

Concepts of Human Resource Management Expert Systems

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I. Introduction

Human resource management (HRM) is the utilization of human resources (HR) at work to achieve organizational and individual goals by recognizing HR as a crucial element [5,8,13]. It helps an organization achieve its future objectives by providing competent, well-motivated employees. HRM is also management of various activities designed to enhance the effectiveness of an organization's workforce [1]. HRM consists of numerous activities or functional areas, including HR planning, job analysis, recruitment, selection, placement, financial compensation, performance evaluation, HR development, labor-management relations, safety, health, and HR research [4,14]. Many quantitative or qualitative techniques have been developed to support the HRM activities, classified as management sciences/operations research (MS/OR), statistical analysis, multiattribute utility theory, multiple-criteria decision making (MCDM), ad hoc approaches (e.g., use of versatile materials, behavior analysis), and human resource information systems (HRIS). More importantly, HRIS can include the three systems of expert systems (ES), decision support systems (DSS), executive information systems (EIS) [15] in addition to transaction processing systems (TPS) and management information systems (MIS) conventionally accepted as an HRIS. An HRIS is regarded as a computer aided HRM system.

An HRIS was defined as a computer based system for simply collecting, storing,

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maintaining, retrieving, and validating certain data needed by an organization about its employees [17]. An HRIS can be seen as a computer based information system [9] grouped into the following six categories: TPS, MIS, DSS, Group DSS (GDSS), ES, case-based reasoning systems (CBRS), and EIS. This implies that HRIS should be developed to solve HR problems appropriately reflecting the problem characteristics of HRM activities.

TPS focus on processing data resulting from the occurrence of employee transactions, such as the employees' data entry, payments, and report generation. MIS use personnel and payroll databases that store large quantities of detailed data concerning transaction processing. A DSS interactively helps HR managers utilize data and models such as forecasting model for HR planning to solve complex, unstructured, and semistructured problems. A GDSS can support the group interviewing process for employee selection and the contract negotiation between union and management. ES allow HR managers to make better decisions with their heuristic knowledge. Case-based reasoning systems have been applied to solve HR problem from old cases or past experiences by overcoming the limitation of rule-based reasoning systems. Finally, originally an EIS serves the information needs of top executives. Internal information is usually generated from MIS related reports within organizations. External information is generated from on-line databases, newspapers, personal contacts, and government reports.

A human resource management expert system (HRMES) is defined as an ES for HRM, or ES in HR problem domains to support eight HRM activities [3]. HRMES emerge to overcome the limitation of traditional database-oriented HRIS. Figure 1 presents the conceptual structure of HRMES. The behavior means all information to

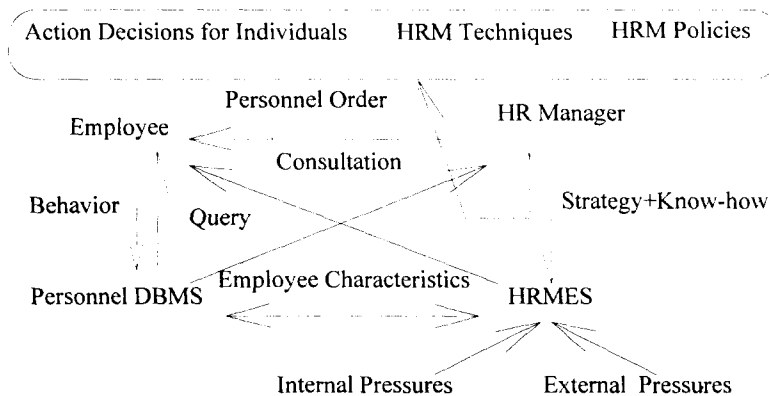


Figure 1. A structure of HRMES.

employees including payroll, performance, job attitude, and career. Two users can acquire useful information from the database management systems for making decisions from the ES that they communicate with each other. The know-how and strategy acquired from HR managers are probably major sources of knowledge in small scale of ES.

II. Relevance of Expert Systems to HRM Problem Domains

Overview

The main motivations for developing an ES in HRM are related to its domain characteristics [3]. Some ES applications currently used in the domain indicate this plausibility. However, what is lacking is a clear analytical perspective on how various HRM problems differ in nature from problems in other domains and the implications of these differences for ES in HRM. Because it is arduous to compare these individual differences with those of other domains that ES have covered, HRM is considered as a sub-domain of management.

Comparing HRM characteristics with those of ES will show the attempts at using ES for HRM. These proofs are accomplished by literature survey, known facts, state of the art HRM, and representation methods such as a decision support framework and a two-dimensional model to validate some hypotheses.

Decision-making Problem

An analytical model of HRM described HRM as a decision-making problem. The HR relations model [12] is an abstraction of the concept of HRM. It opened up a new important perspective, namely the emphasis on the quality of decision-making. Improved decision-making and control can make better utilization of HR and subordinate satisfaction and morale. The model postulates a straight-line relationship from participation to decision-making to increase productivity.

On the other hand, ES have been applied to problem solving and decision-making. Decision-making entails the cognitive process of stimulus, perception, decision, and response [7]. Therefore, ES can support HRM when regarding the process.

Potential Benefits in Common with Management or Business Expert Systems

An ES can provide a large number of benefits to organizations. The benefits of ES applications in HRM domains are less popularly known than those of all applications on management domains. Together with management expert systems or business ES that can solve organizational problems, they give strategic advantages first of all else to the organization [11]. The major benefits of ES include: improving productivity, helping personnel by making more consistent, timely, and accurate decisions in hopes of improving competitiveness and market share, and a reduction in staff personnel by providing automated decision-making [2].

Database Availability

Data and databases are an essential necessity like other managerial domains. They are always available and ready without a need to additionally prepare for ES. Looking at personnel and payroll databases that are prominently used for TPS or MIS shows that the information on employees that becomes major sources of knowledge is already stored in the database.

Suppose the following simple rule in rule-based reasoning systems, the attributes of "age" and "employment-date" are components of the database and the attribute "performance-rating" is acquired from human judgments.

```
IF age > 50 AND employment-date < 1980 AND performance-rating = low  
THEN early-retirement
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The proposition allows to use ES because databases are a key component by the structure of ES and the variable in the rule can be retrieved from the database. Furthermore, business ES can no longer be successful by disregarding database technology.

The Role of HR Managers as Human Experts

An HR manager or specialist is a decision maker who has expertise, normally acts in an advisory capacity or works together with other managers to help them deal with HR matters. The HR manager is primarily responsible for coordinating the management of HR to help the organization achieve its goals [14]. The manager's jobs [16] such as directing, coordinating, negotiating, supervising, rating, planning,

decision-making, monitoring, and administering help us assume that all managers have the same roles with HR managers except for dealing with non-HR problems.

Human Resource Management Activities Matching to Expert System Domains

Most HRM activities are well-bounded, i.e., clearly understood and the definition and the objective are well-defined. The classification of individual HRM activities is relatively easy because they are not so much interrelated with each other. It is easy to identify and divide them into sub-domains in spite of no prepared methodology on how to select an appropriate domain.

Unstructured or Semistructured HRM Activities

A decision support framework is a tool for the analysis of HRM activities and used for a source of the HRIS design. It is useful to employ the same dimension as the MIS framework [6] by searching for a task among HRM activities based on decision types and management levels supported. The taxonomy for the managerial activity consists of three categories. Strategic planning is concerned with long term planning, broad policies, and goals for HR executives. Managerial control deals with tactical issues for middle management.

At the first-line level, managers handle operational issues that are largely of a day-to-day nature. The task orientation of operational control requires information of a well-defined and narrow scope. The three decision types are structured, unstructured, and semistructured. To the extent that a given problem is semistructured or unstructured, there is an absence of a routine procedure, ambiguity in the problem definition, and the lack of decision making procedure. The framework is shown in Figure 2.

Human Resource Management Paradigm Versus Inference Mechanisms

The following three steps [8] of the HRM paradigm that seeks to find sub-goals in order to meet an HRM objective is similar to the inference mechanisms of ES:

HRM: Objective Policy Procedure

ES: Goal Inference Engine Rules

Type of control Type of decision	Operational control	Managerial control	Strategic planning
Structured	application control, interview preparation, attendance control, employee data preparation and entry	workforce analysis, availability analysis, forecasting labor shortages, labor cost management	HR action plans, return on investment measures, tracking expenditures
Semi-structured	staffing schedule	skill inventory design, career planning, job assignment, pay budgets, recruitment evaluation	employment planning, HR project initiation, determining incentive strategy
Unstructured	selecting training techniques, evaluating training outcomes	pay structure design, job design, performance policy, choosing applicant qualifications, choosing recruitment sources, health planning	resource allocation, contract negotiations, employee welfare

Figure 2. A decision support framework.

Human resource managers make the objective more specific by developing policies that are general guides to consistent decision-making, as well as procedures or rules specifically aimed at decision-making on how to do a particular activity. The policy is a general guide to searching for a solution. Policies allow HR managers to focus on decisions in which they already have the most experience and knowledge. Backward chaining mechanism for an ES corresponds to the policy from the goal. The procedure is a specific direction to action. For example, job satisfaction is an objective in a job placement ES. The principle of the right-person-in-the-right-place becomes the policy and aptitude tests or personality tests are used to make rules.

Advancement of Information Technology

Technological advances in computer hardware and software occur virtually every day. This can improve HRM and raise employee productivity. Even during tough economic times, technological changes must be tracked to maintain a competitive edge [10]. Failure to keep up with developments in this rapidly changing area can threaten a firm's competitive position and possibly even its survival.

Major IT include application and communication software, teleconferencing, voice mail, telecommuting, ES, graphical user interfaces, multimedia. Through

telecommuting, employees work at home and transmit data over telephone lines tied to computer. Through multimedia, employees are immediately drawn to the presentation with stereo sound or full motion video, which makes multimedia useful in sales presentations and in training and development.

An ES is a special kind of information technology (IT) as a computer-based IS. Current HRM issues intend to use IT to gain competitive advantage over rivals and change competitive scope. This state confirms that ES can also contribute to HRM like other IT. For example, if a company decides on using a broader geographic scope to acquire better recruiting sources, competitive scope is changed by IT to act as a consultant to a human.

Support: IT => HRM, ES < IT => Support: ES => HRM

Existence of Shallow Knowledge

Human resource knowledge can be represented as both premises and conclusions. A premise is a precondition and a conclusion is an action decision. It is helpful to describe how an HR manager can express reasoning knowledge in the form of rules. Production rules are procedural or operational knowledge that specify what to do when. Above all, rules can more clearly explain the possibility for making a knowledge base than any other knowledge representation techniques.

Complex HRM Environment

Many interrelated factors affect to achieving HRM activities. The following eight elements contributes as the component of a diagnostic model to develop an HRM system: focus, domain, external pressure, internal pressure, organizational type, achieving technique, people, and data and knowledge source. This focus denotes what an HRM system gives organizations as goals. The domain seeks appropriate functional activities or means what to do under the focus. Remaining components are related to how to do.

These factors that affect a firm's HR from outside its boundaries comprise the external pressures. They usually include union procedures and requirements, legal regulations, composition of labor force, geographic location of the organization, society, customers, and economic condition.

Internal pressures are considered as internal environment on HRM. Factors that affect a firm's HR from inside its boundaries comprise the internal environment. The

primarily internal factors include the firm's goal or mission, policies, corporate culture, nature of the task, work group, and management style of upper managers.

Organizational characteristics can be divided into profit (e.g., manufacturing firms), or nonprofit organizations (e.g., government) and the types of them that affect to develop a unified HRM system are classified as size, complexity, and stability.

People elements are users and developers. As with senior HR executives, their interest in personnel data is key promotions, executive searches or succession plans. HR functional professionals are trained in and assigned to a specific area of HR. HR managers typically have some knowledge of all areas of HR but have less specific expertise than the functional professionals..

Measures are required to evaluate an HRM system's effectiveness. Criteria such as grievance rates, turnover, accident rates evaluates whether outcomes of an HRM system developed in an organization under these HRM environment satisfy the employees' need and organizational goals somewhat.

The components in an HRM environment can be summarized as six elements. The arrow denotes a recommended ES contribution.

HRM Environment = (E, I, O, P, N, L)

E: External pressure Knowledge base

I: Internal pressure Knowledge base

O: Organizational classification System scope, Complexity, Project cost

P: People element User, Expert

N: Quantitative measure Validation

L: Qualitative measure Validation

Complexity Analysis of HR Firms

Situations of HRM environment are different in each firm regarding hardware and software techniques. A two-dimensional model analyzes the complexity of organizations when the firm is to develop an HRM system. In the model, the two complexities include not only the complexity of knowledge such as many people, depth of expertise, many sources of information, and uncertainty in information, but also the complexity of technology such as diversity of platforms needed, diversity of IT, and degree of system integration. In Figure 3, the arrow on the grid of the two-dimensional model represents a system development sequence recommended or ease of HRM systems application to the firm. The industry with the lower

complexity of knowledge and the complexity of technology guarantees more success of the system than others.

In service firms with many employees that must work in diverse areas, high development technologies need to achieve them owing to, for example, the difficulty in gathering the information of employees through telecommunication networks. But, the complexity of knowledge is relatively low because of strict evaluation criteria defined that exactly follow their performance to jobs. On the other hand, research centers or usually classified as nonprofit organizations are confined that the complexity of knowledge is high and the complexity of technology is low. Because the employee's evaluation often depends on the manager's judgment, it is burdensome to quantitatively evaluate an individual job performance. But the technology for systematization is relatively easy.

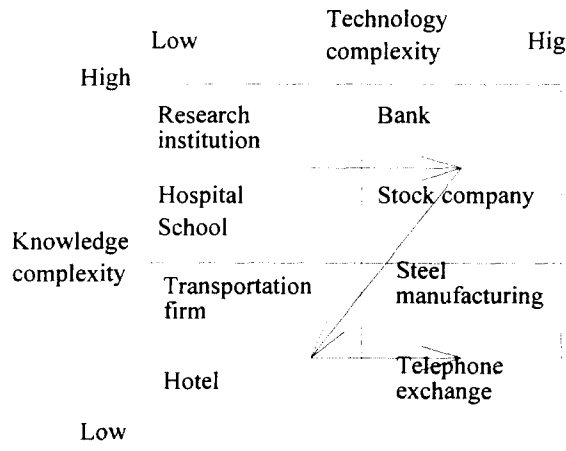


Figure 3. Two-dimensional model.

Knowledge Representations of HR Domains Using Rules

Production rules are procedural or operational knowledge, that specifies what to do when. In HR planning (Figure 4), rules consist of the selection of planning methods, checking preliminary conditions for the demand analysis and internal inventory analysis, and actions according to a current employment status. Job analysis (Figure 5) includes the rules of selection of the appropriate analysis method, precondition for the process, composition of the document required as a result such as the job description. Selection focuses on such decisions as hire, hold, reject, and transfer through employee test (Figure 6). In recruiting (Figure 7), rule sets include checking

the preliminary condition for the recruiting process, selection of recruiting methods and sources, selection of candidates, and the overall policies taken by organizations. Compensation (Figure 8) covers the two rules of pay-level and pay-strategy. In labor-management relations (Figure 9), rules cover how to determine the decision in negotiation process.

IV. Summary

We have discussed the concept of HRMES that focuses on the representation of knowledge for each HR domain. Compared with traditional MS/OR techniques, ES in HRM not only support complex managerial decision-making effectively and efficiently but also provide competitive advantages in organizations. Among HRM techniques that perform these activities, we recommend IT including high level information systems such as ES. The decision support framework describes how IT are important and a possibility to apply these information systems to HR domains.

The most appropriate domains in which ES can be built include planning, job analysis, recruitment, selection, performance evaluation, compensation, training, and labor-management relations. The set of rules for HRM activities helps HRM system builders more understand HRM procedures and design knowledge bases. However, the knowledge representation using rules is likely to be in different forms as builders analyze the domains in different ways.

V. Acknowledgments

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RULE: selection of HR planning techniques
IF consensus-of-a-group = reliable AND
questionnaires = available AND estimation-of-employment-needs = best
THEN Delphi

RULE: analysis of present and future requirements of job
IF estimation-of-org-condition = accomplishment AND
linking-business-activity-to-HR-requirement = accomplishment AND
forecasting-HR-requirement = accomplishment
THEN demand-analysis = ok

RULE: examining the current internal inventory of employees
IF forecasting-technique = available AND analysis-of-activity-change = ok
AND forecasting-inside-outside-movement = accomplishment
AND skill-inventory-analysis = accomplishment
THEN internal-analysis = ok

RULE: comparison of demand and supply
IF external-analysis = ok AND internal-analysis = ok AND
demand-analysis = ok AND external-supply + internal-supply > demand
THEN condition = surplus

RULE: action decisions with a shortage of employees
IF employee-shortage = small AND highly-skilled-employees = yes
THEN action = overtime

IF employee-shortage = small AND highly-skilled-employees = no
THEN action = training or promotion

RULE: action decisions in surplus conditions
IF employee-condition = shortage AND early-retirement = disagreement OR
union = aggressive
THEN action = work sharing

IF labor costs = high AND downsizing-motivated-by-business goal = true
THEN action = quit

Figure 4. Rules for HR planning.

RULE: selection of the job analysis method
IF number-of-employees > 500 AND incomplete-information-received = ok AND
target = salary-and-hourly-worker
THEN method = questionnaires
RULE: qualified interviewer
IF interest-in-worker = sincere AND terminology-used = worker's language
AND job-study-skill-or-knowledge = ok AND
verification-of-the-job-information- prepared = ok
THEN interview = ok
RULE: checking the completeness of the job description
IF job-title = ok AND job-summary = ok AND job-duty = ok AND
working-condition = ok AND definition-of-equipment = ok
THEN job description = ok
RULE: an example of job specification
IF degree-of-intelligence-required = high AND education > high school
AND experience-level > average
THEN job = software handling

Figure 5. Rules for job analysis.

RULE: employee test
IF intelligence = ok AND personality = good AND achievement =ok
AND aptitude = ok AND physical-examination = ok
THEN employee-test = ok
IF neurotic-tendency = high AND self-sufficiency = low AND
introversion = low AND self-confidence = high AND sociability = average
THEN personality-test = good
RULE: selection decision
IF age < 30 AND sex = male AND education > college AND
employee-test = ok
THEN decision = hire
IF age > 30 OR sex = female AND employee-test = ok
THEN decision = hold

Figure 6. Rules for selection.

RULE: checking the availability of recruiting plan
IF required-applicant-qualification = agree AND recruitment-sources = ok
AND inducement-plan = ok AND quality-of-recruiter = agree
THEN recruiting-plan = ok

RULE: decisions about how to generate source of the applicants
IF external-recruiting = ok AND necessity-of-special-worker AND
cost-for-program = available
THEN recruiting-method = internship

IF motivation-of-employee-movement = high AND HR-planning = agree
AND computer-system = not-available
THEN method = job-posting

IF org-size = large AND org-complexity = low AND org-stability = high
THEN radio-commercial

RULE: finding recruiting sources for each job
IF cost-of-recruiting = low AND recruiting-policy = outside-referral
AND past-image = good AND number-of-schools = large AND
qualified-worker = true
THEN sources = school

RULE: evaluation of candidates
IF past-work-experience = true AND college-major = agree AND
salary-requirement = agree OR military-experience = agree OR awards
=true
THEN qualified-worker = true

RULE: policy on internal or external recruiting
IF labor-market = shortage AND government-regulation = high AND
inducement-plan = bad AND organization-location = bad OR
organization-image = bad
THEN policy = positive

IF short-term-change-in-need = high AND uncertainty-of-environment = high
AND growth-of-service-industry = high
THEN policy = temporary

Figure 7. Rules for recruitment.

RULE: pay-level decisions on influencing factors

IF minimum-wage-rate = high AND maximum-hour = low AND
 union-attitude = strong AND economic-condition-of-others = competition
 AND labor-market = tight AND org-status = ok

THEN higher-wage

IF labor-budget = available AND size-of-org = large AND
 managerial-pay-strategy = high

THEN org-status = ok

IF match-to-long-range-policy = yes AND managerial-attitude = positive

THEN managerial-pay-strategy = high

RULE: pay policies to compensation objectives

IF ability-to-attract = positive AND
 ability-to-retain-quality-employees = positive AND reducing-pay-dissatisfaction
 = positive

THEN above-market

IF ability-to-attract = negative AND
 ability-to-retain-quality-employees = negative AND increasing-productivity =
 unknown

THEN below-market

RULE: job evaluation methods

IF ranking-of-job = ok OR grading-system = ok OR point-system = ok
 OR factor-comparison = ok

THEN job-evaluation = ok

RULE: clerical worker grading-system

IF work = simple AND supervisory-responsibility = no AND public-contact = no

THEN class-I

IF work = complex AND supervisory-responsibility = yes AND public-contact =
 yes

THEN class-V

RULE: point-system

IF skill-required > 60 AND education-required > 70 AND
 job-complexity > 90 AND physical-requirement > 80

THEN first-degree-job

RULE: classifying occupation groups

IF vice-presidents = yes OR managers = yes OR project-leaders = yes

THEN skill-group = managerial-group

Figure 8. Rules for compensations.

RULE: preparing labor and management relations
IF labor-contract = ok AND grievance = accept AND
mediator = ok AND arbitration = ok
THEN bargaining = ok

RULE: reaching a formal contractual agreement
IF hours-of-work = agree AND rates-of-pay = agree AND
overtime = agree AND arbitration = agree
THEN labor-contract = ok

RULE: reflection on a complaint about organization policy
IF gather-grievance = yes AND work-with-union-representative = yes
AND weighing-grievance = yes
THEN grievance = accept

RULE: evaluation of mediator who helps labor and management reach agreement
IF impartiality = low AND sincerity = high AND communication-skill = high
AND expertise = high AND self-control = high
THEN mediator = ok

RULE: decisions on unsolvable dispute for binding settlement
IF grievance = not-accept AND (arbitrator = full-time OR arbitrator =
labor-economics)
AND time-delay = no AND expense = low
THEN arbitration = ok

RULE: decisions on types of strikes
IF economy = booming OR cost-of-strikes = high OR unemployment = high
THEN strikes = short

RULE: decisions on lockout
IF strikes = long OR slow-down = high OR damage-to-property = high
OR labor-disorder = high
THEN lockout = agree

Figure 9. Rules for labor-management relations.

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< 국문초록 >

인적자원관리 전문가시스템의 개념

변 대 호 · 서 참 교

본 논문은 인적자원관리에 필수적인 전문가시스템의 개념에 대해서 논의하고 있다. 전문가시스템을 인적자원관리분야에 적용하기 위해서는 전문가시스템의 개발과 관련된 일반적인 고려사항들 뿐만 아니라, 인적자원관리와 관련된 고유한 특성들이 고려되어야 한다. 본 논문에서는 인적자원관리 전문가시스템의 장점과 구조를 제시하였으며, 전문가시스템 개발을 위한 단계별 구체적 활동을 논의하였다. 아울러, 규칙을 이용한 인적자원관리의 지식표현법 및 예제를 통해서 인적자원관리정보시스템의 하부 시스템으로서의 전문가시스템의 특성에 대해서도 논의하였다.