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# Use of Managerial Decision Categories for Selecting KA / KR Techniques in HRM Problem Domains

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## Abstract

Selection of appropriate knowledge acquisition and representation techniques is regarded as a major task in the development of expert systems. This depends on the characteristics of problem domains. Expert system builders have often adopted a technique without a formal analysis of application domains. The purpose of this paper is to provide the best knowledge acquisition and representation technique for use in human resource management problem domains. In an attempt to meet this purpose, the conceptual contingency model that suggests the best technique according to managerial decision categories is used as a guidance. In order to determine the priority of managerial decision categories, the Analytic Hierarchy Process and an extended method are proposed.

## I. Introduction

Human resource management (HRM) consists of numerous activities or functional areas (Bartol & Martin, 1991 : Couger, 1988 : Ivancevich, 1992 : Mondy & Noe, 1993). Possible areas which are in particular potentially suited to expert system (ES) applications include : staffing, training, development, control, employee selection, wage adjustment, performance appraisal, and career counseling (Extejt & Lynn, 1988 : Humpert et al., 1989 : Edwards, 1992 : Lehner 1992). ES research in managerial domains have some different issues compared with other non-managerial

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domains. Blanning (1985) summarized important tasks that should be undertaken, including knowledge acquisition (KA), knowledge representation (KR), inference strategy, and system validation.

Our concern is to find KA techniques and/or KR techniques (KAT/KRT) best suited to HRM problem domains. This is a key technological issue for ES development. Byun & Suh (1994) described five issues central to ES development for HRM. In this paper, HRM problem domains are confined to the following nine activities : planning (PLAN), job analysis (JOB), recruiting (RECR), selection (SELE), placement (PLAC), performance evaluation (PERF), compensation (COMP), training (TRAN), and labor-management relations (LAB).

Recall that KA is time-consuming, expensive and a bottleneck in the ES development procedure. In spite of a number of KAT discussed (Grabowski, 1988), they have been independently used disregarding domain characteristics, i. e., many-to-many relationships between possible techniques and application domains. Only describing the inherent advantages and disadvantages of techniques is not enough to evaluate their relevance to a domain. Furthermore, the investigation of ready-made systems successfully developed and widely used can no longer assure a proper guidance due to several reasons of the system's success or failure lied beyond KAT/KRT.

In managerial problem domains, Kim & Courtney (1988) described that selection of a KAT is dependent on the attributes of the problem domain and types of knowledge associated with a specific type of decision. Furthermore, KR is closely related to KA and knowledge base design. KR is an output of KA and the output of KR supplies prior information for knowledge base design. Many KR systems have both advantages and disadvantages (Ramsey & Schultz, 1989). Baldwin & Kasper (1986) compared such KR schemes as logics, semantic nets, production rules, frames, procedural, and direct representation according to some dimensions and conceptually matched them to organizational domains. These two research projects have the common attribute in that KAT/KRT should be used within any decision categories in organizations. Mintzberg (1979) used his organizational model and the roles of each of the parts to define four decision categories : operating decisions (OP), coordinative decisions (CO), exception decisions (EX), and strategic decisions (ST). See the guidance for KAT/KRT according to managerial decision categories (Table 1).

We consider two strategies. The local strategy is appropriate for the small scale system development in case we have a need to initiate only one ES that covers nine HRM activities. The global strategy is used in common with the entire domain that reflects all domain weights by combining individual domain importance. To do this, an exploratory study is performed that includes the evaluation of human resource managers' judgments with respect to

[Table 1] KA/ KR techniques in management-domain

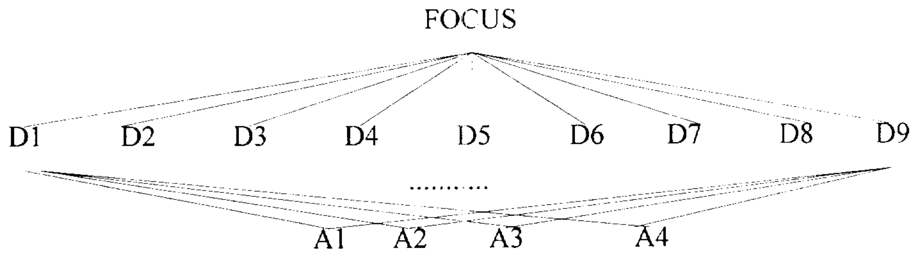
| Decision Categories | KA Techniques | KR Techniques |
|---|---|---|
| Operating decisions | Knowledge engineer-driven, machine-driven (induction) | Production rules and procedures |
| Coordinative decisions | Knowledge engineer-driven (grid method, protocol analysis) | Frames and semantic nets |
| Exception decisions | Expert-driven (visual modeling) | Frames, semantic nets, and direct |
| Strategic decisions | Combination of above | Combination of above |

Sources : Baldwin and Kasper (1986) ; Kim and Courtney (1988)

four decision categories. As a result of the Analytic Hierarchy Process (AHP), an appropriate KAT/KRT will be selected in terms of the guidance from the conceptual mapping. In that procedure, two cases are examined to select priorities for these decision categories. One is to consider no weights on criteria. The other is to derive criteria weights with several factors affected by the decision making procedure. This implies an idea to extend the original AHP (Saaty, 1980) using different evaluation schemes.

# Ⅱ. The AHP approach

The AHP model represents a hierarchy with respect to a decision maker (Figure 1). The overall AHP model includes a group of decision makers and the goal node is changed to the decision makers. The focus is the evaluation of KAT/KRT. Each domain stands for a nominal criterion without its importance and a decision category is mapped to an alternative. The procedure that introduces individual judgments into the decision making process, is needed for pairwise comparisons. Originally Saaty (1980) suggested that a 1-9 scale can be used to quantify the decision maker's strength of feeling between any two alternatives with respect to a given criterion. However, our scale adopted here has a different notion unlike the scale definition used such as preference or importance.




D1: Planning
D2: Job analysis
D3: Recruiting
D4: Selection
D5: Placement
D6: Compensation
D7: Performance evaluation
D8: Training
D9: Labor-management relations

A1: Operating decisions
A2: Coordinative decisions
A3: Exception decisions
A4: Strategic decisions

[Figure 1] The AHP model hierarchy with respect to a decision maker

## 2. 1 Four decision categories and revised comparison scale

A pairwise comparison scale by the AHP uses ratio measurements to rate the alternatives in terms of rating levels of the lowest level criteria. The ratings or intensities of the criteria that propose to use are excellent, very good, good, average, below average, poor, and very poor. In the comparison of alternatives, the question arises : which one is more important or preferable than the other one? But these rating schemes can be extended. A variety of meanings can be laid at the same scale. With regard to comparing the distances of various cities from an origin, a very natural response would be to compare relative distances of pairs of cities. For example, a city is nine times further from the origin than is another city. Thus, ratio scale judgments on the relative distance of each city pair can be supplied. For another example, when considering the comparison of production lead time of two products, short, long, very short or very long can also be used as ratings of criteria. The distance and the lead time are quantitative measures.

Our rating scheme evaluates the degree of similarity between paired decision categories (Table 2). These similarities denote the degree of inclusion of an HRM activity between two related to decision making. If a domain is quite similar to a decision category, almost all works performed in the domain are characterized by the decision category. However it is hard to quantify their similarities because the extent is mostly based on expertise and experiences unlike using quantitative measure such as distance or lead time. Recall the procedure for the similarity check of tangible or intangible cases when developing a case-based reasoning system. Cases are known as memory organization packets. However, our scheme reveals some common properties of the notion "similarity" but it is different in that no similarity matrix is involved in the comparison procedure.

[Table 2] Scales used for pairwise comparisons

| Value | Definition | Explanation |
|---|---|---|
| 1 | Not similar | Both factors are absolutely different to the objective or criterion |
| 3 | Moderately similar | Experience and judgments are slightly similar one factor over another |
| 5 | Strongly similar | Experience and judgments are strongly similar one factor over another |
| 7 | Very strongly similar | Dominance of a factor over another is demonstrated in practice |
| 9 | Extremely similar | The evidence of similarity of one factor over another is unquestionable |
| 2,4,6,8 | Intermediate values | |

## 2. 2 Data collection

The Delphi technique was used to get responses from senior human resource managers who are working in outstanding Korean firms. Questionnaires can be applied in a more formal way. As shown in the Appendix, the questionnaire consists of three parts. Part Ⅰ summarizes a demographic survey. Part Ⅱ is to rate Likert scales including three questions and Part Ⅲ describes the rating scheme for pairwise comparison.

The mailing list was compiled from a random sampling of the listed companies dictionary as well as the companies that have announced employee recruiting through newspapers. All firms selected belong to profit making organizations where the number of employees is greater than 1,000. A total of 130 questionnaires were mailed during two months. Fourteen responses were received yielding a response rate of 13 percent. Three responses were determined to be unusable for the AHP with incomplete data, resulting in 11 analyzable responses. The list of firms included in study includes ; (1) Sam Yang Co., Ltd., (2) Tong Yang Cement Co., (3) Hyundai HRM Committee, (4) Inkel Co., (5) Hankuk Economic Newspaper, (6) Chosun Brewery Co., Ltd., (7) Dacom Co., (8) Hankook Cosmetics Co., Ltd., (9) Samsung HRM Committee, (10) Dong-A Pharmaceutical Co., Ltd., (11) Lucky HRM Committee, (12) Inchon Iron & Steel Co., Ltd., (13) Kang Won Industries Ltd., and (14) Korea Telecommunications Co.

### 2. 3 AHP computations

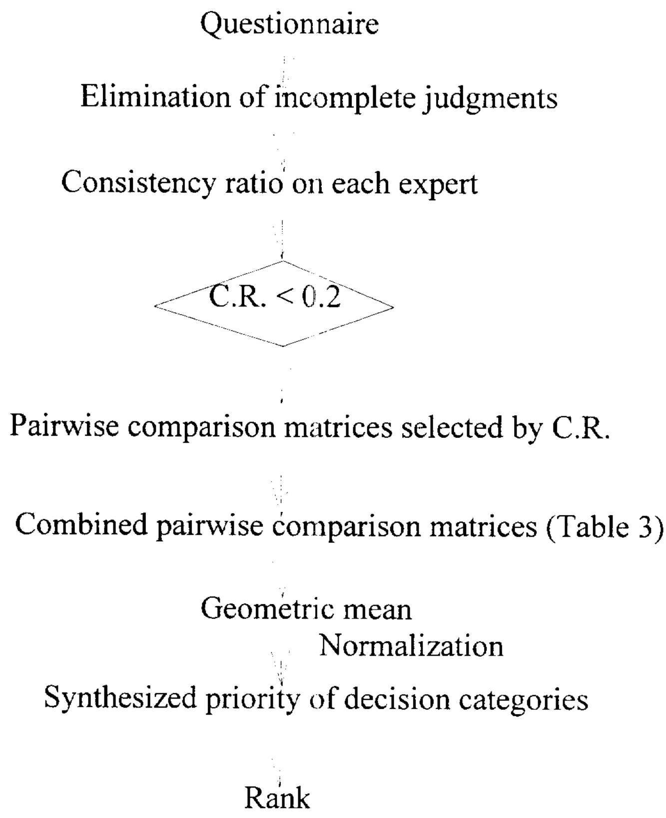
Pairwise comparisons are made between all the categories at one level in the hierarchy with respect to goal. Local weights are then computed for each decision category. In this case, local weights are the same as the global weights that serve as the cardinal rankings of the decision categories. The software package Expert Choice 8.0 (Forman, 1983-1991) was used to generate the weights. It is normal for under seven persons to be involved in the AHP because the AHP deals with the group decision making problem that regards a decision maker as a node of the model hierarchy. For the consensus of group judgments, a pairwise comparison matrix of which the consistency ratio is less than 0. 20 is taken. Note that if the consistency ratio is less than 0. 10, then the group judgment is reasonable and if it is less than 0. 20, then tolerable (Saaty & Kearns, 1985).

With the individual pairwise comparison matrices, the combined matrix is driven by the geometric mean of each element in the pairwise comparison matrices. The geometric mean is the uniquely appropriate rule for combining judgments because it preserves the reciprocal property in the combined matrix (Aczel & Saaty, 1983). Table 3 displays the geometric mean that denotes the synthesized priority of decision categories after selecting the matrices in which the consistency ratio is less than 0. 2. Refer to the procedure of the AHP computation

[Table 3] Combined pairwise comparison matrices

| Domains | | OP | CO | EX | ST | G.M. | Priority (CP) | Rank |
|---|---|---|---|---|---|---|---|---|
| PLAN | OP | 1 | .14 | .52 | .20 | .360 | .048 | 4 |
| | CO | | 1 | 5.19 | .87 | 2.38 | .316 | 2 |
| | EX | | | 1 | .32 | 2.06 | .273 | 3 |
| | ST | | | | 1 | 2.74 | .363 | 1 |
| JOB | OP | 1 | 3 | 3.7 | 1.87 | 2.14 | .247 | 2 |
| | CO | | 1 | 2 | .18 | .590 | .068 | 4 |
| | EX | | | 1 | .22 | 1.87 | .216 | 3 |
| | ST | | | | 1 | 4.06 | .469 | 1 |
| RECR | OP | 1 | .15 | .13 | .12 | .220 | .030 | 4 |
| | CO | | 1 | 2.23 | .15 | 1.22 | .165 | 3 |
| | EX | | | 1 | .15 | 1.70 | .230 | 2 |
| | ST | | | | 1 | 4.25 | .575 | 1 |
| SELE | OP | 1 | .25 | .62 | .17 | .400 | .056 | 4 |
| | CO | | 1 | 1.58 | .29 | 1.16 | .162 | 3 |
| | EX | | | 1 | .27 | 1.97 | .276 | 2 |
| | ST | | | | 1 | 3.61 | .506 | 1 |
| PLAC | OP | 1 | .21 | 3 | .77 | .830 | .110 | 4 |
| | CO | | 1 | 3.46 | 3 | 2.65 | .351 | 1 |
| | EX | | | 1 | .33 | 2.07 | .273 | 2 |
| | ST | | | | 1 | 2.01 | .273 | 2 |
| COMP | OP | 1 | .2 | .33 | .25 | .359 | .075 | 4 |
| | CO | | 1 | .50 | .33 | .955 | .200 | 3 |
| | EX | | | 1 | 3 | 2.05 | .429 | 1 |
| | ST | | | | 1 | 1.41 | .296 | 2 |
| PERF | OP | 1 | .89 | 5 | 1.8 | 1.68 | .223 | 4 |
| | CO | | 1 | 3.66 | 2.23 | 1.74 | .231 | 3 |
| | EX | | | 1 | .26 | 1.95 | .259 | 2 |
| | ST | | | | 1 | 2.17 | .288 | 1 |
| TRAN | OP | 1 | .65 | .86 | .65 | .780 | .117 | 4 |
| | CO | | 1 | 2.23 | .84 | 1.30 | .194 | 3 |
| | EX | | | 1 | .21 | 1.85 | .277 | 2 |
| | ST | | | | 1 | 2.76 | .413 | 1 |
| LAB | OP | 1 | .23 | 1.18 | .14 | .440 | .064 | 4 |
| | CO | | 1 | 1.63 | .44 | 1.33 | .192 | 3 |
| | EX | | | 1 | .23 | 1.89 | .274 | 2 |
| | ST | | | | 1 | 3.25 | .470 | 1 |

G.M.: geometric mean




[Figure 2] Procedure of the AHP computation

### 2. 4 Evaluation and discussion

In general, the best KAT/KRT were the combined approach (Table 4). As a result, ST accomplished the highest rank in such domains as PLAN, JOB, RECR, SELE, PERF, TRAN, and LAB. Because CO accomplished the highest rank in PLAC, the knowledge engineer-driven approach was best suited to the KAT and frames and semantic nets are best suited to the KRT. Because EX accomplished the highest ranking in COMP, the expert-driven approach was best suited to the KAT and frames, semantic nets, and direct representation were best suited to the KRT.

[Table 4] Summary of recommended KA/ KR techniques

| Domains | KA Techniques | KR Techniques |
|---|---|---|
| PLAN | CA | CA |
| JOB | CA | CA |
| RECR | CA | CA |
| SELE | CA | CA |
| PLAC | KE-driven | Frames, Semantic nets |
| COMP | Expert-driven | Frames, Semantic nets, Direct |
| PERF | CA | CA |
| TRAN | CA | CA |
| LAB | CA | CA |

CA : combined approach

The geometric mean can also be used to compute synthesized priorities for all domains in order to decide the global strategy as follows ;

$$OP=(.048\times.247\times\cdots\cdots\times.064)^{1/9}=.087$$
$$CO=(.316\times.068\times\cdots\cdots\times.192)^{1/9}=.192$$
$$EX=(.273\times.216\times\cdots\cdots\times.274)^{1/9}=.274$$
$$ST=(.363\times.469\times\cdots\cdots\times.470)^{1/9}=.393$$

ST accomplished the highest priorities and the combined approach was also best suited to the KAT/KRT. Round of errors cannot establish that the sum of the priorities is equal to 1.

Here it is necessary to consider the difference of the priorities. If there are any significant differences between two decision categories, it is admirable to select the decision category with a higher priority as a really best one than any others. We wish to test the equality of the mean effect which is ;

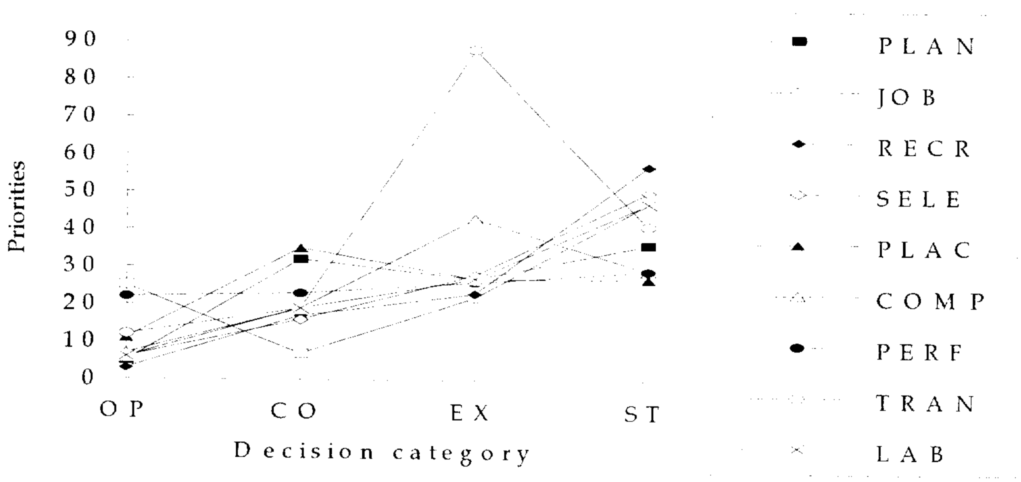
$$H_0 : \mu_1=\mu_2=\mu_3=\mu_4$$
$$H_1 : \mu_i\neq\mu_j, \text{ for at least one i, j}$$

| Source of variation | SS | df | MS | F |
|---|---|---|---|---|
| Between decision categories | 4825 | 3 | 1608 | 9.40 |
| Error | 5473 | 32 | 171 | |

[Figure 3] ANOVA table for one-way classification

With the analysis of variance (ANOVA) for the one-way classification (Figure 3), the factor levels are substituted for the four decision categories and observations are substituted for the nine domains. At $\alpha=0.05$, $F=9.40>F\ (.95;3,\ 32)=2.92$, we conclude H1 the factor level means are not equal, or that the four different decision categories do not lead to the same mean priorities. Thus, the significance between decision categories and their priorities is accepted as cardinal information as well as ordinal rankings.

With regard to domain effects, the effects of the decision categories at different levels of the domains are examined by plotting the synthesized priorities as shown in Table 3. Due to no replication data, the two-way classification method cannot be used. A graphical analysis was proposed (Neter, Wasserman, & Kutner, 1990). As shown in Figure 4, the priority curves for the different decision category levels are not parallel. Therefore, the decision categories have a significant effect according to the domain levels. The attempt to introduce the concept of the global strategy that associates these domain effects is validated.




[Figure 4] Interaction effects between two factors

# Ⅲ. The modified AHP approach

### 3. 1 Overview of three decision factors

The modified analytic hierarchy process (MAHP) is employed that is composed of opposite evaluation schemes : series of ratings with respect to criteria and pairwise comparisons with respect to alternatives. Although the conventional AHP determines weights of criteria with the same scheme as alternatives, i. e., pairwise comparison. However the MAHP employs a different comparison method to a different hierarchical level. Although a 9-point scale has been used for the AHP, a 5-point rating method sometimes respondents can be relieved from having to check an increasing number of answers when evaluating criteria. We can say that the MAHP is a combined approach that can enhance the limitation of the AHP in terms of small number of comparisons. Thus another reason lies in that it deals with a set of factors that affect the decision about criteria weights.

Three decision factors for domain rating include : degree of strategic importance, degree of unstructure, and degree of management level support. The degree of importance and the degree of unstructure for each domain are selected based on the following propositions :

P1 : The most critical element for success in the ES is choosing the right problem to work on (Liebowitz, 1989). If we concentrate on picking a good application domain, we will have an excellent start on the road to developing a successful ES (Casey, 1989).

P2 : Expert system technology has been adopted to support strategic decision making (Goul, 1987). Strategic planning is characterized as a series of phases beginning with situation assessment, strategic issue analysis or environmental scanning.

P3 : An ES is more strongly recommended for tasks that involve reasoning with uncertain or incomplete information (Weitz & Meyer, 1990). The domain is characterized by the use of expert knowledge, judgment, and experience (Liebowitz, 1989).

As a global strategy, a domain judged by experts is more importantly preferred to selecting first of all. In our opinion, these judgments are often political and result from the organizational status including knowledge complexity as well as technology complexity. For example, ES builders like to select the domain as a candidate that is evaluated to have a higher complex knowledge and a lower complex technology related to development. For another example, if a domain is highly necessary to be used by a system to acquire strategic success in organizations, the domain becomes a candidate with much more weights than others in spite of the estimation of poor knowledge and technology of the domain.

Next, ESs have been applied more to semi-or unstructured activities than structured activities. Structured activities are not a good candidate because they need no accumulation of domain knowledge and know-how. The classification of which one is unstructured or not is regarded as an intelligence step in the general decision making procedure. This needs no further discussion about this.

The third decision factor is selected based on organizational issues related to management levels support. If an ES to cover a domain can support a cooperative management levels with a variety of user levels to the fullest extend, it will receive a higher weight than any other domain.

### 3. 2 Mathematical development for domain weights

In order to select the best KAT/KRT, we consider three factors as deciding individual domain weights (see Section 3.1 in detail). Summarized reasons are as follows : strategic importance of each domain is a political and independent factor on ES project costs and effectiveness in their organizational environment. it is a competitive decision factor compared with other firms ; semi-and unstructured domains will lead an ES project to be successful like non-HRM domains ; and the user of ES should equally be included in three managerial levels as the principle of ES characteristics comparing with other management support systems such as decision support systems and executive information systems.

As a rating scheme Likert scales were employed for deriving domain priorities. See five rating levels in Part II of the Appendix. Likert scaling is generally referred to as the technique of summated rating. Scales are scored by assigning weights for response alternatives to items. A total score for each respondent is calculated by summing the value of each item that is checked. The following notation for domain $i$, $(i=1,\ldots,9)$ is introduced to be attached with the explanation of computational variables :

$N$ : Number of respondents $(N=14)$.

$n$ : Number of domains $(n=9)$.

$scj$ : Score $j$ for each rating level $j$, $j=1,\ldots,5$.

$nsj$ : Number checking that score for rating level $j$ $(nsj \leq N)$.

$WTi$ : Weighted total for domain $i$ $(\sum_{l=1}^{5} scl \times nsl)$.

$WMi$ : Weighted mean for domain $i$ $(WTi/N)$.

$Ii$ : Priority of degree of importance, $i=1,\ldots,n$.

$Ui$ : Priority of degree of unstructure, $i=1,\ldots,n$.

$li$ : Weighted mean of degree of low level management support, $i=1,\ldots,n$.

$mi$ : Weighted mean of degree of middle level management support, $i=1,\ldots,n$.

$ni$ : Weighted mean of degree of top level management support, $i=1,\ldots,n$.

$Mi$ : Priority of management level support $(M_i=(l_i+m_i+n_i)/3 \div \sum_{i=1}^{n}(l_i+m_i+n_i)/3)$, $i=1,\ldots,n$.

The notion of "priority" rather than "weight" such as Ii and Ui is in the normalization of each weighted mean which divided it by the sum total of weighted means for all domains, as follows :

$$(WMi/\sum_{k=1}^{n} WMi),\ i=1,\ldots,n. \tag{1}$$

From them, the composite priority is calculated as a product of the priority of three factors :

$$Wi=Ii\times Ui\times Mi,\ i=1,\ldots,n. \tag{2}$$

The domain priority is computed by the normalization of these composite priorities that makes the sum of them equals to 1 :

$$DPi=Wi/\sum_{k=1}^{n} Wk, \qquad i=1,\ldots,n. \tag{3}$$

Let $SPij$ be the synthesized priority and $CPij$ be the local or combined priority of domain $i$, decision category $j$ as shown in Table 3.
We get

$$SPij=DPi\times CPij/\sum_{i}^{n} DPij,\ i=1,\ldots,n,\ j=1,\ldots,c. \tag{4}$$

### 3. 3 Results

Data collection was also performed through the questionnaire to be discussed in Section 2. Tables 5-9 summarize the results of the rating analysis for $Ii$, $Ui$, $Mi$, respectively. In the tables the standard deviation delineates the measure of dispersion of the experts' judgments. That is, a lower standard deviation gives a higher agreement among them.

[Table 5] Computing table for "degree of domain importance"

| Domains | S<br>1 | C<br>2 | O<br>3 | R<br>4 | E<br>5 | WT | WM | PW (I) | SD |
|---|---|---|---|---|---|---|---|---|---|
| PLAN | 0 | 0 | 1 | 9 | 4 | 59 | 4.21 | .113 | .57 |
| JOB | 0 | 1 | 2 | 8 | 3 | 55 | 3.92 | .105 | .82 |
| RECR | 0 | 1 | 6 | 5 | 2 | 50 | 3.57 | .096 | .85 |
| SELE | 0 | 0 | 2 | 5 | 7 | 61 | 4.35 | .117 | .94 |
| PLAC | 0 | 0 | 2 | 5 | 7 | 61 | 4.35 | .117 | .37 |
| COMP | 0 | 0 | 2 | 8 | 4 | 58 | 4.14 | .111 | .66 |
| PERF | 0 | 0 | 3 | 7 | 4 | 57 | 4.07 | .109 | .73 |
| TRAN | 0 | 0 | 1 | 9 | 4 | 59 | 4.21 | .113 | .59 |
| LAB | 0 | 0 | 1 | 9 | 4 | 59 | 4.21 | .113 | .57 |

WT : weighted total ; WM : weighted mean ; PW : priority weights ; SD : standard deviation

[Table 6] Computing table for "degree of unstructure"

| Domains | S<br>1 | C<br>2 | O<br>3 | R<br>4 | E<br>5 | WT | WM | PW (I) | SD |
|---|---|---|---|---|---|---|---|---|---|
| PLAN | 1 | 5 | 6 | 1 | 1 | 38 | 2.71 | .105 | 1.01 |
| JOB | 3 | 6 | 2 | 3 | 0 | 33 | 2.35 | .091 | 1.22 |
| RECR | 1 | 3 | 7 | 2 | 1 | 41 | 2.92 | .113 | .99 |
| SELE | 1 | 5 | 5 | 2 | 1 | 39 | 2.78 | .108 | .86 |
| PLAC | 1 | 3 | 4 | 6 | 0 | 43 | 3.07 | .119 | 1.20 |
| COMP | 0 | 8 | 2 | 3 | 1 | 39 | 2.78 | .108 | 1.08 |
| PERF | 1 | 4 | 4 | 3 | 2 | 43 | 3.07 | .119 | 1.20 |
| TRAN | 3 | 3 | 6 | 1 | 1 | 32 | 2.28 | .088 | .92 |
| LAB | 0 | 2 | 3 | 6 | 3 | 52 | 3.71 | .144 | .99 |

[Table 7] Priorities for three levels management support

| Domains | LL | ML | TL | TS | MS | PW (M) |
|---|---|---|---|---|---|---|
| PLAN | 2.35 | 3.57 | 4.35 | 10.27 | 3.42 | .114 |
| JOB | 2.64 | 3.71 | 3.21 | 9.56 | 3.18 | .106 |
| RECR | 3.21 | 3.21 | 3.71 | 10.13 | 3.37 | .112 |
| SELE | 2.50 | 3.28 | 3.78 | 9.56 | 3.18 | .106 |
| PLAC | 2.57 | 3.28 | 3.78 | 9.63 | 3.21 | .107 |
| COMP | 2.14 | 3.42 | 4.00 | 9.56 | 3.18 | .106 |
| PERF | 2.14 | 3.57 | 4.07 | 9.78 | 3.26 | .108 |
| TRAN | 3.35 | 3.85 | 4.00 | 11.20 | 3.73 | .124 |
| LAB | 2.64 | 3.50 | 4.14 | 10.28 | 3.42 | .114 |

LL : low level ; ML : middle level ; TL : top level ; TS : total score ; MS : mean score

[Table 8] Normalized domain priorities

| Domains | I | U | M | W | DP | Rank |
|---|---|---|---|---|---|---|
| PLAN | .113 | .105 | .124 | .00147 | .115 | 5 |
| JOB | .105 | .091 | .091 | .00086 | .067 | 9 |
| RECR | .096 | .113 | .105 | .00113 | .088 | 7 |
| SELE | .170 | .108 | .107 | .00196 | .153 | 1 |
| PLAC | .117 | .119 | .107 | .00148 | .116 | 4 |
| COMP | .111 | .108 | .114 | .00136 | .106 | 6 |
| PERF | .109 | .119 | .116 | .00150 | .117 | 3 |
| TRAN | .113 | .088 | .114 | .00113 | .088 | 7 |
| LAB | .113 | .144 | .118 | .00192 | .150 | 2 |

[Table 9] Synthesized priorities of decision categories combined with domain priorities

| Domains | Combined Priority (*CP*) | | | |
|---|---|---|---|---|
| | OP | CO | EX | ST |
| PLAN | .048 | .316 | .273 | .363 |
| JOB | .247 | .068 | .216 | .469 |
| RECR | .030 | .165 | .230 | .575 |
| SELE | .056 | .162 | .276 | .506 |
| PLAC | .110 | .351 | .273 | .273 |
| COMP | .075 | .200 | .429 | .296 |
| PERF | .223 | .231 | .259 | .288 |
| TRAN | .117 | .194 | .277 | .413 |
| LAB | .064 | .192 | .274 | .470 |

[Table 9] (continued)

| Domains | | Synthesized | Priority (*SP*) | |
|---|---|---|---|---|
| | OP | CO | EX | ST |
| PLAN | .006 | .037 | .031 | .041 |
| JOB | .017 | .005 | .014 | .031 |
| RECR | .003 | .105 | .020 | .050 |
| SELE | .009 | .024 | .043 | .077 |
| PLAC | .013 | .041 | .031 | .031 |
| COMP | .008 | .021 | .046 | .031 |
| PERF | .025 | .027 | .030 | .034 |
| TRAN | .010 | .017 | .025 | .036 |
| LAB | .009 | .028 | .042 | .071 |
| SUM | .101 | .215 | .282 | .402 |

By (3), the selection domain is highly significant in ES development (Table 8). By means of combining these domain priorities with those of decision categories, shown in Table 9, the ST dominated others given by 0.402. Therefore, the combined approach was best suited to the KAT/KRT.

However, the difference of the priorities between two decision categories that acquired rank 1 and 2 is equal to or more than those measured by disregarding domain weights. This makes an additional statistical test needless. Therefore, the original ranking is agreed as the guidance of the global strategy.

### 3. 4 Sensitivity analysis

Sensitivity analysis is a method for verifying the result of decision making by the AHP (Saaty & Kearns, 1985). The main purpose of sensitivity analysis is to see the relative importance of information or how possible changes in information will affect results. A sensitivity analysis can be performed to see how sensitive the alternatives are to be changed in the importance of the criteria (Dyer & Forman, 1992). The basic principle of sensitivity analysis is based on the adjustment of local or global priorities (Seidmann & Arbel, 1984). Let us denote by $L(i+1, i)$ for the matrix of local weights relating level $(i+1)$ to level $i$. The global priorities of elements in level $(i+1)$ are given, therefore, by $g(i+1)=L(i+1, i)g(i)$, where $g(i)$ is the vector of global priorities of elements in level $i$.

The Expert Choice implementation of the AHP provides four graphical sensitivity analysis modes : dynamic, gradient, performance, and two dimensional analysis. Here performance sensitivity analysis is employed. A performance sensitivity depicts how well each alternative performs on each criterion by increasing or decreasing the importance of the criteria, as well as how each sub-criterion performs on each main criterion by increasing or decreasing the importance of the main criteria. It should be pointed out that if the criteria are not sensitive, it would be better to eliminate them from the AHP model.

Our focus is to examine the degree of contribution of three factors ($I$, $U$, $M$) to the model. We wish to test the null hypothesis :

$$H_0 : \text{Three factors are equally important.}$$

In other words if we can accept $H_0$, the composition of the original model hierarchy is validated because there is no change of the rank of alternatives when adjusting weights of three factors. Nothing can be deleted in the model. If we cannot accept $H_0$, there is evidence to delete any one of them in the hierarchy although we cannot be assured which one is least important.

The proposed sensitivity analysis procedure for the test of the hypothesis is described as follows :

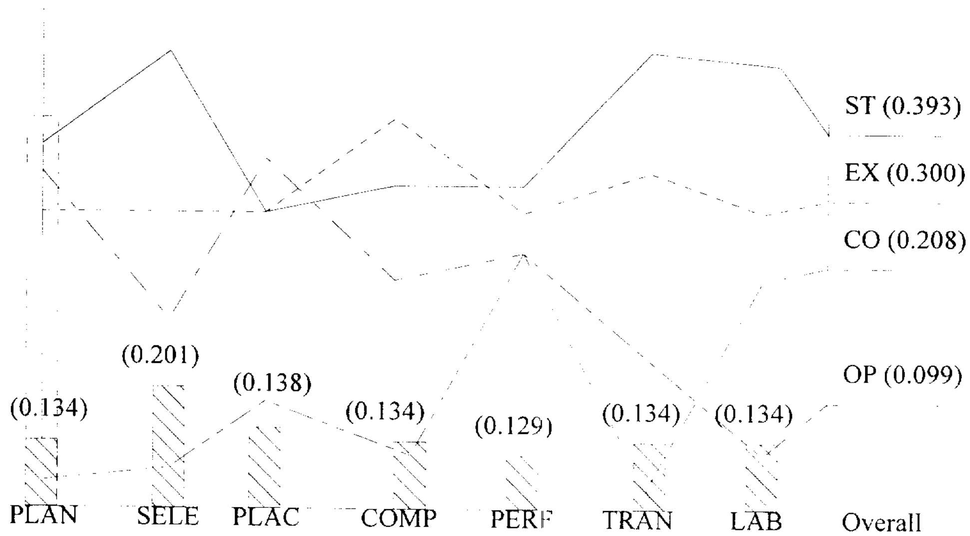
Step 1 : Select seven domains based on domain priorities (*DP*) (see Table 8).

Step 2 : Consider overall rank of four decision categories based on synthesized priorities (*SP*) (see Table 9).

Step 3 : Compute priorities of decision categories for each factor *I*, *U*, *M* as well as those of domains selected in Step 1 ; that is, *Ii* x *CPij*, *Ui* x *CPij*, *Mi* x *CPij*.

Step 4 : For each factor, increase the domain priorities until change of the overall rank by Step 2 (see Figure 5 for "I").

Step 5 : For each decision category, compute the sum of the paired rank difference between the overall rank and the adjusted rank by Step 4 (Table 10).




[Figure 5] Performance with respect to "I" for nodes below : "degree of domain importance"

[Table 10] Adjusted ranks by performance sensitivity analysis

| Factor | DC | OR | PLAN | SELE | PLAC | COMP | PERF | TRAN | LAB |
|---|---|---|---|---|---|---|---|---|---|
| I | OP | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 |
| | CO | 3 | 2 | 3 | 1 | 3 | 3 | 4 | 3 |
| | EX | 2 | 3 | 2 | 3 | 1 | 2 | 2 | 2 |
| | ST | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |
| | SUM | | 2 | 0 | 4 | 2 | 0 | 2 | 0 |
| U | OP | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | CO | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 3 |
| | EX | 2 | 3 | 2 | 3 | 1 | 2 | 2 | 2 |
| | ST | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |
| | SUM | | 2 | 0 | 4 | 2 | 0 | 0 | 0 |
| M | OP | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | CO | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 3 |
| | EX | 2 | 3 | 2 | 3 | 1 | 2 | 2 | 2 |
| | ST | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |
| | SUM | | 2 | 0 | 4 | 2 | 0 | 0 | 0 |

OR : Original rank by SP ; SUM : Sum of the paired difference between the original rank and the adjusted rank when maximizing domain priorities

As shown in Table 10, the sum of rank difference reveals nearly equal for each factor except for the training domain. Therefore we can conclude that all factors should importantly be regarded in the model and accept the null hypothesis. In other words, these factors are similarly correlated with each other. Furthermore, our approach by dividing HRM problem domains into individual sub-domains could not acquire a particular result for KAT/KRT selection. A representative KAT/KRT suited for all HRM domains (i. e., KAT/KRT mapping into strategic decision categories) can uniquely be applied to each domain.

# Ⅳ. Conclusion

Evaluation and selection of KAT/KRT should be a major task in ES development. In managerial problem domains, a conceptual contingency model mapping these various techniques to Mintzberg's managerial decision categories was proposed as a guidance for the technique evaluation. We extended this research and evaluated these techniques confined to HRM problem domains. An exploratory study was accomplished that synthesizes various human resource managers' judgments. Four decision categories were ranked in the domains using the AHP. An extension of the AHP called the MAHP is proposed that performs ratings of domain weights, by introducing three decision factors with some propositions.

As a result, strategic decisions were given the highest priorities in the decision categories and the techniques that combine expert-driven, knowledge engineer-driven, and machine-driven techniques were best suited to the KAT. KRT are also recommended as the combined approach. Verification of our model was accomplished by a performance sensitivity analysis.

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# Appendix

## A Questionnaire for the AHP

### Part Ⅰ. Background Information

The total number of respondents was 14.

1. Your experience in managing human resources.

   2 years < (2) 2-5 years (2) 5-10 years (7) > 10 years (3)

2. What kind of severe problems do you have in human resource management?

   lack of prepared data (3) complex environment (7) lack of information systems related to human resources (3) change of government regulations (0) change of executive policy (1)

3. What kind of methods do you rely on to assist in making personnel decisions?

   personnel information systems (4) past cases (4) personal judgments or experience (5) competitive firm's cases (1)

4. Are your personnel information systems sufficient for the job support?

   very well (1) average (5) insufficient (8) unknown (0)

### Part Ⅱ. Examination of Domain Characteristics

1. Classify each of the following areas as to how you perceive its strategic importance or urgency for achieving organizational profits.

   Likert scale : 1 : rarely important 3 : average 5 : very important 2,4 : intermediate value

A. Planning ( ) B. Job Analysis ( ) C. Recruiting ( ) D. Selection ( ) E. Placement ( ) F. Compensation ( ) G. Performance Evaluation ( ) H. Training ( ) I. Labor-management Relations ( )

2. Classify each of the following areas as to how you perceive its structure.

   Likert scale : 1 : structured 3 : semistructured 5 : unstructured 2,4 : intermediate value

A. Planning ( ) B. Job Analysis ( ) C. Recruiting ( ) D. Selection ( ) E. Placement ( ) F. Compensation ( ) G. Performance Evaluation ( ) H. Training ( ) I. Labor-management Relations ( )

3. Classify each of the following as to how you perceive the degree of participation of three management levels needed to perform the tasks in each area.

Likert scale : Low 1 2 3 4 5 High

| Areas | Low | Middle | Top |
|---|---|---|---|
| Planning (PLAN) | | | |
| Job analysis (JOB) | | | |
| Recruiting (RECR) | | | |
| Selection (SELE) | | | |
| Placement (PLAC) | | | |
| Compensation (COMP) | | | |
| Performance evaluation (PERF) | | | |
| Training (TRAN) | | | |
| Labor relations (LAB) | | | |

Part Ⅲ. Evaluation of Decision Categories

Read the reference material carefully that explains the four decision categories. Circle one number per pairwise comparison below using this scale :

1 : not similar 3 : moderate 5 : strong 7 : very strong 9 : extremely similar

| Decision Categories | Judgment | Scale | | Decision Categories |
|---|---|---|---|---|
| Operating (OP) | 9 8 7 6 5 4 3 2 | 1 | 2 3 4 5 6 7 8 9 | Coordinative (CO) |
| Operating (OP) | 9 8 7 6 5 4 3 2 | 1 | 2 3 4 5 6 7 8 9 | Exception (EX) |
| Operating (OP) | 9 8 7 6 5 4 3 2 | 1 | 2 3 4 5 6 7 8 9 | Strategic (ST) |
| Coordinative (CO) | 9 8 7 6 5 4 3 2 | 1 | 2 3 4 5 6 7 8 9 | Exception (EX) |
| Coordinative (CO) | 9 8 7 6 5 4 3 2 | 1 | 2 3 4 5 6 7 8 9 | Strategic (ST) |
| Exception (EX) | 9 8 7 6 5 4 3 2 | 1 | 2 3 4 5 6 7 8 9 | Strategic (ST) |