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E-Recruiting Technology Investment for Fixed Recruiting Cost Reduction

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ABSTRACT

In this paper, a mathematics-based economic decision model for e-recruiting technology investment is introduced to evaluate the economic impact of various e-recruiting technologies. A classical economic order quantity (EOQ) model was extended to include costs uniquely associated with recruiting activities such as staffing and coordination costs. We derive a minimum employment level for an optimal investment in e-recruiting technologies. The model suggests that the optimal investment cost increases rapidly near the minimum number of employees to be recruited, but the growth of the optimal e-recruiting technology investment cost slows down as the total number of employees to be recruited becomes greater than the minimum number of employees to be recruited.

1. INTRODUCTION

To capture the ever-increasing job seekers in the online labor market, a variety of business-to-labor market (B2L) e-recruiting sources have been introduced since mid-1990s. Some of the widely applied B2L e-recruiting sources include general-purpose job board (e.g., Monster.com; HotJobs.com), niche job board (e.g., JournalismJobs.com; MarketingJobs.com), e-recruiting application service provider (e.g., Recruitsoft; Brassring), hybrid (on-line and off-line) recruiting service provider (e.g., New York Times; Wall Street; Chronicle of Higher Education), e-recruiting consortium (e.g., DirectEmployers.com; NACElink), and corporate career web site (e.g., Cisco; IBM).

Since the introduction of e-recruiting sources in the mid-1990s, a large body of literature has provided anecdotal and descriptive evidence of the effectiveness and efficiency of e-recruiting systems. However, a great risk lies in the over-investment in e-recruiting technologies misled by industry hypes as we have witnessed in the dot.com boom and bust. As most large companies have come to view e-recruiting technology as a resource critical to the success of their recruiting strategy, what is needed urgently is the development of a sound decision model of e-recruiting technology investment. In practice, in order for HR managers to secure budgets for investment in e-recruiting technologies, they must justify the return-on-investment in e-recruiting investment to the senior management who place much emphasis on the corporate bottom line. A decision model of e-recruiting technology investment can help them to rigorously evaluate various e-recruiting alternatives and to gain insights into the economic tradeoffs associated with e-recruiting investment.

This paper complements the body of literature on IT evaluation methodologies by presenting an economic e-recruiting investment model. The base for our analytical model is the classic economic order quantity (EOQ) model widely used in manufacturing and inventory management. Since critical differences exist in cost components and cost functions between the classic EOQ model and the recruiting decision model, we expanded the EOQ model to take into consideration cost components that are unique to the recruiting decision-makings. The expanded model allows us to determine the optimal number of employee to be recruited per recruiting cycle, timing of the employment, and the optimal level of investment in recruiting technologies that minimizes the total recruiting cost.

This study proceeds as follows: Section 2 discusses the economic recruiting decision model for determining the optimal number of employees to be recruited per recruiting cycle and the timing of recruiting. Section 3 presents an economic decision model for e-recruiting technology investment and analyzes the relationships between various model parameters and cost performances. Finally, Section 4 concludes with managerial implications.

2. AN ECONOMIC RECRUITING DECISION MODEL

In this section, we introduce an economic recruiting decision model and examine relationships between the model parameters and the optimal number of employees to be recruited. The economic recruiting decision model presented here is based on the cost minimization in staffing model of Dyl and Keaveny (1983). Dyl and Keaveny (1983) presented an analytical model for staffing decisions made by human resources professionals. Their model provided a framework for estimating the optimal size of employment during an employment-planning horizon. Their model explicitly considers overstaffing and understaffing costs and a tradeoff between them. Overstaffing reduces overtime cost at the expense of underutilized labor forces. On the other hand, understaffing incurs overtime cost by overly utilized labor forces. While Dyl and Keaveny assumed that an instantaneous employment of the entire batch of employees takes place at the beginning of the recruiting cycle, we incorporated an on-demand recruiting factor that narrows the timing gap between actual employment and employment needs. The on-demand recruiting factor reflects more reasonably the typical hiring practices of recruiters.

The economic recruiting decision model expands the classic EOQ model. The problem structure of the economic recruiting decision is similar to that of inventory management. While the objectives of these two models are the minimization of total cost, their cost functions and cost components are different from each other. The classic EOQ model

Table 1 Categories of Recruitment Related Costs

Categories of Staffing Cost	
Fixed Recruiting Costs	Development of job specifications
	Development of hiring criteria
	Advertising expense
	Management of recruiting activities
	Recruiter compensation and travel expense
	Sorting candidates
	Planning interviews
	Applicant tracking
Coordination Costs	Checking references
	Identification and processing of hiring needs
	Collecting and processing of job applications
	Prescreening
	Contacts of candidates
	Interviews coordination (phone calls)
	Candidate Visits
	Candidate Feedback
	Contracting
Overstaffing Costs	Excess training expense
	Excess compensation
Understaffing Costs	Overtime compensation
	Lost sales/production opportunities

identifies the optimal order quantity that minimizes the total inventory management cost. Similarly, the recruiting decision model seeks the optimal number of employees to be recruited per recruiting cycle that minimizes total recruiting cost. While the fixed recruiting cost in the economic recruiting decision model is comparable to the setup cost in the EOQ model, the economic recruiting decision model has several unique cost components: overstaffing and understaffing cost, coordination cost, and on-demand recruiting factor. Table 1 lists categories of the recruitment related costs.

The economic recruiting decision model consists of four major recruiting costs: fixed recruiting, overstaffing, understaffing, and coordination costs. The fixed recruiting cost is typically dependent on the recruiting sources. For example, the fixed recruiting cost incurred by traditional newspaper advertising and recruiting agencies are generally more expensive than that of job boards and corporate career web sites. The coordination cost is dependent on the business process. Overstaffing and understaffing costs per employee are relatively constant due to the requirement of the labor contract.

The economic recruiting decision model is based on a number of assumptions. It is assumed that the initiation of each recruiting cycle incurs a certain fixed recruiting cost. The overstaffing occurs when the number of hired employees is higher than that of employees needed for business operations. The overstaffing cost is derived from the underutilized labor portion of the total salaries paid to employees. The understaffing occurs when the number of hired employees is lower than that of employees needed for business operations. The understaffing cost is derived from the overtime costs of the employees who were assigned to the overtime work. Due to inflexibility in the labor market and constant changes in the business environment, a company is typically in either an overstaffing or understaffing situation during most of the time. The total overstaffing and understaffing costs are linearly related to the average number of overstaffed and understaffed employees during the planning period, respectively.

The economic recruiting decision model also assumes that the total number of new employees to be hired is known and constant. While certain groups of employees hired by a company do not have a regular employment pattern, the majority of employees generally follows a standard recruiting process and accounts for most of the recruiting related costs. For the majority of employees, the annual turnover rate, growth of labor forces, and related labor costs can be estimated in advance and reflected in the annual budget and recruitment plan. Next we introduce a nomenclature used throughout this paper and discuss a model formulation.

Nomenclature

C_e=annual cost of overstaffing per new employee ($/employee/period)
C_s=annual cost of understaffing per new employee ($/employee/period)
t_e=time period of excessive employment stated as a fraction of a planning period T
t_s=time period of labor shortage stated as a fraction of a planning period T
t_e+t_s=one recruiting cycle
N = the number of employment per recruiting cycle
N^*= the optimal number of employment per recruiting cycle
N_e^*= the optimal number of excessive employees (overstaffing) per recruiting cycle
$N_e/2$=the average number of excessive employees (understaffing) in a recruiting cycle
$(N-N_e)/2$=the average number of excessive employees in a recruiting cycle
C_a=a fixed recruiting cost per recruiting cycle
C_c=a coordination cost per new employee during planning period T
E=the number of annual new employees
o=daily turnover rate
r=daily recruiting rate
è=on-demand recruiting factor

$$\theta = \left(\frac{r-o}{r}\right) = 1 - \frac{o}{r}, \quad 0 \le \theta \le 1$$

T=planning period (assumed to be one)

Model Formulation

Mathematically, the recruiting cost per recruiting cycle is defined as follows:

$$RC = C_e t_e (N_e/2)\theta + C_s t_s ((N - N_e)/2)\theta + C_a + C_c N \qquad (1)$$

Then, the total recruiting cost of new employees during a planning period is derived by:

$$\text{Min } TRC = \frac{C_e N_e^2 T\theta}{2N} + \frac{C_s (N-N_e)^2 T\theta}{2N} + \frac{C_a E}{N} + C_c E \qquad (2)$$

If the first derivative of Equation (2) is taken with respect to N_e, set it equal to zero, and solved, we have an optimal N_e^*.

$$N_e^* = N\frac{C_s}{(C_e + C_s)} \qquad (3)$$

By substituting N_e^* in TRC, taking the first derivative of Equation (4) with respect to N, setting it equal to zero, and solving, we have an optimal number of employees N^* to be recruited per recruiting cycle.

$$\text{Min } TRC = \frac{C_e N\left(\frac{C_s}{C_e + C_s}\right)^2 T\theta}{2} + \frac{C_s N\left(\frac{C_e}{C_e + C_s}\right)^2 T\theta}{2} + \frac{C_a E}{N} + C_c E \qquad (4)$$

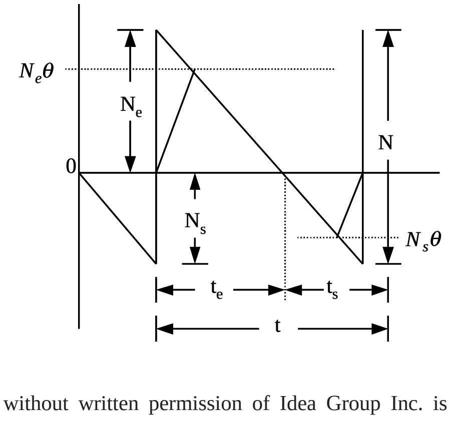
$$N^* = \sqrt{\frac{2C_a E(C_e + C_s)}{C_e C_s \theta}}, \text{ (Planning period } T = 1\text{).} \qquad (5)$$

Figure 1 depicts overstaffing and understaffing of employees and the impact of an on-demand recruiting factor ¸ on the number of overstaffing and understaffing of employees. When all the employees to be hired per recruiting cycle are employed at the same time (i.e., instantaneous employment), the on-demand recruiting factor ¸ is equal to one. As employees are employed at a time close to the time when they are actually needed, the on-demand recruiting factor ¸ approaches to zero. When the on-demand recruiting factor ¸ reaches zero, the timing of actual employments matches exactly that of the hiring needs and the overstaffing and understaffing costs are equal to zero.

Example

Consider the following recruiting situation. Based on a historical turnover rate and growth plan, a company predicts that the number of new employees to be hired annually is 500. No matter how many employees are recruited, a fixed recruiting cost is incurred per recruiting

Figure 1 Staffing of Employees and On-Demand Recruiting Factor



cycle. There is a tradeoff between the frequency of recruiting cycles and staffing costs. As the number of recruiting cycles during a planning period increases, the fixed recruiting cost increases linearly and staffing cost decreases.

The recruitment lead-time and the timing of the recruiting initiation determine the overstaffing and understaffing costs. The overstaffing cost is incurred when the hired employees are not fully utilized due to excessive labor forces. The understaffing incurs a certain overtime cost when a labor shortage forces existing employees to work overtime to meet production schedules. When overtime is not used, the understaffing cost may be estimated from the lost sales opportunities. The coordination cost is variable and dependent on the total number of new employees to be hired. The company needs to find the optimal number of employees to be recruited per recruiting cycle during a planning period that minimizes the total recruiting cost. The following parameters are assumed for this example:

Model Parameters

C_e=$5,000/employee to be hired/planning period
C_s=$6,000/employee to be hired/planning period
C_a=$1,000/recruiting cycle
è=1.0
C_c=$1,500/employee to be hired/planning period
E: 500/planning period

The straightforward applications of Equations (3), (4) and (5) lead to the following optimal solutions:

N^*=19
N_e^*= 10
TRC^*=$802,224.88

Figure 2 (a) and (b) show the relationships between the optimal number of employees to be hired per recruiting cycle and on-demand factor and fixed recruiting cost. As can be seen from Figure 2 (a) and (b), on-demand factor and fixed recruiting cost affect the optimal number of employees per recruiting cycle in the opposite direction in minimizing the total recruiting costs, respectively. The decrease of on-demand factor has an effect of reducing the average number of employees to be hired during the planning period and reducing total overstaffing and understaffing cost. On the other hand, the reduction of the fixed recruiting cost makes the decrease in the number of employees to be hired per recruiting cycle more attractive.

Figure 2 (a) Relationship between On-Demand Recruiting Factor and Optimal Number of Employees

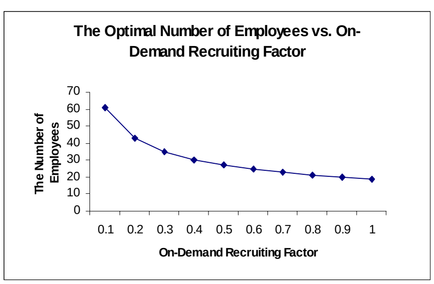
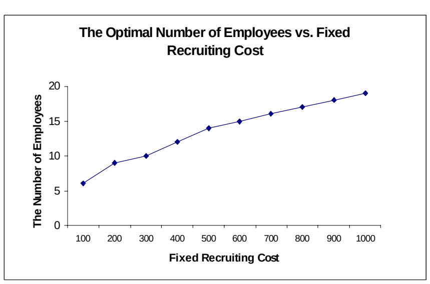


Figure 2 (b) Relationship between Fixed Recruiting Cost and Optimal Number of Employees



The reduction of the fixed recruiting cost and on-demand recruiting factor, ceteris paribus, decreases the total recruiting cost, respectively. While the economic recruiting decision model is a useful tool as a human resource planning and recruiting, it does not address the investment decisions that can effect the change of parameter values of fixed recruiting cost and on-demand recruiting factor in the decision model. We address these questions in the following section.

3. AN ECONOMIC DECISION MODEL FOR E-RECRUITING TECHNOLOGY INVESTMENT

In this paper, we define *e-recruiting as a company-wide recruiting activities and practices that utilize a variety of electronic means throughout the entire recruiting process*. In the past decade, companies have invested heavily in e-recruiting technologies to reduce the recruiting cost and improve the recruiting process. While a body of literature has shown the cost-effectiveness and efficiency of the e-recruiting technologies, these studies presented descriptive results at best, and the tradeoff between investment costs and benefits has not been formally investigated. Studies of corporate IT investment show that most business organizations overspend in IT technologies, but rarely achieve superior financial returns (Carr [2003]). To complement the deficiency of the existing body of literature, we present an economic decision model for e-recruiting technology investment and analyze the relationship between an investment in the e-recruiting technologies and the total recruiting cost. The economic decision model for e-recruiting technology investment allows us to identify the condition under which a company would be better off with the e-recruiting investment and to gain insights into the reasons individual companies make different investment decisions in the e-recruiting systems.

Investment in Recruiting Fixed Cost Reduction

In the previous economic recruiting decision model, the fixed recruiting cost C_a was assumed to be constant. In this section, we assume that the C_a is an exponential function with a base e where an e-recruiting investment cost of S reduces the fixed recruiting cost. Billington (1987) suggested a similar exponential function with base e to determine the optimal investment cost for the reduction of setup costs in the classic EOQ model. Porteus (1985) suggested an EOQ model to study optimal investment in setup cost reduction for the cases of both a logarithmic and a power setup cost function. In this paper, Equation (2) is extended to include investment cost of S, resulting in Equation (6).

$$\text{Min} \quad TRC = \frac{C_e N\left(\frac{C_s}{C_e + C_s}\right)^2 \theta}{2} + \frac{C_s N\left(\frac{C_e}{C_e + C_s}\right)^2 \theta}{2} + \frac{C_a E}{N} + C_c E + S \qquad (6)$$

An exponential investment function for the reduction of C_a is defined in Equation (7).

$$C_a = L + (H - L)e^{-\lambda S}, \ S \geq 0 \qquad (7)$$

where H is the highest fixed recruiting cost incurred when there is no investment in e-recruiting technology and L is the lowest fixed recruiting cost achievable by the investment of S.

To derive the optimal solution for the technology investment, the first derivative of Equation (6) is taken with regard to S and set to zero, and solved. The result is given by

$$\frac{\partial TRC}{\partial S} = \frac{C_a' E}{N} + 1 \qquad (8)$$

$$\frac{\partial C_a}{\partial S} = -\frac{N}{E} \qquad (9)$$

The first derivative of Equation (7) is taken with regard to *S*. The result is given by

$$\frac{\partial C_a}{\partial S} = -\lambda(H-L)e^{-\lambda S} = -\lambda(C_a - L) < 0 \qquad (10)$$

Setting Equation (9) equal to Equation (10) and substituting Equation (5) for *N* in Equation (11) yields Equation (12). Then, by solving Equation (12), we derive the optimal fixed cost C_a* from Equation (13).

$$-\frac{N}{E} = -\lambda(C_a - L) \qquad (11)$$

$$\lambda E(C_a - L) = \sqrt{\frac{2C_a E(C_e + C_s)}{C_e C_s \theta}} \qquad (12)$$

$$C_a{*} = d + \sqrt{d^2 - L^2} \qquad (13)$$

where

$$d = L + \frac{(C_e + C_s)}{C_e C_s \theta \lambda^2 E} \qquad (14)$$

Given the optimal fixed recruiting cost C_a^*, then optimal investment S^* and N^* are derived from Equations (15) and (16), respectively.

$$S{*} = \frac{\left(\ln \frac{(C_a{*} - L)}{(H-L)}\right)}{-\lambda} \qquad (15)$$

$$N{*} = \lambda E(C_a{*} - L) \qquad (16)$$

To identify the minimum number of employees to be recruited during a planning period for the optimal investment, Equation (13) is set less than or equal to *H* and solved, resulting in Equation (17). Note that the minimum employees to be recruited can be derived from Equation (17) without the optimal solutions. Therefore, $\frac{2(C_e + C_s)H}{C_e C_s \theta \lambda^2 (H-L)^2}$ can serve as a threshold value for investment decision-makings.

$$E \ge \frac{2(C_e + C_s)H}{C_e C_s \theta \lambda^2 (H-L)^2} \qquad (17)$$

Analysis of E-Recruiting Investment: Example
Base Parameters

C_e=\$5,000/planning period
C_s=\$6,000/planning period
H=\$1,000
L=\$200
F=1.0
G=0.1
W=\$1,500
Z=\$1,000
ë=0.0001
â=0.0001
=0.00003
Base C_a=\$1,000
Base *è* =1.0
Base C_c=\$1,500

Total recruiting cost with no investment in recruiting technology: \$802,224.88

÷ Using Equation (17), the minimum number of employees to be recruited for the investment in the reduction of fixed recruiting cost is given at 115. At an employment level of less than 115, no optimal investment cost can be found. Both no investment and optimal investment incur approximately the same total recruiting cost at 115 employees to be recruited. As the total number of employees to be recruited is near the minimum employment level of 115, the investment cost increases rapidly. However, as the total number of employees to be recruited increases, the growth rate of the investment cost slows down. On the other hand, the savings in the total recruiting cost increases linearly, as the total number of employees to be recruited increases.

4. DISCUSSIONS AND CONCLUSION

Currently, most large business organizations are operating their own career web sites to give detailed job information, to explain the culture and benefits, and to promote a long-tem relationship with job seekers. However, despite this popularity of e-recruiting, there are yet no significant statistics available on the return-on-investment of the various e-recruiting technologies and the effectiveness of management practices.

To complement the body of studies that are mostly descriptive in nature, we presented two analytical recruiting decision models that are based on the classic EOQ models used in inventory management areas. The first model serves as a decision support tool that helps HR professionals make a decision on the optimal number of employees to be recruited and the timing of recruiting initiation that minimize the total recruiting cost. The second decision model extends the first model by considering an optimal investment in e-recruiting technologies in addition to the decisions considered in the first model. The second model gives managers insights into why individual companies make different investment decisions in the e-recruiting systems. We analyzed the optimal investment decisions based on four major cost components: fixed recruiting cost, on-demand recruiting factor, and overstaffing and understaffing costs. While we used an exponential function with a base *e* as a form of investment functions, other functional forms can be easily applied to the model and the optimal investment decisions can be made readily with the help of computer software such as spreadsheet software.

Our analysis suggests that in general, higher employment levels will result in larger optimal investment costs but with a larger cost savings. For example, companies with an expansion plan or a large turnover are likely to enjoy greater investment opportunities. An investment cost function becomes similar among companies due to standardization and componentization of the e-recruiting technologies. Therefore, individual companies' particular recruiting cost structure and employment needs are likely to create different investment opportunities for each company.

To the best of our knowledge, our study is the first effort in developing e-recruiting investment decision models and analyzing the impact of the e-recruiting technologies on the corporate cost savings. This study provides valuable insights into the benefits and costs associated with the investment in the e-recruiting technologies. With the proposed decision model and other complementary decision factors in mind, managers will be able to make a better investment decision. In a nutshell, achieving a strategic advantage from the e-recruiting systems lies not in the lavish investment in technologies, but in the superior management of e-recruiting technologies and processes.

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