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## The Effects of Transformational Leadership and Transactional Leadership of R&D Researchers on Organizational Effectiveness and R&D Outcomes in Korea

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**Abstract:** The purpose of this study is to examine R&D outcomes of R&D researchers and a relationship between transformational leadership, and transactional leadership and organizational effectiveness for survival of companies in complex business environments. The study was mainly conducted for R&D researchers working in the business of L in Korea. 245 questionnaires of total 300 copies distributed were collected, of which 231 copies except for missing values were used for statistical analysis. The data processing was divided into convergent validity meaning an internal consistency among items within dimension to evaluate measuring variables and distinction validity meaning independence among the dimensions and the exploratory factor analysis was conducted using SPSS 18.0K to verify the data. And for the convergent validity, the confirmatory factor analysis following the exploratory factor analysis was divided into exogenous variables and endogenous ones and conducted using the measuring model of AMOS 18.0. This study analyzes the effect on organizational effectiveness and R&D outcomes according to leadership forms of R&D researchers. And, there are similar studies of related variables but there is no model considering all suggested variables, so this study is meaningful because this study is to investigate a relationship between transformational leadership, transactional leadership of R&D researchers and organizational effectiveness and R&D outcomes.

**Keywords:** R&D Researchers, Transformational leadership, Transactional leadership, Organizational Effectiveness, R&D Outcomes.

### INTRODUCTION

In the midst of intensifying competition among companies around the world at the beginning of the knowledge-based economy, science technology is emerging as the core element in business competitiveness. As a result, companies are investing substantial amounts of resources in securing technological leadership and producing outstanding R&D outcomes. In other words, companies are facing the need to create a new channel through which their R&D researchers can respond to the environmental changes. Given the nature

of the position that requires creative thinking and determination, for researchers, psychological factors such as perceived sense of belonging, loyalty, and solidarity play important roles. Therefore, for effective management of a research center, it is necessary to actively manage the researchers so that they can have a positive perception of their organization and tasks. In other words, it is important to understand the appropriate type of leadership in guiding the researchers and, based on such understanding, to examine the effects of the leadership type on improving organizational effectiveness and R&D outcomes. However, research on this subject is rare and limited. Therefore, this study analyzed the effects of organizational leadership on organizational effectiveness and R&D outcomes, in the process in which R&D researchers working for Korean companies perform their tasks, and to provide basic data to help find a way to improve organizational effectiveness and R&D outcomes by motivating and improving job satisfaction of the researchers.

## **THEORETICAL BACKGROUND**

### **Transformational Leadership and Transactional Leadership**

Stogdill (1974) argued the definition of leadership varies as widely as the number of researchers who who conducted research on the subject, and that it depends on the perspective of the leadership researcher. Campbell (1977) suggested the operational definition of leadership differs according to the purpose of each study on the subject, while Karmel (1978) stated that it is difficult to give a specific and unified definition to different types of leadership in a harmoniously universal and variable sense. In other words, different researchers have used different approaches to research on leadership.

The transformational leadership theory, which argues that inducing voluntary participation from members of an organization can contribute to the organizational development, has been researched since the early 1980s. It focuses on achievement of the leader rather than reaction from the members or individual attributes of the leader, and emphasizes transforming the status quo by identifying problems of the current system and proposing a vision for the organization's future to the members of the organization (Lussier and Achua, 2001). The term was coined by the political sociologist Burns (1978) in his book 'Leadership,' and, in 1990, charisma, individualized consideration, intellectual stimulation, and inspirational motivation were proposed as four dimensions of transformational leadership. Bass (1996) argued that, if an organization is ready for and capable of and desires transformation, it needs to choose transformational leadership as the leadership paradigm, and that transformational leadership is suitable for leadership needs and demand within a learning organization.

Transactional leadership is a process in which the leader uses action, compensation and incentive to induce desirable behaviors from the subordinates, and this process is based on exchange or transactional relation between the leader and his or her subordinates (Kuhnert, 1994). According to Burns (1978), transactional leadership occurs when an individual exercises initiative in enters into a contract with another person for the purpose of exchanging something valuable. Based on this concept, Bass (1985) distinguished transactional leadership from transformational leadership, and proposed, as behavioral components of transactional leadership, contingent reward and management by exception. Contingent reward has an active implication in that it emphasizes reward for outcome that meets the relevant criteria, while management by exception is a passive concept that suggests corrective measures be taken only if the outcome does not satisfy the criteria (Avolio, Waldman and Einstein, 1988). Contingent reward means that the leader should

provide incentive or reward to his or her subordinates when they achieve the level of performance set by the leader, for the purpose of reinforcing motivation, whereas management by exception implies that the leader intervenes when there is an exceptional event and is sometimes accompanied by negative feedback or reinforcement.

Bass(1985) argued that, while transformational leadership and transactional leadership exist independently of each other, the two concepts are not mutually exclusive but, rather, complementary, and, therefore, conceptualized transformational leadership as additionally contributing to the effects of transactional leadership rather than substituting it.

### **Organizational Effectiveness**

Organizational effectiveness refers to the extent to which the set goals have been achieved, and is a measure of organizational performance that takes into account effectiveness when assessing whether certain goals have been accomplished. Campbell (1977) conducted literature review on organizational effectiveness and identified over 30 variables that were proposed as indexes, while Dalton and Porter (1980) divided the evaluation criteria of organizational effectiveness into psychological achievement such as organizational commitment and job satisfaction of the members, and economic achievement such as growth, productivity, and profitability. According to previous research, job attitude, which is divided into organizational commitment, job satisfaction, and job involvement, which constitute an area of organizational effectiveness, is linked with actions of the members of the organization according to their perception toward the job and company (Porter and Steers, 1973). Especially, organizational commitment and job satisfaction are highly important factors that determine performance of the organization (Vroom, 1964; Porter and Steers, 1973; Randall, 1987; Caldwell and O'Reilly, 1990; Verquer, Beehr and Wagner, 2003). In this study, organizational commitment and job satisfaction were selected as constituents for measuring organizational effectiveness.

Organizational commitment is one of the important indicators that represent an organization's performance, and has been actively studied by many researchers since the 1960s (Becker, Randall and Riegel, 1995). According to previous researchers, definition of organizational commitment encompasses three conceptual components: strong belief in and acceptance of the goals and values of the organization; willingness to exert utmost effort for the organization; and firm intention to remain a member of the organization. And organizational commitment offers a variety of positive effects such as inducing self-motivation of the members to engage in behaviors that have positive effects on the organization and to maintain their membership in the organization (Morrow, 1993).

Job satisfaction, in general, refers to the emotional and sentimental preference that individuals have toward their job, attitude toward job, and positive emotional state that result from performing one's job (Deci, 1980). Also, as job satisfaction is highly related to improvement of productivity, organizational loyalty, interpersonal relationship, and responsibility, companies that strive to improve job satisfaction of their employees can enjoy long-term benefits such as continuous service and loyalty of the employees (Jerome and Kleiner, 1995).

### **R&D Outcomes**

Cohen and Levinthal (1989) defined outcome as any original and valuable knowledge that is created in the research process and available to the public. Brown and Svenson (1988) argued, regarding research outcomes,

that the overall R&D system creates output through research and development activities by using the input, and transfers the output to produce outcome, which is diffused and, then, results in sociocultural effects. Here, input refers to research workforce, budget, and period, while output includes paper, patent, and prototype. Venkatramun and Ramanujam (1986) divided areas of outcome into financial outcome, operational outcome, and organizational flexibility, while Decotiis and Dyer (1979) identified criteria of R&D outcomes as technical outcome, scientific outcome (technological innovation), commercial outcome, workforce training effect, and efficiency (research funds, period, etc.). In South Korea, Article 2.5 of 'Act on Outcome Evaluation and Management of National R&D Projects' enacted in December 2005 defined

“R&D outcome refers to scientific and technological results generated from research and development, such as patents and papers, and other tangible and intangible, economic, social, and cultural outcomes.”

In general, R&D outcomes are difficult to measure because the types and items of research outcomes that can be generated from R&D activities are extremely diverse and, also, because different R&D organizations emphasize different items in the outcomes. As a result, different measurement and analysis methods have been developed and used, including bibliometric analysis, which utilizes different indexes such as the quantity of the output, i.e. the number of papers, publications, reports, etc., quality of the output as measured by the times cited, and creativity of the output as measured by the number of relevant patents and quantitatively measures the R&D outcome; econometric or financial approach, which is a financial and economic method that analyzes the effects or efficiency of research based on monetary value in relation to the input; and peer review, which aims to evaluate the scientific value of a paper or research application based on opinions of scientists in the relevant or similar fields.

## RESEARCH METHOD

### Research Model and Variable Setting

This study tried to analyze the effects of transformational leadership and transactional leadership of R&D researchers on organizational effectiveness and R&D outcomes. In other words, based on previous research, this study aimed to investigate whether there is statistically significant difference in organizational effectiveness and R&D outcomes between transformational leadership and transactional leadership of researchers, and identify the type of statistical significance.

To do that, this researcher set up the research model as shown in Figure 1 and conducted a 5-point Likert scale based questionnaire survey with the use of the questionnaire items used in previous studies so as to measure transformational leadership, transactional leadership, organizational effectiveness, R&D outcomes.

### Research Hypotheses

The purpose of this study is to find the transformational leadership and transactional leadership of R&D researchers on organizational effectiveness and R&D outcomes. The study issues are presented as follows:

*Hypothesis 1:* Transformational leadership will significantly influence organizational effectiveness.

*Hypothesis 2:* Transactional leadership will significantly influence organizational effectiveness.

*Hypothesis 3:* Organizational effectiveness will significantly influence R&D outcomes.

*Hypothesis 4:* Transformational leadership will significantly influence R&D outcomes.

*Hypothesis 5:* Transactional leadership will significantly influence R&D outcomes.

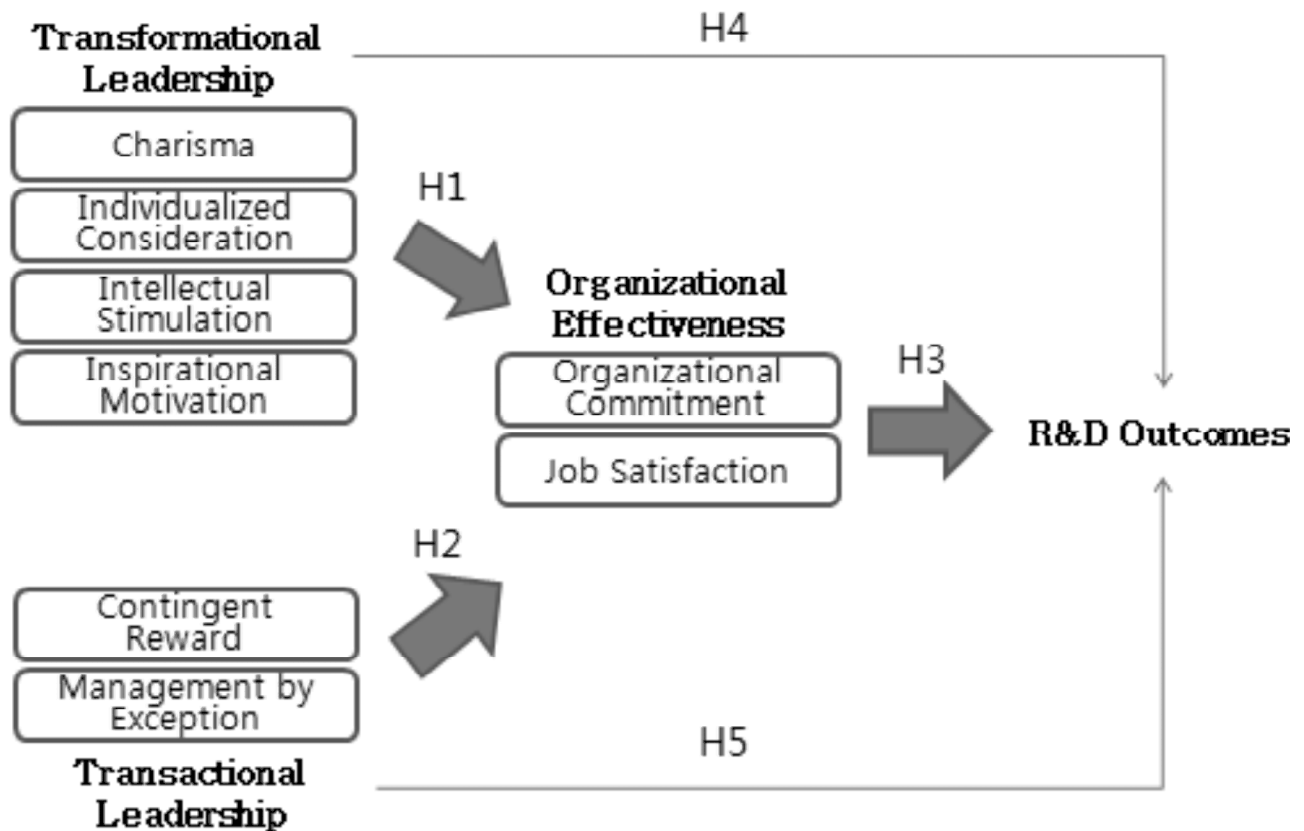


Figure 1: Research model

### General Characteristics of Respondents

A questionnaire survey had been conducted with R&D researchers working in research institute of L Korean company from January 2 to January 31, 2017 for 28 days. In this study, data was collected from R&D staff who were performing R&D tasks. A total of 300 questionnaire copies were distributed through direct interview, and 245 copies were collected. Of them, the copies of respondents who answered questions insincerely or didn't answer some questions were excluded. As a result, a total of 231 copies were analyzed finally.

## RESULT

### Validity Analysis and Reliability Analysis of Measurement Variables

A total of 231 copies of questionnaire were analyzed and the research model in this study was used for understanding correlation between different variables. In order to validate the results of hypothesis validation in this study, reliability and validity of the instrument had to be verified first. To compare with the independent and similar factors studied in previous studies and examine the construct validity of the subjective measuring

tool, this research used SPSS 18.0 K and conducted factor analysis, a general analysis method to find if the measured result of measurement index fits the originally intended theoretical concept. As a method of extracting factors, principal component was applied and thereby factors with more than 1.0 of Eigen value which represents a quantity of distribution for factor explanation. Factor loading was judged to be more than 0.4 which is statistically significant. Varimax was applied to remove multicollinearity, the correlation between factors.

In addition, for feasibility assessment, exploratory factor analysis and confirmatory factory analysis, which was divided into exogenous and endogenous variables, were performed using AMOS 18.0. And then, the convergent validity of each variable and that of latent variables as well as discriminant validity were verified. This method is used widely because reliability verification assumes, but does not verify, internal consistency, and the *p* value of GFI, AGFI, RMR, NFI,  $\chi^2$ ,  $\chi^2$  was used to assess goodness of fit.

Nunnally (1978) argued 0.60 is a sufficient  $\alpha$  value in exploratory research, 0.80 in basic research, and 0.90 in applied research that requires an important decision to be made. Also, Van *et. al.* (1980) generalized that  $\alpha$  value, which is generally required in analyses on an organizational level, that is 0.60 or higher does not cause significant problems for instrument reliability.

## Exploratory Factor Analysis

### 1. Exploratory factor analysis of transformational leadership

In the exploratory factor analysis of transformational leadership, one of the independent factors in the model used in this study, as shown in Table 1, charisma, individualized consideration, intellectual stimulation, and inspirational motivation were identified as factors. According to the table, the eign-value ranged between 1.354 and 2.057, all exceeding 1.0, and, therefore, all independent variables were clearly distinguished. The cumulative distribution was 65.013%, and factor loading larger than 0.4, which, as a result, verified both convergent validity and discriminant validity of measure variables of the same factors. And, all of the four factors showed Cronbach Alpha values larger than 0.6, indicating there was no problem with the instrument.

**Table 1**  
**Exploratory factor analysis of transformational leadership**

Item	Component			
	1	2	3	4
Charisma 3	.801			
Charisma 1	.751			
Charisma 5	.708			
Charisma 4	.570			
Charisma 2	.495			
Individualized Consideration 5		.756		
Individualized Consideration 2		.717		
Individualized Consideration 1		.696		

Table 1 Contd.



<i>Item</i>	<i>Component</i>			
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
Intellectual Stimulation 4			.795	
Intellectual Stimulation 2			.772	
Intellectual Stimulation 5			.658	
Inspirational Motivation 1				.771
Inspirational Motivation 3				.739
Inspirational Motivation 4				.704
Eigen-value	2.057	1.354	1.952	1.622
Explanatory distribution (%)	19.560	12.408	18.034	15.011
Cumulative distribution (%)	19.560	31.968	50.002	65.013
Cronbach Alpha	.724	.673	.701	.689

## **2. Exploratory factor analysis of transactional leadership**

Table 2 shows the result of exploratory factor analysis of transactional leadership, which is another independent factor in this study. According to the table, it consists of contingent reward and management by exception. As the results show, the eigen-value ranged between 2.972 and 3.108, all exceeding 1.0, and, therefore, all independent variables were clearly distinguished. The cumulative distribution was 64.374%, and factor loading larger than 0.4, which, as a result, verified both convergent validity and discriminant validity of measure variables of the same factors. And, both factors showed Cronbach Alpha values larger than 0.6, indicating there was no problem with the instrument.

**Table 2**  
**Exploratory factor analysis of transactional leadership**

<i>Item</i>	<i>Component</i>	
	<i>1</i>	<i>2</i>
Contingent reward 4	.822	
Contingent reward 2	.808	
Contingent reward 1	.799	
Contingent reward 5	.784	
Management by exception 2		.740
Management by exception 3		.726
Management by exception 4		.722
Management by exception 1		.679
Management by exception 5		.667
Eigen-value	3.108	2.972
Explanatory distribution (%)	32.526	31.848
Cumulative distribution (%)	32.526	64.374
Cronbach Alpha	.803	.791

### 3. Exploratory factor analysis of organizational effectiveness

Table 3 shows the results of exploratory factor analysis of organizational effectiveness, which was the intervening variable in this study. According to the table, it consists of organizational commitment and job satisfaction. As the results show, the eigen-value ranged between 3.498 and 3.205, all exceeding 1.0, and, therefore, all independent variables were clearly distinguished. The cumulative distribution was 70.831%, and factor loading larger than 0.4, which, as a result, verified both convergent validity and discriminant validity of measure variables of the same factors. And, both factors showed Cronbach Alpha values larger than 0.6, indicating there was no problem with the instrument.

**Table 3**  
Exploratory factor analysis of organizational effectiveness

Item	Component	
	1	2
Job satisfaction 2	.877	
Job satisfaction 5	.851	
Job satisfaction 1	.796	
Job satisfaction 4	.757	
Job satisfaction 3	.728	
Organizational commitment 4		.896
Organizational commitment 1		.840
Organizational commitment 2		.794
Organizational commitment 5		.779
Eigen-value	3.498	3.205
Explanatory distribution (%)	36.792	34.039
Cumulative distribution (%)	36.792	70.831
Cronbach Alpha	.821	.809

### 4. Exploratory factor analysis of R&D outcomes

Table 4 shows the results of exploratory factor analysis of R&D outcomes, which was the dependent variable in this study. As the results show, the eigen-value ranged 1.831 exceeding 1.0. The cumulative distribution was 60.989%, and factor loading larger than 0.4, which, as a result, verified both convergent validity and discriminant validity of measure variables of the same factors. And, both factors showed Cronbach Alpha values larger than 0.6, indicating there was no problem with the instrument.

**Table 4**  
Exploratory factor analysis of R&D outcomes

Item	Component
R&D outcomes 1	.767
R&D outcomes 3	.751
R&D outcomes 2	.744
R&D outcomes 5	.720
R&D outcomes 4	.706

Table 4 Contd.



Item	Component
Eigen-value	1.831
Explanatory distribution (%)	61.989
Cumulative distribution (%)	61.989
Cronbach Alpha	.694

### Confirmatory Factor Analysis

Prior to analyzing the structural equation model based on the overall causality model, although the convergent validity and discriminant validity of measure variables were verified to a certain extent through exploratory factor analysis, confirmatory factor analysis of the precedence factors was performed by using AMOS 18.0 for unidimensionality verification and statistical verification of the measured items.

#### 1. Confirmatory factor analysis of transformational leadership

The results of confirmatory factor analysis of transformational leadership were presented as statistical values such as  $\chi^2 = 32.006$ ,  $df = 34$ ,  $p$  value for  $\chi^2 = 0.251$ , GFI = 0.917, AGFI = 0.961, CFI = 0.912, RMR = 0.013, NFI = 0.937, and RMSEA = 0.038. Compared to indexes of the fit model, the model proposed in this study had NFI of 0.937 and GFI of 0.917, which are above the recommended values, and the Chi-square value was also significant. For results of confirmatory factor analysis of independent variables, the absolute value of critical ratio related to structural model estimation must be minimum 1.96. As shown in Table 5, in the model used in this study, the CR of each measured variable clearly exceeded 1.96 and the model was found to be significant at the significance level  $p < 0.001$ . Therefore, in this study, the hypotheses can be verified based on the collected data.

**Table 5**  
Confirmatory factor analysis of transformational leadership

Type		Estimate	S.E.	C.R.	P
Charisma 3	<— Charisma	.896	.103	5.210	***
Charisma 1	<— Charisma	1.004	.112	5.323	***
Charisma 5	<— Charisma	1.000			
Individualized Consideration 5	<— Individualized Consideration	1.000			
Individualized Consideration 2	<— Individualized Consideration	.911	.119	4.702	***
Individualized Consideration 1	<— Individualized Consideration	1.027	.132	4.525	***
Intellectual Stimulation 4	<— Intellectual Stimulation	1.000			
Intellectual Stimulation 2	<— Intellectual Stimulation	.698	.068	6.541	***
Intellectual Stimulation 5	<— Intellectual Stimulation	.672	.064	6.365	***
Inspirational Motivation 1	<— Inspirational Motivation	1.000			
Inspirational Motivation 3	<— Inspirational Motivation	1.002	.197	2.079	***

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$

## 2. Confirmatory factor analysis of transactional leadership

The results of confirmatory factor analysis of transactional leadership were presented as statistical values such as  $\chi^2 = 122.302$ ,  $df = 101$ ,  $p$  value for  $\chi^2 = 0.000$ ,  $GFI = 0.901$ ,  $AGFI = 0.807$ ,  $CFI = 0.951$ ,  $RMR = 0.022$ ,  $NFI = 0.909$ , and  $RMSEA = 0.045$ . Compared to indexes of the fit model, the model proposed in this study had  $NFI$  of 0.909 and  $GFI$  of 0.901, which are above the recommended values, and the Chi-square value was also significant. For results of confirmatory factor analysis of independent variables, the absolute value of critical ratio related to structural model estimation must be minimum 1.96. As shown in Table 6, in the model used in this study, the CR of each measured variable clearly exceeded 1.96 and the model was found to be significant at the significance level  $p < 0.001$ . Therefore, in this study, the hypotheses can be verified based on the collected data.

**Table 6**  
Confirmatory factor analysis of transactional leadership

Type			Estimate	S.E.	C.R.	P
Contingent reward 4	<—	Contingent reward	.784	.068	8.211	***
Contingent reward 2	<—	Contingent reward	.851	.071	9.318	***
Contingent reward 1	<—	Contingent reward	.728	.062	9.021	***
Contingent reward 5	<—	Contingent reward	1.000			
Management by exception 2	<—	Management by exception	.732	.053	13.165	***
Management by exception 3	<—	Management by exception	.859	.067	14.250	***
Management by exception 4	<—	Management by exception	.868	.059	15.210	***
Management by exception 1	<—	Management by exception	.915	.062	13.388	***
Management by exception 5	<—	Management by exception	1.000			

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$

## 3. Confirmatory factor analysis of organizational effectiveness

The results of confirmatory factor analysis of organizational effectiveness were presented as statistical values such as  $\chi^2 = 41.378$ ,  $df = 24$ ,  $p$  value for  $\chi^2 = 0.003$ ,  $GFI = 0.942$ ,  $AGFI = 0.898$ ,  $CFI = 0.934$ ,  $RMR = 0.018$ ,  $NFI = 0.923$ , and  $RMSEA = 0.058$ . Compared to indexes of the fit model, the model proposed in this study had  $NFI$  of 0.923 and  $GFI$  of 0.942, which are above the recommended values, and the Chi-square value was also significant. For results of confirmatory factor analysis of independent variables, the absolute value of critical ratio related to structural model estimation must be minimum 1.96. As shown in Table 7, in the model used in this study, the CR of each measured variable clearly exceeded 1.96 and the model was found to be significant at the significance level  $p < 0.001$ . Therefore, in this study, the hypotheses can be verified based on the collected data.

## 4. Confirmatory factor analysis of R&D outcomes

The results of confirmatory factor analysis of R&D outcomes were presented as statistical values such as  $\chi^2 = 87.068$ ,  $df = 37$ ,  $p$  value for  $\chi^2 = 0.000$ ,  $GFI = 0.940$ ,  $AGFI = 0.908$ ,  $CFI = 0.937$ ,  $RMR = 0.023$ ,  $NFI = 0.904$ , and  $RMSEA = 0.063$ . Compared to indexes of the fit model, the model proposed in this

**Table 7**  
**Confirmatory factor analysis of organizational effectiveness**

Type		Estimate	S.E.	C.R.	P
Job satisfaction 2	<— Job satisfaction	1.000			
Job satisfaction 5	<— Job satisfaction	1.174	.131	6.263	***
Job satisfaction 1	<— Job satisfaction	1.198	.123	6.308	***
Organizational commitment 4	<— Organizational commitment	1.000			
Organizational commitment 1	<— Organizational commitment	.775	.073	7.157	***
Organizational commitment 2	<— Organizational commitment	.850	.075	8.030	***
Organizational commitment 5	<— Organizational commitment	1.043	.081	8.165	***

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$

study had NFI of 0.904 and GFI of 0.940, which are above the recommended values, and the Chi-square value was also significant. For results of confirmatory factor analysis of independent variables, the absolute value of critical ratio related to structural model estimation must be minimum 1.96. As shown in Table 8, in the model used in this study, the CR of each measured variable clearly exceeded 1.96 and the model was found to be significant at the significance level  $p < 0.001$ . Therefore, in this study, the hypotheses can be verified based on the collected data.

**Table 8**  
**Confirmatory factor analysis of R&D outcomes**

Type		Estimate	S.E.	C.R.	P
R&D outcomes 1	<— R&D outcomes	.671	.074	4.212	***
R&D outcomes 3	<— R&D outcomes	.943	.079	8.788	***
R&D outcomes 2	<— R&D outcomes	1.039	.078	10.582	***
R&D outcomes 5	<— R&D outcomes	1.000			

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$

### Discriminant Validity

In order to examine discriminant validity of the variables selected in this study, discriminant validity analysis was performed based on the equation below. Discriminant validity between two subjects is verified if, when comparing the average variance extracted (AVE) of each subject and squares of the coefficient of correlation between the two, both AVEs are greater than the square of their correlation coefficient.

$$\frac{\text{Concept reliability} \left( \sum_{i=1}^k \text{std}.\lambda_i \right)^2}{\left( \sum_{i=1}^k \text{std}.\lambda_i \right)^2 + \sum_{i=1}^k (1 - \text{std}.\lambda_i^2)} \geq 0.7$$

Square of [The sum of standard lambda] / Square of [The sum of standardized lambda] + Sum of deviation of measurement error

$$\frac{\sum_{i=1}^k (std.\lambda_i^2)}{\sum_{i=1}^k (std.\lambda_i^2) + \sum_{i=1}^k (1 - std.\lambda_i^2)}$$

$$\frac{\text{Square of [The sum of standard lambda]}}{\text{Square of [The sum of standardized lambda] + Sum of deviation of measurement error}} \geq 0.5$$

However,  $1 - std.\lambda_i^2 = Var(\delta_i) = \text{deviation of measurement error}$

The AVEs were calculated according to the formula proposed by Fornell and Laker (1981) and, in general, AVEs 0.5 and higher are considered to have convergent reliability and, thereby, acceptable. Table 9 shows the AVE between constructs used in the measurement model in this study. As the square of the coefficient of correlation between the constructs did not exceed the AVE, it was concluded that discriminant validity between constructs was secured.

**Table 9**  
**Average variance extracted and Discriminant validity**

<i>Factor name</i>	<i>Charisma</i>	<i>Individualized Consideration</i>	<i>Intellectual Stimulation</i>
AVE	.736	.617	.711
Construct reliability	.919	.854	.894
<i>Factor name</i>	<i>Inspirational Motivation</i>	<i>Contingent reward</i>	<i>Management by exception</i>
AVE	.625	.534	.636
Construct reliability	.857	.767	.772
<i>Factor name</i>	<i>Organizational commitment</i>	<i>Job satisfaction</i>	<i>R&amp;D outcomes</i>
AVE	.602	.678	.667
Construct reliability	.834	.884	.875

### Goodness-of-fit Evaluation of Research Model

#### *This model has nine important variables*

Charisma, Individualized consideration, Intellectual stimulation, Inspirational motivation, Contingent reward, Management by exception, Organizational commitment, Job satisfaction, R&D outcomes. These are the factors extracted by explanatory factor analysis in this research model. To examine the validity of the factor variables, confirmatory factor analysis was conducted. To examine construct validity, goodness-of-fit evaluation indexes, including GFI (goodness of fit index: more than 0.9 means excellent; more than 0.8 good), AGFI (adjusted GFI: more than 0.9), Chi-square(the less the better), and p value of Chi-square (more than 0.05 means proper) were applied.

[Figure 2] illustrates variance structure equation model which was created on the basis of research model with the exception of the variables removed by validity and reliability analyses. The examination results are  $\chi^2 = 479.125$ ,  $df = 257$ , and  $p$  value of  $\chi^2 = 0.000$ , GFI = 0.909, AGFI = 0.812, CFI = 0.931,

RMR = 0.018, NFI = 0.835, TLI = 0.938, Parsimonius CFI = 0.743, Parsimonius NFI = 0.704, RMSEA = 0.043. Given the overall goodness-of-fit indexes, this model is considered to be acceptable overall and table 10 shows the hypotheses accepted based on the result of the structural equation analysis.

**Table 10**  
The results of analyzing a research model structural equation

<i>Transformational Leadership and Organizational Effectiveness</i>		C.R.	P
Organizational commitment	<—	Charisma	2.071 .037*
Job satisfaction	<—	Individualized Consideration	2.526 .011*
<i>Transactional Leadership and Organizational Effectiveness</i>		C.R.	P
Organizational commitment	<—	Contingent reward	1.991 .045*
Job satisfaction	<—	Contingent reward	3.431 ***
Organizational commitment	<—	Management by exception	2.002 .039*
<i>Organizational Effectiveness and R&amp;D Outcomes</i>		C.R.	P
R&D outcomes	<—	Organizational commitment	2.362 .019*
<i>Transformational Leadership and R&amp;D Outcomes</i>		C.R.	P
R&D outcomes	<—	Charisma	4.506 ***
R&D outcomes	<—	Individualized Consideration	1.998 .043*
<i>Transactional Leadership and R&amp;D Outcomes</i>		C.R.	P
R&D outcomes	<—	Management by exception	2.310 .017*

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$

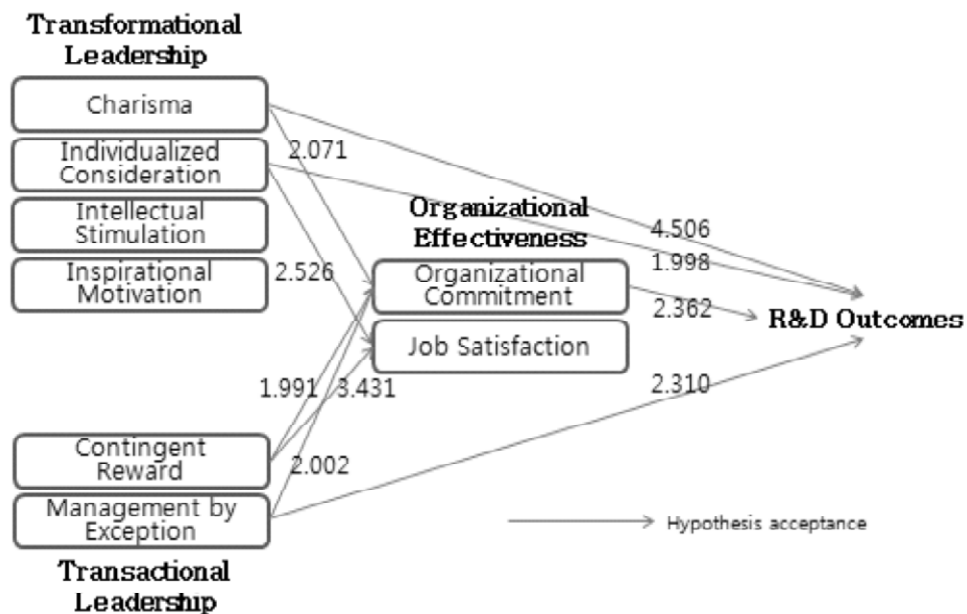


Figure 2: The results of analyzing a research model (on the basis of C.R value)

## CONCLUSION AND DISCUSSION

This study attempted to approach the relationship between transformational leadership and transactional relationship of R&D researchers and organizational effectiveness and R&D outcomes, from an empirical perspective, and had five purposes: first, it investigated whether transformational leadership of R&D researchers has effects on organizational effectiveness; second, whether transactional leadership of R&D researchers has effects on organizational effectiveness; third, whether organizational effectiveness of R&D labs has effects on R&D outcomes; fourth, whether transformational leadership of R&D researchers has effects on R&D outcomes; and, fifth, whether transactional leadership of R&D researchers has effects on R&D outcomes. To do so, the structural relationships of the effects were verified and, in order to prove validity and goodness of fit of the measured variables, exploratory and confirmatory factor analyses were performed. The results of this study suggest that the measured variables can be used again in future research as measured variables.

This study produced the following implications based on verification of the research model and hypotheses: first, in transformational leadership, charisma had a positive effect on organizational commitment and individualized consideration on job satisfaction. Second, in transactional leadership, contingent reward had positive effects on both organizational commitment and job satisfaction, while management by exception has an effect only on organizational commitment. Third, in organizational effectiveness, only organizational commitment had a positive effect on R&D outcomes. Fourth, in transformational leadership, only charisma and individualized consideration had a positive effect on R&D outcomes. Fifth, in transactional leadership, only management by exception had a positive effect on R&D outcomes. Overall, using leadership based on charisma and individualized consideration, and on contingent reward and management by exception can have positive effects on R&D outcomes by improving organizational commitment and job satisfaction.

The findings in this study proposed a direction for the way in which leadership should be formed and nurtured in order to improve R&D outcomes from R&D researchers, and, also, demonstrated the importance of management direction for improving business performance from the users' perspective. Furthermore, although existing research on transformational and transactional leadership and organizational effectiveness used diverse subjects, there is no empirical study on R&D outcomes that is focused on researchers. Therefore, this study has important implications for both academic purposes and management of corporate research centers.

However, this study was limited in that the subjects were selected only among researchers working at the R&D center of L Corporation, which operates in the manufacturing industry. Therefore, future research will need to include researchers in a more diverse range of industries.

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