Effects of Rewards and Collaboration on Patenting and Innovative Activities and Performance

Young-Ki Kim, Seong-Taek Park

Abstract Background/Objectives: ***This study analyzed the factors relevant to the effects of rewards and collaboration on patent and innovative activities and management performance.***

Methods/Statistical analysis: ***PLS was used for the statistical analysis in this study. Widely used across social sciences, PLS is a statistical tool optimizing the empirical testing of measurement and structural models.***

Findings: ***The structural model is verified in terms of the coefficient of determination of the dependent variable, which is explained by the size and direction of the path coefficient, statistical significance and antecedents. First, rewards exerted significant effects on patenting and innovative activities. Second, collaboration exerted significant effects on patenting and innovative activities. Third, patenting and innovative activities exerted significant effects on management performance.***

Improvements/Applications: ***The present findings have a practical implication in that they may serve as an applicable guideline to developing some incentive and support policies using rewards.***

Keywords: Reward, Collaboration, Patent Activity, Innovative Activity, Management performance

I. INTRODUCTION

The Industry 4.0 driven by digital transformation has arrived following Industry 1.0 initiated by James Watt's steam engine in the 18 century, Industry 2.0 driven by electricity, and Industry 3.0 coming down to information based on computers and the internet. With digital transformation emerging as the key trend in corporate business operation, the gap is widening between some companies actively responding to and proceeding with the latest trend and others sitting on their hands [1].

Businesses failing to respond properly to the rapid change in market environment will die out. For example, Nokia and Motorola have been eliminated from the market as a consequence of their failure to pro-actively responding to the emergence of smartphones. It is highly essential to make efforts and take agile actions in response to dynamic changes in market conditions. After all, businesses struggle to survive the tough competition in uncertain market conditions[2,3].

Therefore, companies invest a lot in R&D in an effort to create new products and services. Lately, they are putting enormous efforts in analyzing and utilizing a plethora of internal and external data they have already secured[4]. Still, the individual-level participation in organization-level R&D strategies remains limited. Thus, companies encourage monetary and non-monetary rewards and collaboration.

Given proper rewards, staff members take full advantage of their capacities and contribute to corporate performance as reported by many researchers. Many companies motivate their employees and achieve goals using rewards or incentive schemes. Monetary rewards often take effect immediately, whereas non-monetary rewards do not. Therefore, they need to ponder upon appropriate types of rewards for employees' performance.

Also, businesses value internal and external collaboration now. They used to be focused on internal collaboration, which fell short of their expectations for some ground-breaking innovation or performance, and now they put emphasis on external collaboration. Collaboration potentially facilitates patenting and innovative activities[5,6].

Now, through well-established internal and external collaboration, businesses are capable of unfolding a range of unprecedented innovative and patenting activities, which are directly linked to corporate performance. The latest convergence of multiple technologies instead of a single one enables R&D of new products and services. Therefore, many global corporations collaborate with not only their partners but also competitors for the purpose of innovation.

Global businesses implement an array of support and incentive policies for innovative and patenting activities, which is a feasible strategy when there is no need to take some urgent measures. They capitalize on M&A activities when there is the urgency necessary to strengthen their competitive advantages.

Despite their importance, the causal effects of rewards and collaboration on innovative and patenting activities have not been well-documented. Hence, this paper reviews previous findings on relevant factors, and sets rewards, collaboration, and patenting and innovative activities as antecedents, to analyze the causality between those factors and management performance.

The proposed causality between the factors influencing diverse patenting activities and the causality between patenting and innovative activities and corporate performance will serve as a

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guideline concerning corporate strategies for innovation and patenting.

II. THEORETICAL BACKGROUND

2.1. Rewards

Companies used to adopt the seniority-based personnel management system, but now they have shifted towards the performance-based system conducive to motivating employees. It is reported that the performance-based system has rewards directly linked with performance, allowing organizations to ensure greater justice in wage management, further motivate employees and increase their job satisfaction[7,8].

Also, the performance-based system stimulates the competition among employees, improves their job commitment and work efforts, and ultimately promotes their continuous performance improvement. Notably, compared to non-monetary rewards, monetary rewards take effect relatively immediately.

Park et al.(2013) investigated the effects of rewards on collaboration and barriers, and reported rewards had positive effects on collaboration. Thus, businesses make efforts to reengineer their reward system[6].

2.2.Collaboration

Collaboration is defined as the "cooperative environment where all members are allowed to participate in decision making as a team while sharing value and positively influencing one another" and as a superordinate concept to cooperation or assistance [9].

Friend and Cook (2010) argued collaboration is a form of interactions between more than two equal members who voluntarily participate in shared decision making towards common goals[10]. Roschelle and Teasley(1994) defined collaboration as moderated activities simultaneously taking place as a result of persistent attempts to build and maintain a shared idea[11]. Like rewards, collaboration is directly connected with performance, which is why companies take multi-pronged approaches to encourage and utilize collaboration.

2.3.Patent Activity

Patenting activities are sub-classified into patent management, patent rights and patent support activities. Here, we define patenting activities as patent management activities[6].

Businesses apply patents for their R&D outputs. Some actively use their patents for product development, which results in relatively fewer challenges, whereas others choose not to utilize their patents granted but render them dormant. Such inactive patents are called sleeping patents, which are often found in universities and research institutions as well as business entities[1,2].

Importantly, it is crucial to systematically manage patents once granted. If a company finds its patent unnecessary internally, it may as well assign the patent right to other businesses through technology transfer or licensing. However, when a patent is associated with an original technology and the market is in its initial stage, developing a strategy to systematically exploit it matters most.

2.4. Innovation Activity

Innovation involves implementing new or substantially improved products or services, marketing tactics, organized methods in business operation, and workplace organization or external relationships [12].

Since Schumpeter emphasized the comprehensive innovation in his 'The Theory of Economic Development' published in 1911, innovation has been regarded as the core factor in business administration and economics for businesses or all organizations to survive and secure competitiveness[13].

Definitions of innovative activities vary across researchers. Some sub-classifies innovative activities into technology, production and management innovations, while others categorize innovative activities into exploratory and exploitative activities, and still others divide those into technological and non-technological activities.

Geroski et al.(1993) reported companies pursuing product and process innovation in tandem with organizational changes created higher profits compared with those taking separate approaches to each innovation[14]. Hollenstein (2003) measured technological and non-technological innovation activities, and empirically proved that the innovation performance measured in terms of productivity and sales growth was higher in the group of companies characterized by both technological and non-technological innovation activities[15].

2.5.Management Performance

Mansfield(1972) illuminated companies pursued innovation and thus achieved higher financial performance in highly competitive market segments[16].

In general, as the variables of management performance, financial performance indicators such as revenue growth rates and gross profit percentages are used, as well as non-financial performance indicators including employment, export performance, market share and shareholder value [17, 18]. Financial performance involving profitability, productivity, market share, revenue growth and return on investment is possibly used to measure the management performance [19,20].

Practically, to identify the factors involved in the effects of patenting and innovative activities on management performance, it is necessary to take an approach from the financial perspective [21].

III. RESEARCH MODEL AND HYPOTHESIS

This study aims to establish the causality between the factors relevant to the effects of rewards and collaboration on patenting and innovative activities, and management performance. <Fig. 1>

shows the hypotheses set here to verify the validity of the model.

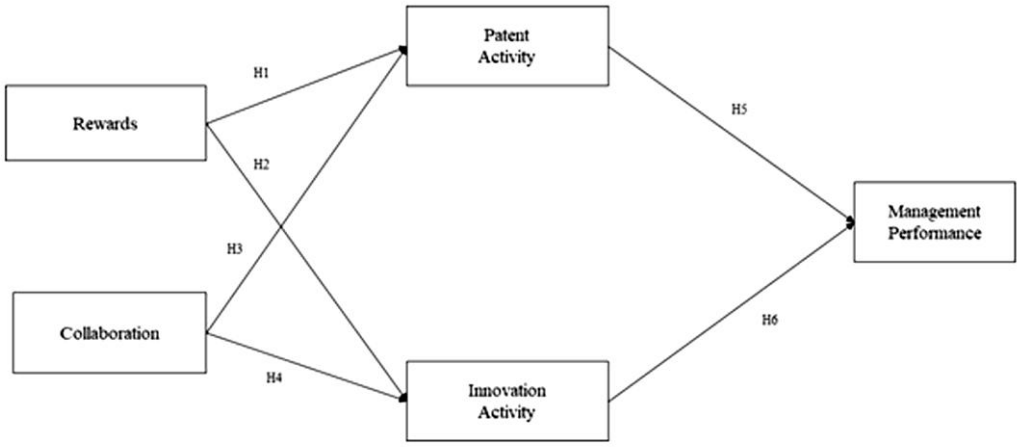

Figure 1.Research Model

Companies make efforts for performance. Particularly, many business organizations encourage employee invention for innovative and patenting activities, without taking proper rewards into consideration. Thus, few performance-related innovative activities are implemented. Generally, proper rewards facilitate employees' willingness to engage in diverse activities.

At the same time, the rapid convergence of distinct technologies overshadows the potential market success of a single technology. Lately, the world is witnessing a new trend of combining data, networks and AI. Also, the emerging platforms are underlining the importance of collaboration in borderless wars. The emerging organizational ethos favorable to collaboration promotes the collaboration-based information sharing. Thus, internal and external collaboration will have significant effects on patenting and innovative activities as hypothesized below.

H1. Rewards will have significant effects on patenting activities.

H2. Rewards will have significant effects on innovative activities.

H3. Collaboration will have significant effects on patenting activities.

H4. Collaboration will have significant effects on innovative activities.

Businesses would manage patenting activities simply by applying patents and managing those patents granted. Yet, the rising importance of intellectual property right involving patents requires some approaches to systematic management and strategic exploitation of patents. Additionally, companies engage in diversified innovative activities for survival, which will influence their management performance as hypothesized below.

H5. Patenting activities will have significant effects on management performance.

H6. Innovative activities will have significant effects on management performance.

IV. RESULTS

4.1.Method and Sample

The questionnaire survey was conducted by the author in July ~ August, 2018. Excluding the general characteristics of the sample, the other items were rated on a Likert scale. Eliminating the sheets containing insincere responses, 121 copies were used for the empirical analysis.

4.2.Validity and reliability analysis

PLS was used for the statistical analysis in this study[22]. Widely used across social sciences, PLS is a statistical tool optimizing the empirical testing of measurement and structural models(Table 1). The convergent validity of the measurement model was tested in light of composite reliability and average variance extracted(AVE), whilst the discriminant validity was tested based on whether the square root of AVE was greater than the inter-construct correlation coefficient or not[23].

Table 1: Discriminant Validity Analysis

	Factor Loading	Composite Reliability	AVE	Cronbachs, Alpha
PMA1	0.7405	0.9296	0.5952	0.9147
PMA2	0.7716			
PMA3	0.7106			
PMA4	0.7209			
PMA5	0.7696			
PMA6	0.818			
PMA7	0.785			
PMA8	0.8285			
PMA9	0.7903			
MP1	0.7868	0.8537	0.5936	0.7719
MP2	0.7386			
MP3	0.807			
MP4	0.7474			
REW1	0.8242	0.9093	0.6673	0.8752
REW2	0.8184			

REW3	0.8409			
REW4	0.7823			
REW5	0.8176			
COR1	0.7999			
COR2	0.8658	0.873	0.6964	0.7814
COR3	0.8366			
IA1	0.7916			
IA2	0.7356			
IA3	0.7823	0.8627	0.6113	0.7878
IA4	0.8157			

The analysis highlighted the following (Table 2).

The composite reliability above 0.7 and the AVE above 0.5 verified the convergent validity[24]. Also, the square root of AVE exceeded the inter-construct correlation coefficient, which verified the discriminant validity. These findings corroborated the validity of the structural model[25].

Table 2: Correlation between Latent Variable

	COR	IA	MP	PMA	REW
COR	0.834506				
IA	0.7242	0.781857			
MP	0.694	0.7302	0.770454		
PMA	0.6712	0.7152	0.6753	0.771492	
REW	0.7623	0.7108	0.6168	0.7521	0.816884

4.3.Hypothesis testing

The structural model is verified in terms of the coefficient of determination of the dependent variable, which is explained by the size and direction of the path coefficient, statistical significance and antecedents. This study verified the significance of all paths with the Bootstrap re-sampling[26].

Table 3: Hypotheses Testing

Path		Coefficient	t-value	Results
H1	REW -> PMA	0.5741	8.9668***	Accepted
H2	REW -> IA	0.3789	6.0342***	Accepted
H3	COR -> PMA	0.2336	3.7183***	Accepted
H4	COR -> IA	0.4353	6.9753***	Accepted
H5	PMA ->MP	0.3133	5.4276***	Accepted
H6	IA ->MP	0.5061	8.5707***	Accepted

* p<0.05, ** p<0.01, *** p<0.001

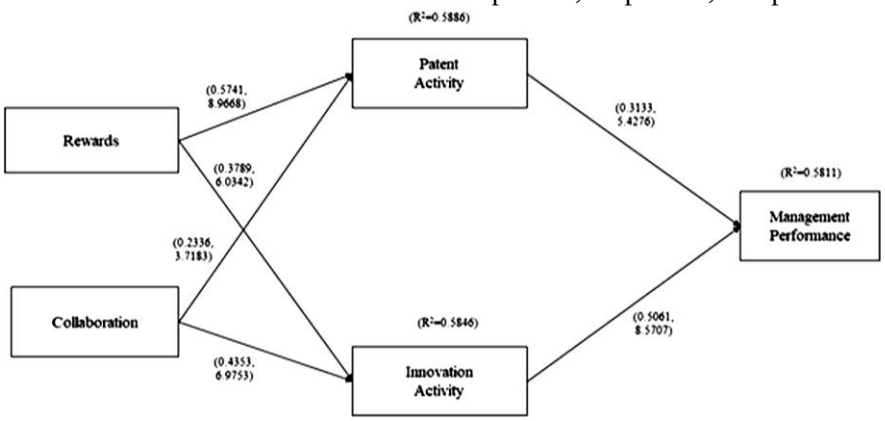

Figure 2.Hypotheses Testing

As shown in <Fig. 2> and <Table 3>, the model was verified and statistically accepted both H1 (rewards will have significant effects on patenting management activities) and H2 (rewards will have significant effects on innovative activities) at a significance level of 5%, H3 (collaboration will have significant effects on patenting management activities) and H4 (collaboration will have significant effects on innovative activities) at a significance level of 5%. H5 (patent activity will have significant effects on patenting management performance) and H6 (innovation activity will have significant effects on patenting management performance) at a significance level of 5%.

Also, the management performance explanatory power(R2) was 58.1%, while the innovative activities and management performance showed 58.8% and 58.4%, respectively. These findings exceeded the generally accepted statistical power (10%), indicating a very strong explanatory power of the model [27].

V. CONCLUSION

This study analyzed the factors relevant to the effects of rewards and collaboration on patenting and innovative activities and management performance, and shed light on the following.

First, rewards exerted significant effects on patenting and innovative activities. This finding suggests CEOs should encourage innovative and patenting activities by designing some proper reward systems and having employees stay informed of such systems so that they can contribute to vitalizing corporate activities including R&D.

Second, collaboration exerted significant effects on patenting and innovative activities. Regardless of internal or external collaboration, innovation requires some collaborative activities. This finding suggests CEOs should perceive the importance of collaboration and reflect it in their organizational system design.

Third, patenting and innovative activities exerted significant effects on management performance. This finding agrees with lots of previous reports. Still, patenting and innovative activities facilitated by rewards and collaboration significantly impacted on corporate performance.

This study has a scholarly implication in that unlike previous studies focusing on the causality between patenting and innovative activities and management performance, it added such variables as rewards and collaboration, surveyed practitioners and

empirically verified the causality.

The present findings have a practical implication in that they may serve as an applicable guideline to developing some incentive and support policies using rewards and collaboration instead of simply encouraging innovative and patenting activities and emphasizing the importance of rewards and collaboration.

Despite the foregoing implications, this study has limitations in that it failed to consider diverse variables relevant to patenting and innovative activities. Also, even though it empirically analyzed real-world companies, the sample size was so small that the findings are rarely generalizable.

Future research needs to draw on more activity variables and derive more antecedents other than those presented in this study. Also, it is necessary to use other statistical analysis methods such as the Delphi method taking the form of ranking and AHP, and to compare the findings with those from other countries

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