



**Instituto de Dirección  
y Organización de Empresa.**

Cátedra de Política  
Económica de la Empresa

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Núm. 271

## **MANAGING BRAINS**

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Professor (em.) für Betriebswirtschaftslehre an der  
Humboldt-Universität zu Berlin

UNIVERSIDAD  DE ALCALÁ

Doc. 1-A  
00/271



**CONFERENCIAS Y TRABAJOS DE INVESTIGACION  
DEL INSTITUTO DE DIRECCION Y ORGANIZACION  
DE EMPRESAS / Núm. 271**

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**5904628505**

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EDITA:

**I.D.O.E. UNIVERSIDAD DE ALCALÁ**

ISBN: 84 - 8187 - 102 - 8

Depósito Legal: M - 20546 - 2001

Imprime: **DIGITAL COLOR 2000, S.L.**

Pº de La Estación, 7 - 28807 Alcalá de Henares

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# I. INTRODUCTION<sup>1</sup>

## 1. Economic change

Some economists talk about the “new economy” versus the “old economy”. They refer to the changes that the internet and e-commerce have triggered in our global economy.

Some managers talk about the “Marxian Counterrevolution” versus the “Marxian Revolution”. They refer to the changes that the new knowledge base has brought to the management of human resources in the modern corporation.

One may doubt whether the new economy is so new after all<sup>2</sup>. The new economy is an economy where three factors play a dominant role:

- the reduction of transaction costs through information technology
- the network effects on demand
- time and speed as a strategic success factor.

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<sup>1</sup> Paper presented to the International Symposium in Commemoration of the 30th Anniversary of Japan Society of Human Resource Management on “Human Resources and Work Life in the Twenty-first Century” on July 21, 2000.

<sup>2</sup> Shapiro, C.; Varian, Hal. R.: Information Rules: A Strategic Guide to the Network Economy. In German: Online zum Erfolg, München 1999.

And these factors have been around in economics for at least half a century.

However, these factors have indeed brought about a “Marxian Counterrevolution” in human resources management. This revolution has become felt by managers during the last decade. Karl Marx saw the essence of industrial capitalism as it developed during the 19th century in the separation of the worker from his means of production: machinery and equipment. Today, managers see the essence of knowledge-based capitalism, as it is currently developing, in the reunification of the worker and his means of production: his brains.

## **2. Outline**

Therefore, human resource management today is “managing brains”. This is the topic of my address to this conference on “Human Resources and Work Life in the Twenty-first Century”. The outline of my talk is as follows.

In the first part I will present some stylized facts about the new problems of managing human resources. The second part shows that the existing body of economic theory is not adequate to reflect the stylized facts. The third part deals with some of the concepts in the management literature that try to capture the new organizational forms of human resources mana-

gement. In the concluding part I will try to show that the concept of “managing brains” can be formalized by building on the old and well-known personnel assignment problem.

## **II. STILYZED FACTS**

The following stylized facts characterize the new era of human resource management:

1. The firms find themselves subject to quickly changing markets due to changing consumer preferences in the developed countries and due to emerging consumer groups in the emerging economies.
2. The firms find themselves able to respond to these changes quickly due to quickly developing communication technology in general and the internet in particular.
3. These changes in the economic and technical environment of firms drive an ever increasing demand for a flexible workforce with a high speed of action and reaction.

4. The employees realize that job hopping has a positive connotation if it is combined with an increase in their individual knowledge base.
5. The employees realize that their labor market is the world. The internet overcomes barriers to entry to and barriers to exit from local or national labor markets.
6. The internet is accessible from everywhere in the world and available to everyone in the world.
7. Self-employment will increase in relation to total employment. The elderly in society will discover that after a work life as an employee they can easily take up self-employment with a computer as a workplace at home and hooked up to the world through the internet.

### **III. THEORIES OF HUMAN RESOURCE MANAGEMENT**

We will now try to answer the question: Do we have a consistent theory of personnel management that helps us understand the stylized facts and that gives orientation to the manager and the entrepreneur how to manage successfully the human resources at his disposal?

Let us review the following five theories:

- classical economic theory
- human capital theory
- productivity theory
- neo-classical economic theory
- contract theory.

## **1. Classical economic theory**

In classical economics, labor is a homogeneous production factor. Labor is perfectly elastic and perfectly mobile. Labor is perfectly under the control of management at zero cost.

This theory does not reflect the stylized facts. Brains are highly heterogeneous. Labor is highly conscious of its reservation wage and will certainly risk conflict with management. Labor is highly mobile particularly in the internet, but not at zero cost. Labor wants to share in the mobility and flexibility rents that firms gain in the new economy.

Classical economic theory did not even reflect reality in the early 20th century adequately. Karl Marx did not believe that human beings would become willingless outer-directed factors of production in an industry characterized by mass production. He believed that a growing army of workers doomed to do routine menial work for minimal wages would rise

in protest and destroy the system that had separated them from the fruits of their work.

Max and Alfred Weber in their studies of bureaucratic organizations analyzed the conditions under which the freedom and the dignity of man could survive in a highly routinized industrial process characterized by Adam Smith's principle of division of labor. They came to the conclusion that there was an optimal degree of division of labor beyond which the workers would lose interest in their work and would cause a reduction in the quality of their work resulting in lower entrepreneurial profits. This would make it mandatory for management to take the work incentives of labor into consideration. Later on, this insight was formulated by McGregor in his well-known "Theory Y".

Long before the advent of human capital theory it had thus become clear that labor is more than a passive factor of production as is assumed in classical economic theory. Labor is a human resource with individual preferences and intentions.

## **2. Human capital theory**

Human capital theory overcomes the assumption of labor as a homogeneous factor. Labor is heterogeneous. It pays the firm to train specialized labor at its own cost. It is in the interest of the firm and of the employee to manage for long-term employment and to invest in the specialized human

resources. Unskilled labor is a willingless and highly mobile factor of production.

This theory does not capture the stylized facts either. Labor is split into unskilled and skilled labor. But skilled labor has a firm-specific knowledge base. Mobility is, therefore, dramatically reduced. Long-term labor contracts have the effect also to increase identification with management and thus reduce the incentive problem.

### **3. Productivity theory**

Productivity theory is based on two different strands of thought. The early “aggressive wages policy”-argument said that the owners of capital are basically lazy. Aggressive wage demands have to force the entrepreneur out of this lethargy into innovation activity. In the end, improved profits due to innovation justify the originally excessive wage demands. The later “efficiency wages argument” postulates that the wage earners are motivated by higher wages to work harder and more efficiently. Therefore, wage advances are justified by the ensuing higher productivity of labor.

Both versions of the theory stress the motivational aspects of human resources management. They rely on the incentives for entrepreneurs as well as for employees to improve productivity. There are no network effects, however. Labor is adaptable to the innovations, but learning is achie-

ved at zero cost. Clearly, productivity theory does not incorporate all the stylized facts.

#### **4. Neo-classical economic theory**

Here we understand neo-classical economic theory as the dynamic production theory with labor as one of the production factors. In this theory we may distinguish two different concepts. The first concept treats labor as a homogeneous factor of production. The second version distinguishes between direct labor input and indirect labor input through the stock of human capital. We will consider the second version of neo-classical economic theory only.

Labor is a quasi-fix production factor. Changes in the employment level are costly. This cost reflects various institutional regimes. Production regimes may differ from country to country.

Human capital reflects the body of knowledge incorporated in the firm's personnel. It is subject to change, based on learning and on the corporate governance system. The corporate governance system may speed up or retard the learning processes in the firm.

This theory assumes that all the different brains of its actual and potential employees can be aggregated into the labor force on the one hand and into the human capital on the other. Combining the neo-classical production theory with quasi-fix factors as it was just described with the

neoclassical vintage model leads to some disaggregation of the human capital but does not change the basic assumption of the theory: the human resources of a firm are closely tied to the differentiated stock of real capital. Learning how to operate new machinery is costly. Costs are costs of information and costs of motivation.

This theory comes close to reflecting the stylized facts. Basically, the knowledge base of the firm is technical knowledge imbedded in the real assets of the firm. Human resources are differentiated to the extent required by the technical nature of the production function. The choice of the production function depends on the costs of adaptation of the human resources. Empirical tests of this theory have shown that these costs are high, resulting in low speed of adaptation. In the future, the costs of adaptation of the work force in the new economy will be low and the speed of adaptation will be high.

While neo-classical theory can be adapted to incorporate higher speed of adaptation of the human resources to the demands of the market, this theory does not reflect very well the changes in output that the firm has to make in order to cope with the changing patterns of demand. Output of the firm is treated as a homogeneous good over time. The stylized facts that characterize the new economy would clearly suggest that the process of output change due to innovation is endogenized.

## 5. Contract theory

Finally, we turn to contract theory. Contract theory in its specific form of the principal-agent theory starts with the individual employee. He and she have their own will clearly expressed in their utility functions. There is uncertainty about market demand and about the knowledge imbedded in the employee as well as about his or her skills. Originally, there is no loyalty between the firm and the employee. Employee loyalty necessary to carry out the job specified by the principal is brought about by the principal with an incentive compatible contract which buys the employee into doing what the owner of the firm, the principal, wants him to do.

This theory seems to come closest to covering the stylized facts. It clearly captures the contractual nature of the employment relationship. The mobility of the worker is determined by his reservation wage. Changing a job does not cause any transaction costs, however. Under the incentive compatible contract, managers may have informational problems in human resource management, but all motivational problems have been solved. Furthermore, contract theory in the form just described is static and thus does not capture the dynamics in modern human resource management. The dynamic form of principal-agent theory stresses the importance of trust and loyalty between the firm and its employees in an efficient long-term relationship. This is clearly the opposite of the stylized facts.

I thus conclude that none of the human resource theories discussed here are an adequate formal representation of the stylized facts that describe the human resources of a firm in the new economy.

#### **IV. MANAGEMENT CONCEPTS**

Lack of theory always leaves a void which is filled with managerial wisdom. In the following part we will discuss five management concepts that try to capture the new developments in human resource management:

- nomad organization
- adhocratic organization
- onion organization
- amorphous organization
- virtual organization.

##### **1. Nomad organization**

The first concept describes a process from fortress organization to nomad organization. A fortress organization is characterized by a highly immobile workforce under the strict command of a fortress commander. This concept is supposed to stand for the late 19th and early 20th century organization with a formal hierarchy, clear job descriptions and low mobility of labor.

The nomad organization, on the other hand, is characterized by a highly mobile workforce, fairly decentralized lines of command and a very fast and effective search for new market opportunities.

This concept captures the characteristics of high mobility of the workforce and fast changes in the market place. It lacks the concepts of individuals moving or being exchanged between different tents or even between different tent villages answering to the changing demand for certain skills.

## **2. Adhocratic organization**

When the concept of adhocratic organization was first developed almost 25 years ago<sup>3</sup>, it was applied to consulting firms and professional firms only. Applicability to other types of firms, particularly industrial firms, was questioned. The discussion of applicability to other service industries was controversial. However, it was generally agreed that this concept might describe a process which might become typical of all firms: from hierarchy to adhocracy.

This process is characterized by an ever-increasing proportion of employees with a valuable and individual knowledge base. These “profes-

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<sup>3</sup> von Falkenhausen, Hasso: Willensbildung in Unternehmen mit großem Akademikeranteil, in: Albach, Horst; Sadowski, Dieter: Die Bedeutung gesellschaftlicher Veränderungen für die Willensbildung im Unternehmen, in: Schriften des Vereins für Socialpolitik NF Band 88, Berlin 1976, S. 505 – 518.

Von Falkenhausen uses the term “intelligent anarchy”.

sionals” are employed in changing projects. These projects are coordinated in a very flat organization. Each employee can shape his or her job to some extent according to his own abilities and her own preferences.

While in a hierarchy it is assumed that employees obey orders from their superiors, in an adhocracy the participant in a project influences group decision making. The group tries to reach consensus on the structuring of the project and on the speed with which each individual step in the solution will be carried out to meet total project targets.

This concept captures the fact of ever-changing market opportunities through its project organization. Above all, it stresses the importance of knowledge orientation. It underscores also the demand for a highly flexible workforce. It meets the requirements of speed by relying on a flat, almost horizontal organization.

### **3. Onion Organization**

The idea that the future organizational form of a corporation would look rather like an onion than like a pyramid is probably as old as the idea of the adhocratic organization. The concept of the “onion organization” was developed by Professor Francesco Kneschaurek of St. Gall Business School. He forecast that the corporation of the future would need very few people at the top and very few people doing routine work at the bottom of the company. The great majority of employees would be in highly skilled jobs in the middle of a rather flat organization.

When this concept was developed, it was quite unclear how the center of the onion would look like. It was clear only that the unskilled jobs would be rationalized away and that top managers would have to delegate responsibility to a much greater extent than was hitherto known.

More recent concepts have tried to shed more light on the interior of the onion.

#### **4. Amorphous organization**

Amorphous organization is one such attempt. The underlying organizational process is one from a rather inflexible organization to a highly flexible amorphous organization without a rigid formal structure. The basic idea of the amorphous organization is that employees with good brains (knowledge and flexibility) work best in a highly unstructured environment where brains cluster around an opportunity, grasp it and exploit it in a process of project membership that changes as specialized inputs of knowledge are required. Brains in this context is a stock of knowledge and skills to be activated whenever the demand for them arises from the ever-changing projects.

This concept captures not only the idea of quickly changing opportunities, of project teams that constantly change their composition as need for different knowledge and skills emerges. It also captures the fact that mem-

bers of the group may be added from outside the firm. The amorphous organization extends its boundaries into other corporations and institutions.

## **5. Virtual organization**

The concept of the amorphous organization does not imply that the individual company is boundaryless. The concept of the virtual company seems to go one step further. It suggests a new dimension of project organization. Projects may involve many partners that are coordinated contractually rather than hierarchically. They may even be informally coordinated by a “lead corporation”.

Each partner specializes in his own specific skills and knowledge. The partners are brought together in an ever-changing process according to the special requirements of the markets at a specific point in time. The partners may be self-employed specialists or may be big firms. The self-employed specialists may, after completion of one project, decide to seek another job challenge as a skilled employee.

## **6. Discussion**

While the different theories of human resource management are mutually exclusive, the management concepts are obviously not. Taken together, one can derive from them some elements of a theory which captures the stylized facts of work life in the 21st century. These are:

- constantly changing jobs with constantly changing demands on individual brains
- ever-changing projects with ever-changing demands on the combination of brains
- heterogeneous workforce composed of individual brains
- network of information on brains inside and outside the company
- high willingness of people with brains to change jobs
- high readiness of firms to let people go and to hire people on the outside market or to employ them as self-employed professionals on a contractual basis.

So let us now try to formalize these concepts.

## **V. A FORMAL CONCEPT OF MANAGING BRAINS**

### **1. The classical assignment problem**

We proceed from the well-known job assignment problem<sup>4</sup>. It can be represented by the following figure (figure 1).

The figure shows a firm with  $n$  activities (tasks) and  $m$  employees. Each employee has been tested for his aptitude to fulfill the demands of a

particular activity. The efficiency of each person for each of the activities is given in the efficiency matrix. The problem is then formulated in the following model ( $m = n$ ).

Maximize the overall efficiency of the firm

$$(1) \quad \max D = \sum_i^n \sum_j^m d_{ij} x_{ij}$$

We assume that all  $d_{ij}$  are positive.

The objective function (1) is maximized subject to

$$(2) \quad \sum_i^n x_{ij} = 1 \quad \text{for all } j$$

Equation (2) guarantees that each employee is assigned to one activity only.

$$(3) \quad \sum_j^m x_{ij} = 1 \quad \text{for all } i$$

Equation (3) makes sure that each activity is assigned to one employee only.

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<sup>4</sup> See Sasieni, Maurice; Yaspın, Arthur; Friedman, Lawrence: Modelle und Probleme der Unternehmensforschung – Operations Research, Würzburg, 1962, chapter 8.

$$(4) \quad x_{ij} = \begin{cases} 0 \\ 1 \end{cases}$$

Equation (4) expresses the logical alternative: The assignment decision is either yes or no.

We call this model the internal labor market problem with no complementarity. Total efficiency of the firm is the sum of all the individual efficiencies on the individual jobs.

## 2. The extended assignment problem

We now turn to the combination of internal and external labor markets in managing brains. This is done by adding to the classical assignment problem a set of additional activities and a set of potential employees to be hired for the activities of the firm. The firm is now represented by figure 2. The extended model is formulated as follows.

Maximize total efficiency of the firm

$$(5) \quad \max D = \sum_i^n \sum_j^m d_{ij} x_{ij} + \sum_i^n \sum_j^M (d_{ij} - a_{ij}) x_{ij}$$

s. t.

$$(6) \quad \sum_i^n x_{ij} = 1$$

Each actual employee can only be assigned to one activity or one activity within a project.

$$(7) \quad \sum_i x_{iU} = 1$$

Each potential employee can only be assigned to one activity or one activity within a project.

$$(8) \quad \sum_j x_{ij} + \sum_J x_{iJ} = 1$$

Each activity (in the firm or in a project) can only be carried out by one inside or one outside employee.

$$(9) \quad x_{ij}, x_{iJ} = \begin{cases} 0 \\ 1 \end{cases}$$

The assignment decision can only be yes or no.

We assume  $d_{ij} > 0$ ,  $(d_{iJ} - a_{iJ}) > 0$  with  $a_{iJ}$  the costs of integrating outsiders in the firm through hiring and training.

$a_{iJ}$  includes also the costs of testing for the efficiency of an individual on a particular activity. Testing reduces the uncertainty about the efficiencies of outsiders for a given activity. We thus assume an information asymmetry about the efficiencies of insiders and outsiders for a given activity.

If  $n = m + M$ , then clearly all inside and outside employees are hired. If  $n < m + M$ , inside employees compete with outside employees for the job activities and projects. The model assumes zero layoff costs. However, it poses no mathematical problem to also include costs of laying off employees. If the activities vector changes constantly, the efficiency matrix has to be adjusted constantly resulting in frequent reassignments of inside and outside employees to the changing activities. Reassignment of workers to activities is done at zero cost.

We will call this model the internal and external labor markets model. The boundaries of the firm are defined by the integration costs of outside employees only. Managing brains means optimizing the assignment of inside and outside employees to the pre-defined activities of the firm. It is assumed in this model that complementarity is zero.

### **3. The extended assignment problem with complementarities**

We now introduce the idea of a flexible project organization into the extended assignment model. A flexible project organization is defined here by

- competition between activities and projects for brains
- complementarity of activities within projects.

The model structure is given in figure 3.

The formal model is given below.

### Setting

$$(10) \quad d^*_{ij} = d_{ij} - a_{ij}$$

and defining a complete team hired from the market by  $x_{ip}$  with  $i$  the index of activities within the projects and  $P$  the index of the project ( $P=1, \dots, P^*$ ) and with  $\alpha > 1$  the complementarity factor, we have for the profit function

$$(11) \quad \max D = \sum_{ij} d_{ij} x_{ij} + \sum_{i,j} d^*_{ij} x_{ij} + \sum_{i,k} d^{\alpha}_{ik} x_{ik} + \sum_P d_P x_P.$$

Total efficiency is the sum of the efficiencies of the inside employees in corporate activities, the efficiencies of the outside employees assigned to corporate activities, the efficiencies of the inside employees assigned to projects, the efficiencies of the outside employees assigned to projects, and the efficiencies of external project teams.

The profit function (11) is maximized subject to

$$(12) \quad \sum_i x_{ij} = 1$$

All inside employees can only be assigned to one activity.

$$(13) \quad \sum_i x_{ij} = 1$$

All outside employees can only be assigned to one activity.

$$(14) \sum_i x_{ip} = Z_p$$

All outside project teams can only be assigned to one project.  $Z_p$  is the number of activities within a project  $P$ .

$$(15) \sum_j x_{ij} + \sum_j x_{ij'} + \sum_k x_{ik} + \sum_p x_{ip} = 1$$

Each activity  $i$  in a corporate activity or in a project activity can be carried out by one person (inside or outside employee) or one project team only.

The (0,1)-condition holds for all the  $x$ .

This model is called the generalized assignment model with project complementarity and a market for project teams. Indeed, there are start-up firms today on the internet that create market places for project teams.

Here we assume that complementarity is defined by a complementarity factor  $\alpha$  which is independent of the kind of project. This is done for simplicity's sake only. It would not change the model substantially if we

introduced a project specific complementarity factor  $\alpha_i$ . It would be more difficult, however, if the complementarity effect depended on the combina-

tion of outside or inside employees in a project team. This would require a combinatorial approach to the problem.

## VI. CONCLUSION

The extended assignment model is a straightforward (0,1)-model of linear programming. It captures all the salient stylized facts like mobility within the firm and between firms, flexible project organization and complementarity of efficiency gains in project teams. The network characteristics of managing brains have been formulated in the LP-model. The dynamics of the network effects have, however, not been formulated explicitly. It is assumed here that the dynamics of the market place are expressed by changes in the activity vector and in the composition of the inside and outside labor markets.

The model clearly shows that managing brains means an assessment of the individual and his or her brains as it relates to activities and projects carried out or considered to be taken up by the firm. The mobility costs of inside and outside employees have been modeled here in a very simple way: by setting the firing costs equal to zero and by defining the hiring costs by  $a_{ij}$ . Thus hiring costs differ from individual to individual and from

activity to activity. It would not be a great problem to formulate a model with firing costs<sup>5</sup>.

In conclusion I submit that the human resources management problems of tomorrow do not require analytical tools which are completely new. Traditional and well-known methods of integer linear programming are well suited to cope with these problems in a rigorous fashion. Managing human resources in the 21st century will be done by using familiar methods.

The extended assignments model clearly specifies the tasks that await human resource management in the 21st century:

- Keep in close touch with marketing management for upcoming opportunities and projects.
- Maintain an inventory of outside brains.
- Keep in direct touch with outside brains in order to assess constantly their availability.
- Maintain an individualized inventory of the knowledge base of inside brains and assess their efficiency on different projects and opportunities.

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<sup>5</sup> To the objective function would be added a firing variable  $x_j^f$  with firing costs  $b_j$ :  $-\sum_j b_j x_j^f$ . A constraint  $x_j + x_j^f = 1$  guarantees that the inside employee  $j$  is either kept ( $x_j = 1$ ) or fired ( $x_j^f = 1$ ).

- Maintain an individualized inventory of the knowledge base of outside brains which may help in the assessment of their efficiency in upcoming projects.
- Develop training programs for outside brains that help reduce the costs of integration.
- Develop job descriptions that are broad and flexible enough to reduce the costs of moving inside brains from an activity to a project and from a project to another project or activity.

These are by no means traditional and well-known tasks for human resource management.

Assessing the knowledge base of individuals and their efficiency on actual and potential projects is not an easy job. Large national and international development agencies that work with a large number of outside consultants have some experience how to manage this problem. Experience shows also that large corporations have tapped the networks of outsiders like professors of management or consultants in order to identify brains in their own company because they did not manage their own stock of brains well.

Including in the network of human resource management so-called centers of excellence for recruiting excellent brains has become an important task of company-university relationships. These will be extended to maintaining close ties with various alumni associations as a source of brains. Presently we witness the growth of start-up internet firms that spe-

cialize in serving companies and alumni associations alike in managing such networks.

The development of corporate universities is another sign of the emerging function of human resource management to assess the knowledge base of individuals and of the company as a whole. Job-related cases and project-oriented group work in these courses help to assess the efficiency of task-related brains.

Careers will be structured less along vertical lines of responsibility but rather along lines of internal widening of the individual knowledge base and of improving the flexibility and speed of tapping the collective knowledge base for action on opportunities. Human resource management will include following the tracks of employees that have left the company for another job outside the firm (salaried or self-employed) so that they may be hired again when a challenging new opportunity arises. Consequently, trade unions will no longer represent employee interests and will lose their role as labor contract intermediaries.

Benchmarking efficient evolutionary name card management may even become a systematic part of human resource management within the larger context of managing a network of brains for corporate success.

Summing up I would like to stress that in my view measuring the elements of the efficiency matrix and keeping them up to date will not only be a central problem of human resource management in the future; it will

also pose great challenges for the science of management in the 21st century.

I am sure, this model will become a widely used tool of human resource management in the 21st century.

Thank you.

