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ABSTRACT

The purpose of this study is to introduce CoP reward allocation (COREA) system that efficiently solves a mathematical optimization problem to optimally allocate limited financial reward and to promote knowledge sharing activities in CoPs. To test the validity and usefulness of COREA, we simulate three knowledge sharing climates in which the majority of CoPs performs below-, on-, or above-average. In addition, we also allow knowledge sharing activity of CoPs to improve or deteriorate over years in each climate. Our experimental results confirm that the proposed COREA system performs significantly better than the currently available reward system over various scenarios. In particular, the COREA system finds approximately optimal financial reward allocations for many cases in which the current reward system fails to find solutions that meet constraints.

Keywords

Communities of Practice, knowledge management, financial reward, reward allocation

INTRODUCTION

As the CEO of HP Lew Platt once lamented as "if HP only knew what HP knows", underutilized knowledge is often regarded as one of the largest hidden costs in organizations. This means that much of the knowledge that organizations needed exists inside the organization but organizations often do not know what they know and have weak systems for locating and retrieving knowledge that resides in them. Therefore, many organizations have adopted various types of knowledge management systems (KMS) based on databases, information technologies, and other communication media to cooperatively integrate business processes and cross-functional activities with some success (Malhotra, 1999). While most of KMS systems are suitable to facilitate the knowledge management processes such as the process of capturing, storing, sharing, and using knowledge (Davenport and Prusak, 1998), they are not designed to facilitate knowledge sharing processes such as encouraging the willingness of individuals to share tacit knowledge that cannot be easily captured and stored in KMS (Nonaka and Konno, 1998). Therefore, more organizations start to pay attention to an informal and self-organizing network structure of employees to share or exchange knowledge, Communities of Practice (CoPs), as an alternative to IT-centered KMS (Brown and Duguid, 1991). Even further encouraging knowledge sharing activities in CoPs, these organizations start to strategically manage and support activities of employees in CoPs (Stock and Hill, 2000; Shan and Dorothy, 2003) with extrinsic rewards (e.g., financial reward) based on performance evaluation criteria (Leonard-Barton and DeSchamps, 1998).

In this study, we present CoP reward allocation (COREA) system that efficiently solves a mathematical optimization problem to optimally allocate limited financial reward and to promote knowledge sharing activities in CoPs. Based on a real CoP reward system in Company A, we compare the proposed reward system with the currently used reward system in terms of budget spending rate (= the proportion of the budget actually spent for rewards) and reward ratio (= the proportion of rewarded CoPs). In general, solutions with higher budget spending rates are preferred (i.e., 100% is the perfect score) and all solutions should meet a minimum reward ratio (say, 15%). To make our research problems more realistic and draw meaningful insights, we consider three types of organizational knowledge sharing climates in which the majority of CoPs performs below than average (immature culture), on average (pre-mature culture), and above average (mature culture), respectively. In addition, for each organization culture scenario, we consider five cases to allow the activity evaluation scores of CoPs to improve (+5% and +10% changes), deteriorate (-5% and -10% changes), or remain same (0% change) compared with those in the previous year.

This paper is organized as follows. We first briefly review KMS and CoPs in Section 2. Then we describe a research problem as a mathematical optimization problem and introduce our simulation model to simulate various organizational cultures to host CoPs in Section 3. In Section 4, we explain our heuristic algorithm to solve problems and present the prototype of CoP reward allocation (COREA) system. In Section 5, we present experimental outputs from simulated scenarios and interpret managerial insights. Finally, Section 6 provides conclusions and suggestions for future research.

COP EVALUATION AND REWARD FOR PROMOTING KNOWLEDGE SHARING ACTIVITY

Knowledge Management Systems and Communities of Practice

The ultimate goal of knowledge management system (KMS) is to effectively facilitate information processing, communication, and knowledge sharing processes and to improve the organizations' competency (Lee, 2001). However, it is still difficult to capture a tacit knowledge which is the basis of individuals' competitive advantage and remains in individuals' internal side (Nonaka, 1994). In addition, it was revealed that knowledge sharing from person to person is preferable through a KMS (Gray and Durcikova, 2005). Note that while knowledge management processes include the process of capturing, storing, sharing, and using knowledge (Davenport & Prusak, 1998), knowledge sharing focuses on the willingness of individuals to share knowledge with others and hence cannot be forced but can only be encouraged (Nonaka and Konno, 1998).

Communities of Practice (CoPs) have been considered a valuable tool to supplement the traditional IT based approaches to knowledge sharing by providing a suitable environment to share or exchange knowledge (Zboralski, 2009). CoPs often involve voluntarily sharing joint working practices and a spirit of mutual community for improving the activity of the participants (Brown and Duguid, 1991; Lesser and Prusak, 2000). For example, Wenger and Snyder (2000; *Italics added by the authors*) defined a CoP as "*groups of people informally bound together by shared expertise and passion for a joint enterprise*." While the self-organizing and informal characteristics of CoPs have been virtually intact, more and more companies are starting to recognize strategic usability of CoPs to share tacit knowledge among employees and hence to adopt CoPs as a new tool to supplement KMS (Stock and Hill, 2000; McDermott, 1999).

CoP Evaluation and Reward

Note that the main purpose of a CoP of employees with different expertise levels is to exchange knowledge from employees with a high expertise level to employees with a low expertise level. As more companies are building and managing CoPs as a core tool for KMS, several researchers studied how to measure and assess the performance of CoPs (McDermott, 1999; Verburg and Andriessen, 2006). However, more studies are needed to develop appropriate organizational reward systems to encourage knowledge sharing activities in CoPs (Bartol and Locke, 2000). In addition, these reward systems should be supplemented with well-conceived action plans, budget supports, and performance evaluation criteria (Leonard-Barton and DeSchamps, 1998). When all the components are in place, it becomes possible to enjoy the benefits of sharing valuable assets embodied in the form of experiences, skills, know-hows, and beliefs of employees.

While several social behavior theories—social exchange theory (SET), expectancy theory, social capital theory (SCT), and public goods theory—are often adopted to explain knowledge sharing behaviors of organizational members, we narrow down our focus on an organizational reward system that is supposed to provide extrinsic rewards to ensure high-quality contributions from experienced experts. In addition, the appropriately implemented reward systems with extrinsic rewards (e.g., financial rewards) are expected to motivate individuals to share various information across groups and actively collaborate with others (Deci, 1971).

PROBLEM SPECIFICATION AND RESEARCH METHODOLOGY

Problem Specification

Company A is one of the largest steel manufacturing companies in the world and it has recognized the importance of knowledge sharing among employees since 1999. In particular, the company adopted CoPs as a supplemental tool to KMS since 2006 and has built an infrastructure for the connected social network among employees. Starting with a project of

"Work-Innovation-Learning" for the purpose of creating competitive knowledge and capitalizing knowledge via CoPs, it currently supports 1,600 CoPs and the total number of participants is about 89,000.

In the past, Company A had financially supported CoPs and the amount of financial reward for each CoP was based on its relative ranking among CoPs in terms of its somewhat subjective knowledge sharing activities. Recently, Company A proposed a new CoP evaluation and reward process that is based on more objective performance measurements and changes (e.g., improvement or deterioration) in CoP activities over years. In short, Company A assigns each CoP one of five possible grades (i.e., very high, high, medium, low, and very low (see Table 1)) after aggregating scores of a chosen CoP based on its performance over five main evaluation criteria (i.e., support, working, innovation, learning, and community activities), which are, in turn, measured through a total of 31 detailed evaluation criteria. For example, if a CoP receives a total of 87 out of 100 over five main evaluation criteria, it receives "Premium," the first grade. Then, Company A determines the amount of financial reward based on the reward grid (refer to Table 2) that considers the advancement and maintenance of the CoP grades over two consecutive years.

Grade	Grade Name	Grade Criteria (Total Score)
First (Very high)	Premium	Over 85
Second (High)	Diamond	Over 75
Third (Medium)	Gold	Over 65
Fourth (Low)	Silver	Over 55
Fifth (Very low)	Bronze	Under 55

Table 1. CoP Activity Reward Grid in Company A

While this new CoP evaluation and reward system is a definite improvement from the old system, two main features should be considered carefully. First, the CoP administrator should be very careful to maintain a pre-determined minimum reward ratio (= the number of financially awarded CoPs out of the total number of CoPs) because a low reward ratio may discourage CoP members to actively participate in knowledge sharing activities in CoPs. Second, the CoP administrator should be very careful to make sure that the total amount of rewards does not exceed the budget for financial rewards. This is not an easy task considering the fact that the CoP reward grid and the amount of reward budget are determined and announced in advance, while the amount of financial reward for each CoP is determined after considering its performance over two consecutive years. In particular, in its current proposed reward system, the grades of CoPs of each year are determined by an absolute evaluation scheme, indicating that any CoPs whose performance score (say, 87) is higher than a specified cut-off point (say, 85 for Premium grade) shown in Table 1 will receive the same grade (say, Premium). Therefore, it is very possible that too many CoPs may receive Premium or Diamond grades for two consecutive years, and hence the total reward amount for these CoPs may exceed the pre-assigned reward budget. In such a case, one of the possible solutions for a CoP administrator is to increase a budget already approved, although it is practically impossible to do so. Another possible solution is to decrease the amount of the reward for each cell in the reward grid, which not only discourages knowledge sharing activities of CoP members but also deteriorates the trust level toward the organization.

$\text{Grade}_{(t+1)}$ / $\text{Grade}_{(t)}$	First	Second	Third	Fourth	Fifth
First	$500	-	-	-	-
Second	$400	$200	-	-	-
Third	$300	$200	$0	-	-
Fourth	$0	$0	$0	$0	-
Fifth	$0	$0	$0	$0	$0

Table 2. CoP Activity Reward Grid in Company A

Our solution is to employ a relative evaluation scheme that flexibly changes cut-off points of grades each year while maintaining the same reward amounts of each cell in the reward grid so that the total reward amount is within the reward budget. For this purpose, we present a CoP Reward Allocation (COREA) System that helps a CoP administrator determine CoP grade criteria automatically each year. In the following sections, we conceptualize this problem as a mathematical optimization problem and provide our solutions while assuming three CoP operational environments with a GUI interface to our solution system.

Research Methodology

Mathematical model

We first show our mathematical model to solve the CoP financial reward allocation problem with a relative evaluation scheme in Figure 1. The objective function of the model is to maximize the amount of the rewards distributed to CoPs while satisfying two major constraints: the total reward amount should be within the budget preset and the reward ratio should be higher than or equal to the target reward ratio. There are additional constraints to validate the mathematical model. For example, the score of a CoP in grade *k* should be higher than the cut-off point dividing grades *k-1* and *k*. The cut-off point between grades *k-1* and *k* is higher than the cut-off point between grades *k* and *k+1*. By solving the proposed model based on the solution procedure (refer to the solution algorithm section), the CoP administrator can optimally determine cut-off points of grades that maximize the total amount of rewards for entire CoPs.

$$Max \sum_{ijk} a_{ik} \cdot x_{ijk}$$

$$subject\ to$$

$$\sum_{j}\sum_{k} x_{ijk} = CoP^{t}{}_{i}$$

$$\sum_{i}\sum_{j} x_{ijk} = CoP^{t+1}{}_{k}$$

$$Score_j \geq Cut_k \cdot x_{ijk}$$

$$Cut_{k+1} \leq Cut_k$$

$$\sum_{ijk} a_{ik} \cdot x_{ijk} \leq B$$

$$\frac{\sum_{ijk} y_{ikj}}{N} \geq RR$$

$$\frac{a_{ik} \cdot x_{ijk}}{B} \leq y_{ijk} \leq a_{ik} \cdot x_{ijk}$$

$a_{ik} = Amount\ of\ reward\ when\ grade\ is\ changed\ i\ to\ k$

$$x_{ijk} = \begin{cases} 1, where\ CoP\ j's\ grade\ is\ changed\ from\ i\ to\ k \\ 0, otherwise \end{cases}$$

$$y_{ijk} = \begin{cases} 1, where\ CoP\ j\ is\ rewarded \\ 0, otherwise \end{cases}$$

i : Index of grade at time t

j : Index of CoP

k : Index of grade at time $t+1$

$CoP^{t}{}_{i}$ = Total number of CoPs which belongs to grade i at time t

$CoP^{t+1}{}_{k}$ = Total number of CoP which belongs to grade k at time $t+1$

$Score_j$ = Score of CoP j

Cut_k = Cut-off point of grade k

N = Total number of CoPs

B = Budget

RR = Target reward ratio

Figure 1. Mathematical Model of COREA

Simulation model

In this paper, we also adopt a computer simulation method as another principal analytical tool because of its flexibility to obtain solutions from multiple simulated situations and robustness of obtained solutions and insights (Starbuck, 2004; Kwon, 2007). We carry out three main simulations to validate the robustness of COREA and these simulations are different in terms of knowledge sharing climates of organizations: immature (scenario A), pre-mature (scenario B), and mature (scenario C) climate. Note that the maturity of organizational knowledge sharing climate may affect the dominant knowledge sharing activity levels of CoPs. For example, we posit that more CoPs in an immature organizational climate show a lower level of activities than CoPs in a mature CoP climate in which all CoPs members collaborate actively because they appreciate the benefits of knowledge sharing from their experiences in the past.

In order to create these scenarios, we first generate CoP activity scores, a set of total 1,653 CoPs at time t, using three distributions (i.e., negative skew-normal, normal, and positive skew-normal) with an average μ=70 and a standard deviation σ=10. Next, we generate another set of 1,653 CoP activity scores at time $t+1$, from the same distributions while changing average values to reflect possible changes in activity scores of CoPs between time t (A_t) and $t+1$ (A_{t+1}) since CoP activity scores at time $t+1$ can be improved or deteriorated compared with activity scores at time t. We consider five different change rates ((A_{t+1} - A_t) / A_t) of CoP activity scores: -10%, -5%, 0%, 5%, and 10%. Using these CoP score sets at time t and $t+1$, we like to compare the performance of solutions based on the current reward system (refer to table 2) and COREA in terms of the total amount of rewards, the reward ratio, and the budget spending rate (the ratio of the total amount of rewards to the budget).

COP REWARD ALLOCATION (COREA) SYSTEM

Infrastructure of COREA

We briefly present the overall infrastructure of COREA system and its relationship to other KMS components in Figure 2. The general interactions between COREA system and KMS components are illustrated as follows; ① CoP members continue their knowledge sharing activities via KMS which has been already implemented, ② Accumulated knowledge and experiences are captured from these activities, and they are automatically stored in the KMS database, ③ Stored information in KMS is regularly synchronized with COREA system that maintains the evaluation criteria of CoP activity, the reward grid, and activity scores of all CoPs in the past, ④ CoP administrator uses COREA system to automatically determine the cut-off points to classify and assign grade scores to CoPs, and accordingly determine the amount of rewards while satisfying constraints of the budget and reward ratio, ⑤ COREA system users such as KM Teams and mangers inquire the information of current CoP activities, grades, and rewards, ⑥ Finally, CoP administrator allocates financial rewards to CoPs.

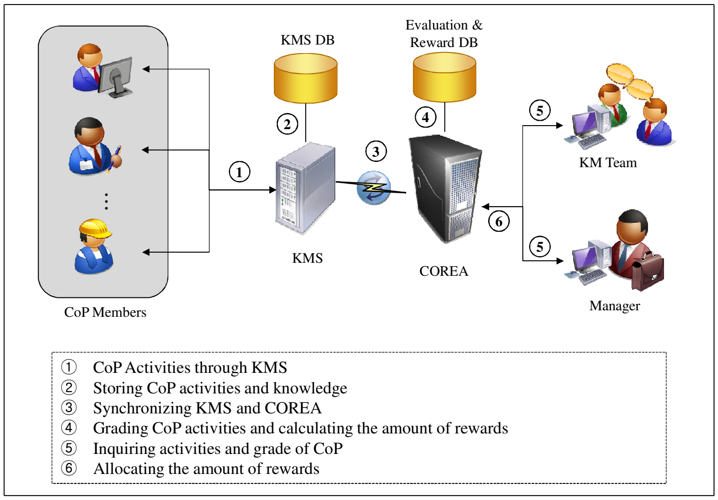


Figure 2. Infrastructure of COREA with KMS

Heuristic Solution Algorithm

Considering the objective and constraints to be met, the mathematical problem in Figure 1 can be considered a special case of knapsack problems (Martello and Toth, 1990). Note that knapsack problems is known to be NP-complete, implying that it is practically impossible to obtain the exact optimal solution within a polynomial time constraint (De Rango et al., 2008). Therefore several techniques such as approximation, randomization, and heuristic algorithms have been proposed to provide an approximately good solution in a polynomial time. We develop our own simple heuristic algorithm to find a feasible solution for COREA system and present it in Table 3.

Pseudo Code

```
S := solution set {cut1, cut2, cut3, cut4, cut5} // current solution
while (true):
    if S is not feasible:
        while (iterations):  // find initial feasible solution
            select cut-off point, direction, degree of change randomly;
            if S is feasible: break; end if;
            if S is improved: update S; end if;
        end while;
    end if;
    N := neighbor sets of S; // greedy algorithm to find approximate optimum
    if no better solution in N than S: break;
    else: update S;
    end if;
end while;
```

Table 3. Pseudo Code

User Interface of COREA

Figure 3 shows the user interface of the COREA prototype. The COREA prototype consists of six modules. The CoP List Module (①) shows the information related to the CoP activity scores and grades at time *t* and *t+1*. The Reward Grid &

Condition Module (②) shows the reward grid, budget, and target reward ratio, which are pre-determined based on the reward policy in a company. Cut-off Points Module (③) consists of two components: "Cut-off Points" and "Apply." "Cut-off Points" shows the current cut-off points (i.e., default solutions) for CoP evaluation, and "Apply" is the component that allows the user to apply the suggested solution. It provides users with a result reflecting the illustrated solution. Thus, users can use this to see the new result after changing the solution manually. Log Module (④) describes a series of results. Users can refer to the log in order to select cut-off points out of multiple candidate solutions. Results Module (⑤) shows the number of CoPs for each cell. Execution Module (⑥) is the component that runs the COREA prototype. It consists of three components: "Run," "Default," and "Close." Users can run the COREA prototype by clicking the "Run" button, and the "Default" button provides users with the default total reward, reward ratio, and number of CoPs in each cell. Finally, users can exit the COREA prototype by clicking the "Close" button.

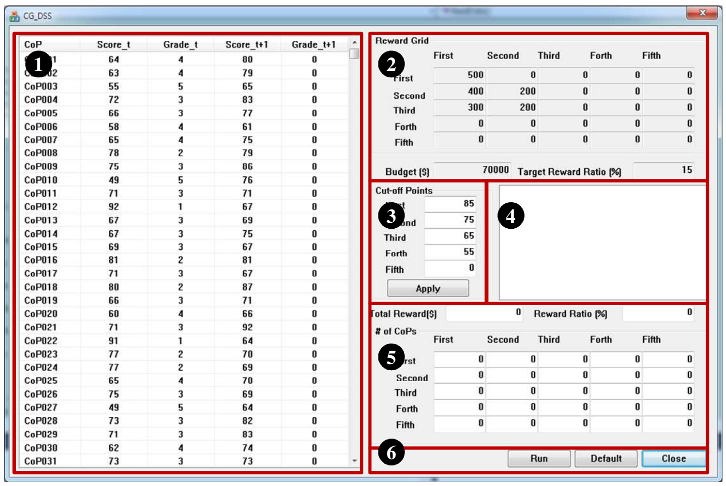


Figure 3. Screen Shot of COREA Prototype

EXPERIMENTAL OUTPUTS

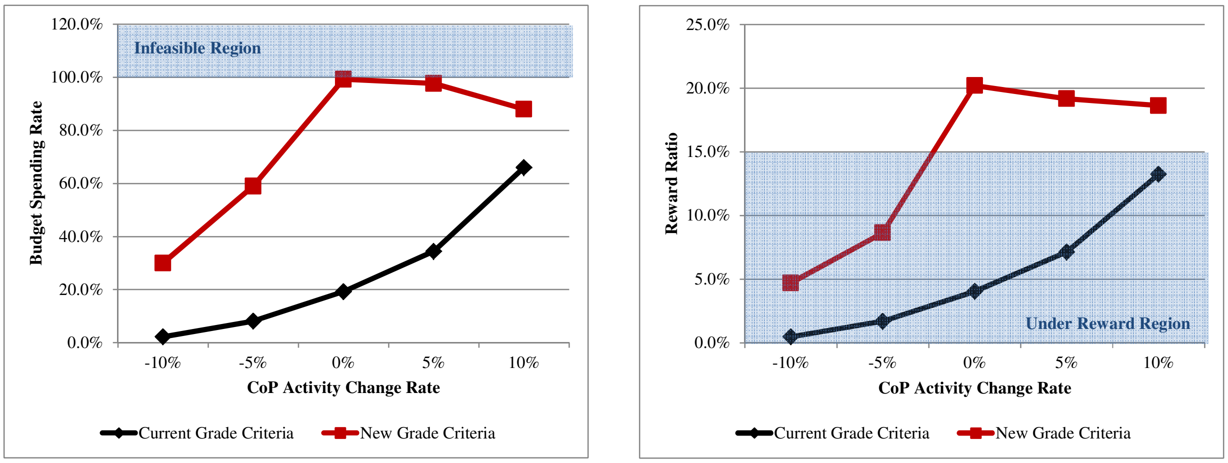
Scenario A: Immature Organizational Knowledge Sharing Climate

In Scenario A, we consider an organization that does not fully develop knowledge sharing culture among CoP members possibly because it takes initiatives to support CoPs activities. In such an organization, we assume that many CoPs under-perform than average while only few CoPs perform excellently and we hence generate CoP activity scores from a negative skew-normal distribution (μ=70, σ=10) while considering five CoP activity change rates (-10%, -5%, 0%, 5%, and 10%) over two years. We present the current system based cut-off points and new grade criteria from COREA in Table 4. Note that the grade criteria of third, fourth, and fifth places from two systems are identical mainly because currently Company A rewards only CoPs whose place is first or second at time $t+1$ (see Table 2). We, however, note that cut-off points for the first and second grade from COREA system are automatically adjusted, getting higher or lower depending on the magnitudes and directions of CoP activity change rates over two years.

Grades	Current Grade Criteria	New Grade Criteria of COREA on CoP Activity Change Rates				
		-10%	-5%	0%	5%	10%
First	Over 85	**Over 70**	**Over 69**	**Over 79**	**Over 79**	**Over 97**
Second	Over 75	**Over 67**	**Over 67**	**Over 66**	**Over 68**	**Over 72**
Third	Over 65	Over 65	Over 65	Over 65	Over 65	Over 65
Fourth	Over 55	Over 55	Over 55	Over 55	Over 55	Over 55
Fifth	Under 55	Under 55	Under 55	Under 55	Under 55	Under 55

Table 4. Suggested Solutions of Scenario A

To illustrate the benefits of dynamic solutions from COREA, we graphically show the budget spending rate and the reward ratio of each case in Figure 4. We immediately notice that while both systems suggest solutions within feasible budget spending rates (a maximum value is 100%), COREA solutions result in significantly higher budget spending rates over all five cases, implying higher portions of budget are appropriately used to reward CoPs as planned. In particular, while budget spending rates based on solutions from COREA for cases when CoP activity scores decreased are below 60% (still much higher than 10% of budget spending rates based on the current grade criteria), those rates for cases of no changes or improved changes in CoP activity scores are close to 100%, a maximum possible value. In addition, while solutions for all cases based on current grade criteria do not meet a minimum reward ratio (15%), COREA solutions meet this requirement for cases of no changes or improved changes in CoP activity scores.



(a) Budget Spending Rate (b) Reward Ratio

Figure 4. Simulation Results on Scenario A

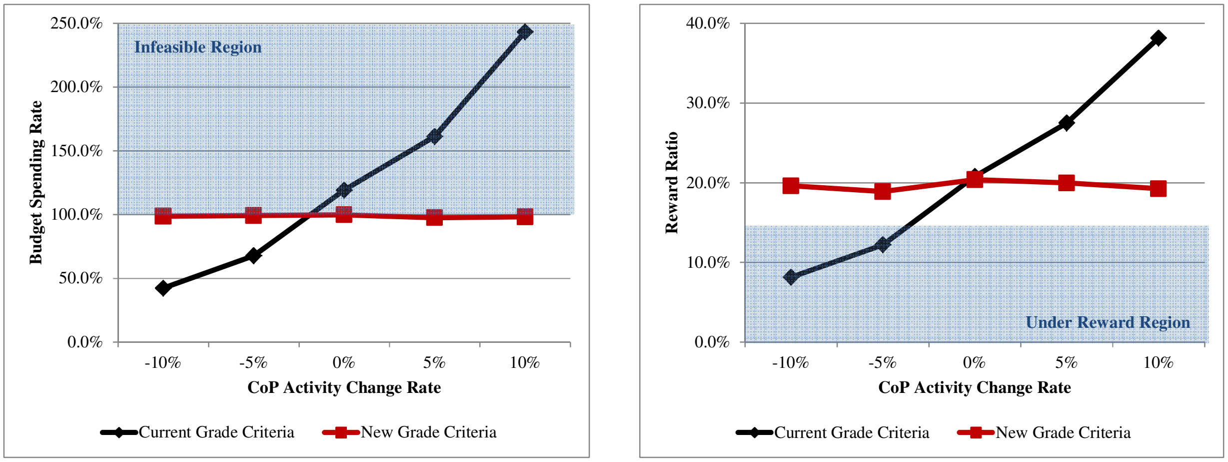
Scenario B: Pre-mature Organizational Knowledge Sharing Climate

In Scenario B, we consider an organization with a pre-mature knowledge sharing culture among CoP members. In such an organization, we assume that many CoPs perform around average scores while few CoPs perform poorly or excellently and we hence generate CoP activity scores from a regular normal distribution (μ=70, σ=10). We note that new grade criteria for the first place from COREA for cases of decreasing CoP activity scores in Table 5 are much higher than those in Scenario A in Table 4 mainly because more CoPs perform close to an average level in a pre-mature culture and COREA finds it necessary to raise the bars to reduce the number of candidate CoPs for financial reward to meet the budget constraint. In particular, for cases of no changes or improved changes in CoP activity scores, suggested grade criteria for the first place from COREA are significantly higher than the current grade criteria to avoid spending rewards over the budget.

Grades	Current Grade Criteria	New Grade Criteria of COREA on CoP Activity Change Rates				
		-10%	-5%	0%	5%	10%
First	Over 85	**Over 84**	**Over 85**	**Over 93**	**Over 95**	**Over 97**
Second	Over 75	**Over 68**	**Over 71**	**Over 75**	**Over 78**	**Over 83**
Third	Over 65	Over 65	Over 65	Over 65	Over 65	Over 65
Fourth	Over 55	Over 55	Over 55	Over 55	Over 55	Over 55
Fifth	Under 55	Under 55	Under 55	Under 55	Under 55	Under 55

Table 5. Suggested Solutions of Scenario B

The effectiveness of COREA is also shown in Figure 5. We first note that the current grade criteria cannot provide feasible solutions for any one of five cases because of over expenditures for three cases (0%, 5%, and 10% change in activity scores) and low reward ratios for two other cases (-10% and -5% in activity scores). In contrast, solutions from COREA for all cases result in budget spending rates close to 100% and always meet a minimum reward ratio constraint.



(a) Budget Spending Rate (b) Reward Ratio

Figure 5. Simulation Results on Scenario B

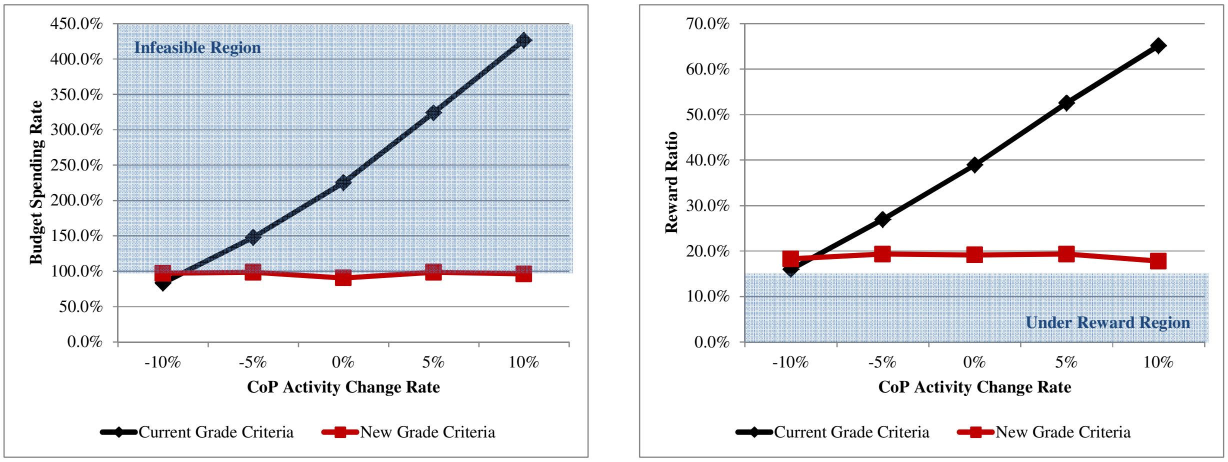
Scenario C: Mature Organizational Knowledge Sharing Climate

In Scenario C, we consider an organization with a mature knowledge sharing culture in which many CoPs perform above average scores while few CoPs perform very poorly. In such an organization, individual CoP member often recognizes the high value of social capital (Lin, 2001) and starts to establish social relationships, causing changes in organizational culture to encourage knowledge sharing (Bock et al., 2005). For Scenario C, we generate CoP activity scores from a positive skew-normal distribution (μ=70, σ=10).

Grades	Current Grade Criteria	New Grade Criteria of COREA on CoP Activity Change Rates				
		-10%	-5%	0%	5%	10%
First	Over 85	**Over 84**	**Over 89**	**Over 98**	**Over 96**	**Over 97**
Second	Over 75	**Over 74**	**Over 77**	**Over 80**	**Over 84**	**Over 88**
Third	Over 65	Over 65	Over 65	Over 65	Over 65	Over 65
Fourth	Over 55	Over 55	Over 55	Over 55	Over 55	Over 55
Fifth	Under 55	Under 55	Under 55	Under 55	Under 55	Under 55

Table 6. Suggested Solutions of Scenario C

Overall, we find similar grade criteria from COREA in Table 6 for Scenario C compared with outputs in Table 5 for Scenario B except that new grade criteria for Scenario C are slightly higher mainly because of high scores of most CoPs in Scenario C. Again, the current grade criteria cannot provide feasible solutions for most cases because of over expenditures for four cases (-5%, 0%, 5%, and 10% change in activity scores), while new grade criteria from COREA result in feasible solutions for all five cases by meeting both minimum reward ratio and budget constraints.



(a) Budget Spending Rate (b) Reward Ratio

Figure 6. Simulation Results on Scenario C

CONCLUSION

Understanding its critical role to encourage and facilitate knowledge sharing activities among employees in CoPs, organizations strategically develop their own performance evaluation criteria and financial rewards systems. One of main requirements of such systems are to optimally allocate limited financial rewards to CoPs based on their performance. In this study, we conceptualize such a problem as a mathematical optimization problem that maximizes budget spending on rewards by dynamically adjusting cut-off points for five possible evaluation grades of CoPs while meeting a minimum reward ratio and keeping the total reward amount within the budget. As our solution to this problem, we present CoP reward allocation (COREA) system that employs a heuristic algorithm to efficiently solve this NP-complete problem.

Experimental results on three simulated organizational knowledge sharing climates, solutions suggested from COREA perform significantly better than solutions from the currently available reward system in terms of budget spending rates and reward ratios. When most CoPs perform poor in immature organizational knowledge sharing climates and their activity scores are deteriorating compared with the previous years, budget spending rates from both systems are far below under an optimal level (100%) although its value from COREA system is much higher than that of the current system (60% vs. 10%). In addition, while solutions for all cases based on current grade criteria do not meet a minimum reward ratio (15%), COREA solutions meet this requirement for cases of no changes or improved changes in CoP activity scores. The most significant difference between two systems is observed in pre-mature and mature organizational knowledge sharing climates in which the COREA system finds approximately optimal financial reward allocations while the current reward system fails to find solutions mainly because it either allocates rewards over the budget or does not reward a minimum number of CoPs.

One of possible future research directions is to do a microscopic analysis at CoP member levels by considering individual responsiveness to extrinsic rewards. Then we will test robustness and reliability of our COREA system after incorporating individual responsiveness and CoP responses as a group to extrinsic rewards in various organizational knowledge sharing climates.

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