case company, job list and result of skill measurement by AHP are described.

5.1 Case and job list

Feature of the case company, target division, major jobs regarding to information systems in this division are summarised as follows.

(1) Company profile

The case company is one of the leading process industries to produce building materials with 11 sites in Japan that performed a large-scale merger with another company in 1995 and 1998. As a result, employees' skill level, personnel management standards and industry culture became quite complicated and varied among workers, divisions and factories. An urgent issue for this company is, therefore, development and application of a simple and relevant skill management procedure. In this paper, a typical information system division collaborating with production management division is focused to investigate.

(2) Function of the case division

The mission of the division is production information management to support production activity in various sites.

(3) List of major jobs

Category of information processing operation consists of the jobs summarised in Table 1.

Table 1 List of information systems concerned jobs

No.	Job contents	No.	Job contents
1	Policy planning for information systems	5	Daily operation of MIMI*3
2	RDB*1 implementation	6	Daily operation of MATPLAN*4
3	Project of Lotus Notes*2 implementation	7	Performance improvement of host system
4	Performance improvement of divisional systems	8	Training / education of corporate information systems

Remark: *1: Relational Data Base *2: A group ware system
*3: A production-logistics scheduling system
*4: A manufacturing cost planning system (Structured matrix model)

5.2 Measured skill level

Table 2 Skill levels of each person and maximum skill level for each job

Person \ Job No.	1	2	3	4	5	6	7	8
A	0.04	0.04	0.09	0.06	***0.29***	0.08	0.04	0.06
B	0.04	0.06	0.04	0.04	0.12	0.13	0.07	0.04
C	0.12	0.19	0.07	0.11	0.06	0.17	0.07	0.12
D	0.14	0.06	***0.25***	0.13	0.06	0.12	0.07	0.20
E	***0.29***	***0.29***	0.24	***0.29***	0.11	***0.23***	***0.33***	***0.25***
Ideal expert's skill level	0.35	0.35	0.28	0.35	0.34	0.26	0.39	0.30
Weight *aj*	0.22	0.15	0.14	0.02	0.09	0.12	0.11	0.15

Remark: ***Bold italic*** denotes maximum skill level of each job provided by the person in charge.

By using hierarchical diagram in Figure 2, AHP analysis, especially pair-wise comparison was performed among criteria and alternatives through interviewing. Table 2 summarises the final result of this analysis.

6. Obtained job formation: Result of step 3

6.1 Assumption

In this case analysis, each parameter of the models is supposed to be the following values mainly for simplification.

$$\underline{n}_j = 1,\ \overline{n}_j = 2,\ \underline{l}_i = 1,\ \overline{l}_i = 2,\ N = 8,\ M = 5 \tag{14}$$

6.2 Summary of the result

To evaluate the effectiveness of each model, a case computation was performed and the obtained results were summarised in Table 3.

Where, "Current" is the formation currently adopted in the case company's office and the resultant formations by TSMM and EPMM, *i.e.* maximising total divisional skill level and maximising entire divisional performance respectively, are given in the suggested columns.

Table 3 Comparison between current and obtained job formations

Person In charge \ Case	Current	Results of model analysis	
		TSMM	EPMM
A	5,8	1,6	4,5
B	3,5	4,8	6,7
C	2,4	3,5	1,2
D	3	2,7	3,8
E	1,6,7	5	1,2

Remark: Figures in this table denote job numbers

Two criteria values for the obtained formations, which are the values of objective functions of each model, are also summarized in Table 4.

Table 4 Comparison between solutions

Model / Attained level	TSMM	EPMM
Total divisional skill	6.300*	5.885
Entire divisional performance	0.070	0.278*

Remark: asterisks in the table means optimal values.

From Table 4, it is notified that total division skill is expected to attain maximum level, *i.e.* 6.300, in case of TSMM, whereas entire division performance will be maximised in case of EPMM, that is, 0.278. It can be also understood from Table 3 that the optimal job formation generated by the cases of EPMM provides fair assignment of jobs to each person, *i.e.* two jobs for each, whereas the current formation and that of the TSMM have unbalanced assignments. Namely, the former might cause the existence of bottleneck person, *i.e.* person E, and the latter cause the idle of the same person.

7. Concluding remarks

In this paper, two prototype OJT (On the Job Training)-based skill management procedures for indirect work processes are discussed. These are Total Skill Maximisation Model (TSMM), and Entire Performance Maximisation Model (EPMM). Main common feature of these procedures is characterised by mathematical programming model with AHP skill measurement for workers. Feasibility and effectiveness of the proposed models are investigated through a case study and the obtained results indicate that proposed procedures provide relevant role for personnel skill and divisional performance management.

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