

Shared Leadership in R&D Teams: Leaders as Antecedent and Team Performance as Consequence

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In order for Japanese manufacturers to have a competitive advantage in the global market, they have to develop new products that are highly original and satisfy customer needs. Therefore an R&D process is required to perform important roles. Because R&D processes are carried out by teams in many cases, promoting the performance of R&D teams is necessary for Japanese manufacturers.

Leadership is one of the most important factors to affect team performance, although there are various others. Many previous studies have indicated that leadership affects team performance considerably (Cohen and Bailey, 1997; Hackman and Walton, 1986; Kozlowski, Gully, Salas and Cannon-Bowers, 1996). Furthermore, some of them demonstrated that leadership has the most significant effect on performance (Sinclair, 1992; Zaccaro, Rittman and Marks, 2001). As a result of this, further research, focusing on leadership, was conducted in the R&D setting and a significant relationship between leadership and R&D team performance was verified.

However, most leadership research focuses on the individual team leader (Kozlowski and Bell, 2003; Stewart and Manz, 1995). This research has clarified the effective leadership of team leaders on the premise that only a single individual can influence team members and performance. However, it is not only a team leader who has an impact on team members and performance. Team members other than team leaders often affect each other, and in some cases they can have an effect on their team leaders. Hence, it is possible that team members other than appointed team leaders display leadership in teams.

In fact, each member is required to show leadership in R&D teams. Since the processes of R&D activities are highly complex and ambiguous, the effects of individual leadership are limited (Day, Gronn and Salas, 2004). Further, team members are researchers and they need autonomy in their research activities. This suggests that they desire that they share the function of leaders and participate in important decision making as team members rather than that team leaders alone take a leadership role inside the teams. In addition, team members are professionals and their specialist areas are different. In order to perform effectively as teams, team members simultaneously have to use their specialties and cooperate with each other. Accordingly they are each required to display leadership in R&D teams.

According to Carson, Tesluk and Marrone (2007), an emergent team property that results from the distribution of leadership influence across multiple team members is defined as shared leadership in this article. Some existing research has shown that shared leadership is positively related to team performance. As mentioned above, it is possible that shared leadership influences R&D team performance. Nonetheless, there is no research that has verified the relationship between shared leadership and team performance in an R&D setting.

Moreover, there are few studies that show the antecedent factors of shared leadership. If shared leadership has positive correlation with team performance, it is required to indicate what factors influence shared leadership.

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I Theoretical Background

1 Shared Leadership

Yukl (2002) defined leadership as influence processes involving determination of the group's or organization's objectives, motivating task behavior in pursuit of these objectives, and influencing group maintenance and culture. From these viewpoints, shared leadership originates from each team member who has influence to direct, motivate, and support other team members for team objectives. Furthermore, shared leadership is a collective construct because it is team property that is created through the series of interactions that team members have with each other involving the negotiation and sharing of leadership responsibilities (Carson *et al.*, 2007). Therefore, shared leadership can be regarded as a leadership network that affects and shapes both the team and individual attitudes and activities.

In order to explain the nature of shared leadership, it is also helpful to describe the difference with other similar constructs, such as empowering leadership and emergent leadership. Empowering leadership is a leadership style where leaders delegate their authority to followers and promote followers' abilities and motivation to achieve team objectives. Delegation, promotion of abilities and motivation may be significantly related to shared leadership. However, empowering leadership focuses on a single individual while shared leadership attaches importance to the fact that leadership is distributed to each member. Further, emergent leadership is a similar construct to shared leadership because shared leadership is usually emergent. Nevertheless emergent leadership focuses on emergence of leadership while shared leadership is concerned with team property.

Some research has verified the positive relationship between shared leadership and team performance thus far (Carson *et al.*, 2007; Pearce and Sims, 2002; Sivasubramaniam, Murry, Avolio and Jung, 2002). However, there is no research in an R&D setting, although it is possible that shared leadership influ-

ences R&D teams.

On the other hand, there are few studies that focus on the antecedents of shared leadership except Carson *et al.* (2007). Carson *et al.* (2007) identified internal team environment and external team coaching as antecedents of shared leadership. Internal team environment has three dimensions, which include shared purpose, social support, and voice. External team coaching is coaching by leaders of outside teams. Because Carson *et al.* (2007) investigated shared leadership of self-managing teams there were no formally appointed leaders in teams. As a result of analyses, it was shown that both internal team environment and external team coaching were related to shared leadership.

Certainly, external team coaching has a significant impact on shared leadership in self-managing teams. Nonetheless, formal leaders have a more significant impact on shared leadership than external leaders in Japanese R&D teams. This is because formal leaders are appointed in Japanese R&D teams and they have authority and responsibilities for activities and performance of teams. Therefore, leadership of formal leaders affects shared leadership remarkably.

2 Leadership in R&D Setting

Some existing research has focused on the effects of leadership on attitude and behavior of team members and team performance in an R&D setting and shown that transformational leadership and gate-keeping leadership has an important impact on them. Hence, it is possible that both leadership styles of formal leaders affect shared leadership.

2-1 Transformational leadership

Transformational leadership has been defined as a leader's behavior influencing followers by broadening and elevating followers' goals and by providing them with confidence to perform beyond the expectations specified in the implicit or explicit exchange agreement (Dvir, Eden, Avolio and Shamir, 2002). According to the transformational leadership theory, much of the previous leadership literature was premised on followers' rational decision-making. Based on that premise, followers behave in or-

der to maximize their rewards in the organization, which requires leaders to integrate followers' rewards with their goals. Therefore, it is most important for leaders to set goals, clarify desired outcomes, provide feedback, and exchange rewards for accomplishments (Dvir *et al.*, 2002).

In reality, however, followers do not necessarily behave in ways based only on rational decision-making. In high performance teams, especially, followers desire to prioritize contributions to team performance over their rational exchange agreement. In the transformational leadership theory, transformational leadership, which promotes followers' motivation to contribute to team performance at the cost of the rational exchange agreement, is distinguished from transactional leadership based merely on the rational exchange agreement between leaders and their followers. Transformational leadership has been extensively studied by leadership researchers in recent years, and a lot of empirical literature has indicated that it is related to job attitudes and performance of followers (Barling, Weber and Kelloway, 1996; Dvir *et al.*, 2002; Dumdum, Lowe and Avolio, 2002; Howell and Avolio, 1993; Lowe and Galen, 1996; Podsakoff, MacKenzie, Moorman and Fetter, 1990; Sosik and Godshalk, 2000; Walumbwa and Lawler, 2003; Yammarino and Dubinsky, 1994).

Some studies have figured out the effects that transformational leadership could have in R&D settings. Berson and Linton (2005) compared the effects of transformational leadership in R&D settings with those in non-R&D settings. As a result, although a significant correlation between transformational leadership and outcome variables including quality climate, job satisfaction, and overall satisfaction was observed in both R&D and non-R&D settings, it was even stronger in R&D settings than in non-R&D settings. Keller (1992) found that transformational leadership was positively related to R&D team performance, which included project quality and budget/schedule rated by project members and managers, respectively. Keller (2006) also pointed out, based on a longitudinal study, that transformational leadership could predict 5-year-later profitability and speed to market. Shin and Zhou (2003) found that intrinsic motivation mediat-

ed the relationship between transformational leadership and creativity of followers in Korean R&D settings, and that followers' conservation, which was one of the values, moderated the relationship between them. They indicated that followers' conservation largely affected the efficiency of transformational leadership in Korean cultural circumstances. Ishikawa (2008) showed that transformational leadership was positively related to R&D team performance in Japanese companies. Ishikawa (2008) indicated that although transformational leadership negatively influenced team performance through the norm for maintaining consensus, it had a positive impact on team performance through team efficacy. These results of previous studies suggest that transformational leadership of formal leaders affects attitude and behavior of team members and team performance significantly. Accordingly, it is likely that transformational leadership of formal leaders influences shared leadership in R&D teams.

2-2 Gate-keeping leadership

For R&D teams, communication is an important factor. This is because communication plays an important role in gathering information that is needed for the successful performance of an R&D team (Allen, 1977; Katz, 1982; Menzel, 1966). R&D team members acquire technological information not only through books and papers but also through external communication, which is communication among specialists outside the organizations (Allen, 1977; Farris, 1972). Therefore, external communication will affect team performance through promoting acquisition of technological information. Ancona and Caldwell (1992) showed empirically that external communication predicted R&D team performance.

However, information required for R&D performance is not only technological information. For example, it is necessary for R&D performance to also acquire information about manufacturing processes or customer needs. In order to acquire such information, internal communication, which is communication with members inside organizations such as members of the manufacturing or market-

ing departments, is useful. Therefore, internal communication will also affect R&D performance. Kahn (1996) showed empirically that internal communication predicted R&D team performance.

Gatekeeper is a communication star who can perform both internal communication and external communication frequently. It is difficult to smoothly perform both internal and external communication, since both contexts are different from each other. However, gatekeeper can perform both kinds of communication positively. Moreover, gatekeeper can also perform intra-team communication. Gatekeeper acquires technical information through external communication and transmits this to team members. Moreover, gatekeeper promotes cooperation and adjustment between departments through internal communication.

Allen (1977) empirically showed that in R&D teams in which gatekeeper exists, team members other than gatekeeper also come to perform intra-team communication and internal communication positively. Other members could perform intra-team communication and internal communication in comfort, since gatekeeper acquires and transmits technical information required for R&D performance from the outside.

Allen (1977) suggested that gatekeeper did not always correspond to the leader. That is, the leader and gatekeeper may exist simultaneously and play different roles respectively in a team. Conversely, it implies that some leaders perform the role of gatekeeper. In fact, there were some leaders who played the role of gatekeeper in sample teams of Allen (1977). When the leaders are also playing the role of gatekeeper simultaneously, smooth communication within the team will be performed and team members perform intra-team, internal, and external communication positively. Leadership that plays the role of gatekeeper is defined as gate-keeping leadership. Ishikawa (2007) found that gate-keeping leadership influenced communication of team members positively and as a result promoted team performance in Japanese R&D teams. Therefore, it is probable that gate-keeping leadership affects shared leadership in R&D teams.

II Hypotheses

Transformational leadership shows visions and clear goals that are attractive to team members. Further, it unites and inspires team members to achieve the visions and goals. The influence from transformational leadership is powerful, and sometimes too powerful. For that reason, it is possible that transformational leadership hinders team members from playing leadership role. In particular, some research has indicated that ideal influence, which is one dimension of transformational leadership, could suppress voice and criticism (Hogan, Raskin and Fazzini, 1990; O'Connor, Mumford, Clifton, Gessner and Connelly, 1995; Sandowsky, 1995). Moreover, Ishikawa (2008) found that transformational leadership fostered the norm for maintaining consensus in Japanese R&D teams. The norm is informal rules of conduct for behaviors considered important by most group members (George and Jones, 2005). The norm for maintaining consensus is the norm that promotes the importance of consensus per se (Postmes, Spears and Cihangir, 2001). When the norm for maintaining consensus is high in teams, it is hard to express opinions that are against leaders' intentions or team tendencies for team members. Under such leadership, team members feel it is difficult to influence each other voluntarily.

Hypothesis 1. Transformational leadership of formal leaders is negatively related to shared leadership.

Gate-keeping leadership of formal leaders can promote team members to display leadership. One reason is that gate-keeping leadership encourages communication between team members. Under gate-keeping leadership, team members actively communicate with inside employees and outside professionals, and they acquire information that is needed for effective R&D activities. These activities foster team members' abilities and knowledge that are related to their specialty. Those team members are also motivated to struggle to accomplish their research themes and to contribute to achievement

of their teams' goals. Team members who have high research abilities and high motivation for team goals tend to influence other team members.

Secondly, gate-keeping leaders understand that various kinds of communication are required for acquiring important information, and that various contexts are required for them. This is because they recognize various information is needed for knowledge creation since knowledge creation originates from the combinations of various existing information. Hence, it is likely that gate-keeping leaders understand not only various information but also various cognitive frameworks and sense of value are necessary for R&D team performance because diversity of cognitive framework and sense of value, which are bases for information processing, are required for knowledge creation (Pelz and Andrews, 1966). Under such leaders, team members recognize various contexts are required for team performance and they feel it is easy to declare their own opinions, even if they include criticism. As a result, team members tend to influence each other.

Hypothesis 2. Gate-keeping leadership of formal leaders is positively related to shared leadership.

Trust and cooperation among team members are strengthened by the fact that each team member performs leadership reciprocally. Exerting leadership voluntarily, team members can enjoy autonomy in their research activities. Increasing autonomy further encourages their intrinsic motivation significantly. Moreover, team members can share important information by sharing leadership. For the reasons mentioned above, shared leadership can influence R&D team performance. Actually, some previous studies empirically verified the relationship between shared leadership and team performance (Carson *et al.*, 2007; Ensley, Hmieleski and Pearce, 2006; Mehra, Smith, Dixon and Robertson, 2006; Pearce and Sims, 2002; Sivasubramaniam *et al.*, 2002).

Existing studies have not verified that relationship in an R&D setting. However, shared leadership is more important for R&D team performance. This is because shared leadership can influence intrinsic motivation, which is one of the most important factors that affects creativity, of team members. Cre-

ativity is very important for R&D performance since the goal of R&D activities is creation of new knowledge that is useful for new product development. Furthermore, knowledge creation requires information that can be a base for new knowledge. Therefore, sharing of various information inside teams with shared leadership can affect R&D team performance. In addition, it is necessary for effective R&D activities to strengthen information processing ability as teams by distribution of leadership among members because R&D processes are ambiguous and uncertain.

Hypothesis 3. Shared leadership is positively related to R&D team performance.

III Methods

1 Sample

The sample consisted of 124 development teams from 7 firms engaged in manufacturing industrial parts. In addition, 124 team leaders (100% response rate), 692 researchers (84.4% response rate) and 29 managers (100% response rate) participated in the study. Each researcher was a member of only 1 team, and each team was managed by one of 29 managers. Among the leaders, 91.9% were men, 8.9% of them held a doctoral degree, and their average age was 36.0 years old. Among the team members, 88.0% were men, their average age was 29.7 years old, and their average tenure in the team was 1.9 years. Average team size was 5.6 people.

Distribution and collection of the questionnaire were performed via the middle or high-level managers of the development department of each firm.

2 Measures

Transformational leadership was measured by twelve items adapted from Bass's Multifactor Leadership Questionnaire (Bass and Avolio, 1992). A sample item is: "I am proud to be associated with the leader". Each team member was asked to rate his/her leader's behavior on a 5-point response scale. Each of the four sub-dimensions, that is, idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration,

Table 1 Descriptive Statistics and Correlations

	Mean	s.d.	1	2	3	4	5	6	7	8
1. Age: Leader	35.99	4.65								
2. Phd.: Leader (dummy variable)	0.09	0.29	-0.02							
3. Team size	5.59	1.20	-0.10	-0.06						
4. Average age: Member	29.68	1.83	-0.03	-0.03	0.09					
5. Team tenure: Member	1.92	1.14	-0.07	-0.06	0.02	0.06				
6. Transformational leadership	3.17	0.61	0.16	-0.02	0.00	0.07	0.00	(0.89)		
7. Gate-keeping leadership	3.35	0.76	0.10	0.09	-0.12	0.10	-0.01	0.08	(0.87)	
8. Shared leadership	3.39	0.73	0.01	0.14	-0.29**	-0.05	-0.11	-0.33**	0.29**	
9. R&D team performance	3.03	0.92	0.12	0.18*	-0.12	-0.02	0.10	0.19*	0.30**	0.24** (0.90)

Scale reliability are in parentheses along the diagonal.

* $p < 0.05$, ** $p < 0.01$.

was measured by three items. In order to verify that these four factors did contribute to an overall transformational leadership index, a confirmatory factor analysis was conducted. The result of the analysis suggested that a higher-order factor solution provided an adequate fit ($\chi^2 = 131.27$ ($p < 0.05$), CFI = 0.94, RMSEA = 0.04, NFI = 0.93).

Gate-keeping leadership was measured by five items adapted from Hirst and Mann (2004). Each team member was asked to rate his/her leader's behavior on a 5-point response scale. A sample item is: "The leader is coordinating the team's task with outside stakeholders."

Shared leadership was measured by following Carson *et al.* (2007), which adopted a social network approach (Mayo, Meindl and Pastor, 2003) by using density. Density is a measure of the total amount of leadership that is displayed by each team member. Each team member was asked to rate each of his/her peers on the following question: "To what degree does your team rely on this individual for leadership?" on a 5-point response scale. Density was calculated by totaling all team members' ratings of each other's leadership and dividing that sum by the total number of potential connections among team members. Following the above calculation, teams in which many team members rate many of their peers as leaders yield higher density scores than teams in which only one individual or a few individuals are perceived as showing leadership. In this study, distribution of leadership rather than effectiveness or quality of leadership is focused on. Shared leadership is conceived along a continuum from the low-end team property, in which a single individual displays leadership, to the high-end team

property, in which every team member exerts leadership. Therefore, density is an adequate measure of shared leadership.

Team performance was measured by four items adapted from Keller (2001), that is: technical quality, schedule performance, cost performance, and overall team performance. The managers, who are higher in rank than team leaders were asked to rate each item on a 5-point response scale. Beforehand, the validity of this measure had been confirmed by interviewing some managers in R&D departments.

Control variables included the leader's age and possession or non-possession of a Ph.D. and his/her team size, all of which were provided by the leaders, as well as the team members' average age and tenure provided by the team members.

3 Aggregation Tests

Transformational leadership, gate-keeping leadership, and shared leadership were aggregated to mean values within each team, because this was the unit of the analysis. To justify this aggregation, r_{wg} (a within-group correlation) was computed to assess the amount of agreement between the team members (James, Demaree and Wolf, 1984). The mean r_{wg} values were ranged from 0.73 to 0.88 for transformational leadership, ranged from 0.74 to 0.89 for gate-keeping leadership, and ranged from 0.70 to 0.81 for shared leadership. These results indicated a good within-group agreement for those variables. In addition, one-way analysis of variance showed that between-group differences were more significant than within-group differences for those variables.

IV Results

The mean values, standard deviations, and coefficient alpha (α), as well as a correlation matrix are shown in Table 1. As expected, shared leadership had a significant positive correlation with transformational leadership and a negative correlation with gate-keeping leadership. Shared leadership also indicated a significant positive correlation with team performance. Further, team performance had significant positive correlations with transformational leadership and gate-keeping leadership.

To test the relationship between both transformational leadership and gate-keeping leadership and shared leadership, regression analyses were employed, the results of which are shown in Table 2. In step 1, only control variables were entered. In addition to step 1, transformational leadership and gate-keeping leadership were entered into the analysis in step 2. The results of these analyses show that transformational leadership was negatively related to shared leadership, while gate-keeping leadership was positively related to shared leadership. Hence, these results supported hypotheses 1 and 2.

To test the relationship between shared leadership and team performance and the effect of shared leadership as a mediator between both transformational leadership and gate-keeping leadership and team performance, hierarchical regression analyses were employed, the results of which are presented in Table 3. According to Baron and Kenny (1986), establishing the role of any mediator in the relationship between an independent variable and a dependent variable involves meeting four conditions. The first is that an independent variable is related to a mediator. Secondly, a mediator is related to a dependent variable. The third condition is that an independent variable is related to a dependent variable. Finally, the strength of the relationship between an independent variable and a dependent variable is reduced when a mediator is added to the model.

In step 1, only control variables were entered into the analysis. In addition to step 1, transformational

leadership and gate-keeping leadership were entered into the analysis as independent variables. Transformational leadership had no significant correlation with team performance, while gate-keeping leadership had a significantly positive correlation with team performance. In step 3, shared leadership was added to the analysis as a mediator. It shows transformational leadership, gate-keeping leadership, and shared leadership were positively related to team performance. The positive relationship between gate-keeping leadership and team performance still remains significant, though it was expected to disappear. Because the strength of negative correlation between transformational leadership and team performance was reduced by adding shared leadership, a significantly positive correlation between them emerged in step 3. On the other hand, the strength of the positive correlation between gate-keeping leadership and team performance was decreased by adding shared leadership, although the relationship between them was still significant. Those results correspond with the expectancy of Hypothesis 3.

V Discussion

The results of this study aiming to examine the relationship of leadership of formal leaders as an antecedent to and R&D team performance as a consequence of shared leadership provided important evidence to demonstrate a strong relationship between them. Transformational leadership was negatively related to shared leadership and gate-keeping leadership was positively related to shared leadership. Furthermore, shared leadership had a positive relationship with R&D team performance.

This evidence indicates that formal leaders are required to exert gate-keeping leadership to promote R&D team performance because gate-keeping leadership of formal leaders fosters team performance through encouraging shared leadership. On the other hand, the results of the analyses suggest transformational leadership positively influences R&D team performance through factors other than shared leadership since in step 3 of Table 3,

Table 2 Results of Regression Analyses for Shared Leadership

	Step 1	Step 2
Controls		
Age: Formal leader	-0.02	0.01
Ph.D.: Formal leader (dummy variable)	0.12	0.09
Team size	-0.28**	-0.24**
Average age: Team member	-0.02	-0.03
Average team tenure: Team member	-0.10	-0.09
Leadership of Fomal Leader		
Transformational leadership		-0.35**
Gate-keeping leadership		0.28**
R^2	0.11*	0.29**
Adjusted R^2	0.07	0.25
ΔR^2		0.18**

The estimates are standardized regression coefficients.
 * $p < 0.05$, ** $p < 0.01$.

transformational leadership is positively related to team performance by adding shared leadership to the analysis. It can be inferred that transformational leadership is effective if the negative influence on shared leadership is suppressed.

Now, how can we suppress the negative effect of transformational leadership? First, formal leaders should perform gate-keeping leadership and transformational leadership simultaneously. The construct of gate-keeping leadership is different from the construct of transformational leadership. Therefore it is possible for leaders to play both roles. If leaders perform gate-keeping leadership with transformational leadership, leaders can reduce the negative influence of transformational leadership on shared leadership since gate-keeping leadership is likely to depress the too strong influence of transformational leadership on team members. Gate-keeping leadership promotes communication between team members by fetching various kinds of information into the teams. Hence, it fosters autonomy of team members because autonomy is needed for frequent and flexible communication. It is possible that autonomy reduces the negative effect from transformational leadership.

Secondly, transformational leaders should delegate and empower team members to reduce the negative influence from transformational leadership. The negative effect of transformational leadership on shared leadership is inevitable because its

Table 3 Results of Regression Analyses for R&D Team Performance

	Step 1	Step 2	Step 3
Controls			
Age: Formal leader	0.13	0.07	0.07
Ph.D.: Formal leader (dummy variable)	0.19*	0.17	0.14
Team size	-0.10	-0.07	-0.01
Average age: Team member	-0.01	-0.05	-0.04
Average team tenure: Team member	0.12	0.12	0.14
Leadership of Fomal Leader			
Transformational leadership		0.17	0.26**
Gate-keeping leadership		0.26**	0.18*
Shared Leadership			0.26**
R^2	0.07	0.17**	0.22**
Adjusted R^2	0.04	0.12	0.16
ΔR^2		0.10**	0.05**

The estimates are standardized regression coefficients.
 * $p < 0.05$, ** $p < 0.01$.

impact is too strong. Accordingly, it is important that leaders should intentionally suppress the negative effect of it by delegation or empowerment to promote leadership of team members.

The findings of this study suggest that formal leaders are required not only to show adequate leadership but also to promote leadership of other team members for team performance. Hence, development of leadership of team members is needed as well as leadership of formal leaders. Furthermore, a development program on leadership, which focuses on leadership development of followers, is also demanded for Japanese manufacturers.

As with most research, this study cannot be exempt from some limitations. The first is that the data regarding transformational leadership, gate-keeping leadership, and shared leadership were all collected from a common set of sources. Although researchers have shown that common method bias was rarely significant enough to invalidate research findings (e.g., Doty and Glick, 1997), replications and extensions of the findings are needed. The second is that the use of cross-sectional data precluded definitive assertions regarding causality. To prevent this from recurring in future studies, a longitudinal design will be essential. The third is that the subdivisions of research and development were not separately examined. A prior study implied that the difference between research and development could be an important moderator in terms of the correla-

tion between transformational leadership and R&D team performance (Keller, 1992). Therefore, research that distinguishes between the two subdivisions will be awaited with interest.

Despite these limitations, it is hoped that the present study has made at least some theoretical contributions to the literature on shared leadership in R&D teams, as well as practical contributions for those who are responsible for developing effective R&D leadership.

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