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Leadership and Creativity in Research and Development Laboratories: A New Scale for Leader Behaviours

by

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LEADERSHIP AND CREATIVITY IN REASERACH AND DEVELOPMENT LABORATORIES: A NEW SCALE FOR LEADER BEHAVIOURS

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ABSTRACT

Using a qualitative approach Gupta and Singh (in press) developed an inventory of leader behaviors that promote employee creativity. In this study, we construct and validate scales that can measure the leader behaviors proposed by Gupta and Singh (in press) quantitatively. We surveyed 584 scientists working in 11 Indian R&D laboratories for this purpose. Exploratory and confirmatory factor analyses revealed five creativity-enhancing leader behaviours - task-oriented, recognising and inspiring, empowering, team-building and developing, and leading-by-example. We discuss the implications of the study findings for future research and management practices.

Keywords: Leadership; leader behaviours; employee creativity; R&D management.

INTRODUCTION

Research and Development (R&D) work is a driving force of the global economy and the main source of scientific breakthroughs (Dewett, 2007). R&D teams provide an organisation with competitive advantage by generating, deploying, transferring, and integrating new technological knowledge (Ángel & Sánchez, 2009). Employee creativity, typically defined as the production of novel and useful ideas for organisational products, services, or processes (Amabile, 1983; Zhang & Bartol, 2010), has become one of the key drivers of growth, performance, and valuation in organisations today. Engaging in behaviours that are creative process and outcomes is an integral part of an R&D professional's role requirement (Montag, Maertz & Baer, 2012). The identification of key factors that can foster and sustain R&D professionals' engagement in creative behaviours carries significant implications for enhancing organisational competitiveness (Manolopoulos, 2006; Zheng, Khoury & Grobmeier, 2010). In recent years, research on knowledge workers and knowledge-intensive firms such as R&D firms is proliferating (Khatri, Baveja, Agrawal & Brown, 2010). Alvesson (2000) defines knowledge-intensive firms as firms where most work can be said to be of an inte

the critical role in the achievement of broader societal goals, it tends to demand quite different kind of authority relationships as compared to those that are seemingly performing less critical roles (Clarke, 2002; Elkins & Keller, 2003; Kar, 1971). These characteristic of R&D professionals pose unique challenges to leadership. There is, however, little empirical research about the skills necessary to lead R&D professionals (Berson & Linton, 2005). The purpose of the present study is to examine the behaviours of R&D leaders and to establish an empirical basis for understanding their effectiveness in today's R&D organisations. We build on a set of studies that were carried out in government-owned R&D laboratories in India and develop scales to measure leadership that is sensitive to the requirements of R&D professionals, teams, and departments. Specifically, the study aims to identify the important leader behaviours that encourage creativity in a R&D work environment.

LITERATURE REVIEW

Measuring Leadership in R&D Environments

Researchers studying the impact of leader behaviours on employee creativity continue to use an available, "validated" questionnaire for their research without careful consideration about the relevance of the content for their research question and sample (e.g. Gong, Huang & Farh, 2009; Jung, Chow & Wu, 2003; Zhang & Bartol, 2010). Most of the studies testing the impact of leadership on employee creativity are inspired by the popular two-factor behavioural conceptualisations (e.g. initiating structure/task-oriented and consideration/relation-oriented – Blake & Mouton, 1964; Fleishman, 1953; transformational and transactional – Bass, 1985). The apparent differences between the leadership requirements of traditional and R&D environments suggest that conventional measures of leadership may apply only partially to empowered environments (i.e. R&D) (Arnold, Arad, Rhoades & Drasgow, 2000; Khatri, 2005; Yukl, 1999,

Table 1. Leader Behaviours Identified by Gupta and Singh (in press)

Behaviour	Definition
Task-Oriented Behaviours	
Clarifying	Assigning tasks, providing directions about how to do the work, and communicating a clear understanding of job responsibilities, task objectives, deadlines, and performance expectations.
Problem Solving	Identifying work-related problems, pointing out problems and giving suggestions to improve, and acting decisively to implement solutions to resolve important problems or crises.
Monitoring	Gathering information about work activities and external conditions affecting the work, checking on the progress and quality of the work, evaluating the performance of individuals through regular meetings.
Buffering	Serving as the main buffer between their teams and the labs, in order to filter down unnecessary administrative duties to protect staff time, while ensuring communication between the lab and the members.
Empowering Behaviours	
Consulting	Checking with people before making changes that affect them, encouraging suggestions for improvement, inviting participation in decision making, and incorporating the ideas and suggestions of others in decisions.
Empowering	Allowing subordinates to have substantial responsibility and discretion in carrying out work activities, handling problems, and making important decisions.
Relation-Oriented Behaviours	
Inspiring	Using influence techniques that appeal to emotion or logic to generate enthusiasm for the work, commitment to task objectives, and compliance with requests for cooperation, assistance, support, or resources.
Supporting	Acting friendly and considerate, being patient, and helpful, showing sympathy and support when someone is upset or anxious, and being like a friend.
Developing	Shows concern for development, helps identify skill deficiencies, does things to facilitate a person's skill acquisition, professional development, and career advancement, and allows access to resources and facilities.
Recognising	Providing praise and recognition for effective performance, significant achievements, and special contributions, and expressing appreciation for someone's contributions and special efforts.

years were dropped from the sample to ensure that subordinates knew thei

Doing this reduced the list of behaviour items from 55 to 39. The list of retained and dropped items is provided in Table 3. The remaining 39 items were then used in the final survey.

Table 3. Pilot Testing of Leader Behaviour Questionnaire

Item	Number of times reported "not applicable (?)"	Dropped / Modified

	unnecessary political interference.		
26.	Avoids unnecessary administrative tasks to protect productive time.	6	No change
27.	Clarifies priorities and deadlines.	9	No change
28.	Assigns work carefully depending on each employee's strengths.	9	Dropped
29.	Clarifies the person's responsibilities and his/her scope of authority.	8	No change
30.	Clearly explains the assignment to me.	9	No change
31.	Points out possible problems in my ideas.	8	No change
32.	Handles work-related problems in a decisive and confident way.	6	Dropped
33.	Takes the initiative in identifying and resolving work-related problems.	6	Modified
34.	Resolves work-related problems quickly to prevent unnecessary costs or delays.	8	Modified
35.	Is an expert in his/her field.	4	No change
36.	Works as hard as he/she can.	5	No change
37.	Accepts failures and does not blame juniors for them.	5	No change
38.	Leads by example in terms of abiding by the rules of the institute.	5	Dropped
39.	Sets high standards for performance by his/her own behaviour.	5	Dropped
40.	Observes operations directly when it is feasible.	6	Dropped
41.	Asks specific questions about the progress of work.	4	No change
42.	Conducts periodic progress review meetings.	3	No change
43.	Monitors key process variables as well as outcomes.	3	No change
44.	Gives credit (e.g. name in the journal publication) to people involved in a project based on their contributions.	5	Dropped
45.	Appreciates specific contributions and achievements.	3	No change
46.	Provides recognition that is timely.	4	No change
47.	Praises improvements in performance.	3	Modified
48.	Says things that make me feel proud to be part of this research group.	5	No change
49.	Develops in me proud feeling of giving something back to the society.	5	No change
50.	Expresses confidence in me even when there is a difficult task.	7	Dropped
51.	Encourages me to see the situation as one full of opportunities.	6	No change
52.	Provides written materials and documents, and answers requests for technical information.	13	Dropped
53.			

1999). As is typically the case with discrete item responses, the

Table 4. Results of Exploratory Factor Analysis

Factor Label, Reliability and Items	Factor				
	1	2	3	4	5
Factor 1 – Task-oriented behaviour (Cronbach α = .94)					

Factor 4 – Team building and developing behaviour (Cronbach = .91)					
1. Emphasizes common interests and values.	.04	.01	-.04	.78	-.02
2. Encourages interaction amongst colleagues.	.01	.04	.02	.69	.03
3. Encourages cooperation and teamwork.	n1 0<0003>3r		-.02		

leading by example and supporting behaviour categories. The factor was labelled as leading by example behaviour.

Confirmatory Factor Analysis

The R&D leader behaviour subscales were next analyzed by confirmatory factor analyses (CFA), with LISREL 8.52 (Jöreskog & Sörbom, 1993) to examine the factor structure of the proposed instrument. CFA was also used to check for the discriminant and convergent validity of the five factor model. We followed the test suggested by Bagozzi and Phillips (1982) and later by Anderson and Gerbing (1988) to check for the two validities. This test involves comparing the five factor model to a similar model in which the correlations among the factors are all constrained to 1. A significantly lower χ^2 value for the model in which the correlations are not constrained to unity would indicate that the constructs are not perfectly correlated and that discriminant validity is achieved. We considered a number of alternative factor models in the process of evaluating the proposed factor structures. The appropriateness of each model was examined using several indices of fit such as the ratio of chi-square to its degrees of freedom (χ^2/df), the Root Mean-Square Error of Approximation (RMSEA), Standardized Residuals (SRMR), Goodness of Fit Index (GFI), Incremental Fit Index (IFI), and Non-Normed Fit Index (NNFI).

Table 5. Model Fit Indices for Each Model

Model	χ^2	df	χ^2/df	NNFI	IFI	GFI	SRMR	RMSEA	χ^2
5-factor	1515.26	677	2.24	.99	.99	.86	.042	.051	--

CFA was conducted using the second sample (cases with the random variable equal to 0) having 280 respondents. Table 5 summarises the fit of the competing models. The 5-factor CFA showed very good fit with the data and confirmed the presence of the 5-factor structure. All items had significant loading ($p<.01$) on their respective factors. The five factor model showed significantly high correlation ($r = .76$) between *task-oriented behaviour* and *team building and developing behaviour*, and a high correlation ($r = .73$) between *task-oriented behaviour* and *recognising and inspiring behaviour* (see table 6). Due to these high factor inter-correlations, we examined two four-factor models. In the first four-factor model, model 'A', *task-oriented behaviour* and *team building and developing behaviour* were combined into one factor. In the second four-factor model, model 'B', *task-oriented behaviour* and *recognising and inspiring behaviour* were combined into one factor. Comparisons of the five-factor model and each of the four-factor models showed significant changes in the chi-square to degrees of freedom ratios; model A - $\Delta\chi^2/\Delta df = 85.1$ ($p<.01$), model B $\Delta\chi^2/\Delta df = 196.4$ ($p<.01$). Ratios of this size provided evidence for the existence of separate factors underlying task-oriented, team building and developing behaviour, and recognising and inspiring behaviour.

Next, a three factor model was tested merging items of *task-oriented behaviour*, *team building and developing behaviour* and *recognising and inspiring behaviour*. The three factor model showed significantly poor fit than the four factor model ($\Delta\chi^2/\Delta df = 273.63$, $p<.01$). A two-factor model, formed by merging of items of task-oriented, team building and developing, recognising and inspiring, and lead by example behaviours also showed significantly poor fit than the three factor model ($\Delta\chi^2/\Delta df = 271.89$, $p<.01$). Finally, a one-factor model showed a very poor fit than the two-factor model ($\Delta\chi^2/\Delta df = 21719.03$, $p<.01$).

The factor means, standard deviations, inter-correlations between factors, Cronbach's alpha reliabilities, composite reliability of the measurement model, and Average Variance Extracted (AVE) are presented in table 6.

Table 6. Descriptive Statistics and Correlations

Leader Behaviours	CR[a]	M	SD	1	2	3	4	5
1. Task-Oriented behaviour	.94	3.55	.88	(.58)	.53	.22	.58	.40
2. Recognising and Inspiring behaviour	.93	3.59	.95	.73**	(.67)	.31	.54	.42
3. Empowering behaviour	.86	3.82	.79	.47**	.56**	(.51)	.39	.31
4. Team Building and Developing behaviour	.90	3.73	.90	.76**	.74**	.62**	(.58)	.44
5. Leading-by-Example behaviour	.85	4.03	.81	.63**	.65**	.56**	.66**	(.54)

a CR: Composite Reliability of the measurement model

Average Variance Extracted (AVE) for each factor is provided in parenthesis along the diagonal; Values above the diagonal (i.e. AVE) are square of correlations; **p<.01(two-tailed); N=584

AVE for each factor is given in the parenthesis along the diagonal. The average variance extracted for all the five leader behaviour factors is greater than 0.5, thereby suggesting adequate convergent validity (Fornell & Larcker, 1981; Ping, 2005). Moreover, the square of the correlation between two factors (values given above the diagonal in Table 6) is not greater than either of their individual AVEs, suggesting that the factors each have internal (extracted) variance greater than variance shared between the factors and have adequate discriminant validity (Fornell & Larcker,1981; Ping, 2005). The internal consistency of the measurement model was assessed by computing composite reliability. These composite reliability coefficients ranged from .85 to .94 and are greater than the benchmark of .60 recommended by Fornell and Larcker (1981). Results in Tables 5 and 6 provide evidence of the convergent and discriminant validities of the R&D leader behaviour instrument. We call the measurement instrument as 'Leader Behaviour Scale for R&D Context' (LBS-RnD), as was done by Gupta and Singh (in press).

Task-oriented behaviour is primarily concerned with accomplishing a task in an efficient manner. The category includes clarifying roles and objectives, monitoring, problem solving and buffering behaviours. *Recognising and inspiring behaviour* is primarily concerned with the providing praise and recognition for effective performance and using influence techniques that appeal to emotion or logic to generate enthusiasm for the work.

Involving subordinates in the decision-making process often leads to better acceptance of decisions and increases the chance of getting them implemented in organisations. In line with the findings of previous researches on leadership and creativity (e.g. Zhang & Bartol, 2010), *empowering behaviour* emerged as a significant behavioural dimension. Leaders can set standards of high performance by their own behaviour. By doing so they motivate their subordinates to emulate them and also show them how to be successful at work. Leaders who lead by example are considered to be more charismatic and transformational and can influence followers to internalise attitudes and beliefs that subsequently serve as a source of intrinsic motivation to carry out organisational mission (Shalley & Perry-Smith, 2001). *Leading by example* is the fifth behaviour dimension that emerged from the study.

Regardless of the particular behavioural category, subordinates' ratings were either consistently favourable or unfavourable. As suggested by Arnold et al. (2000), the moderate to high correlations among the behaviour dimensions may be a property of leader behaviour rating scales. These results demonstrate a 'halo effect', or subordinates' tendency to have a holistic perception, favourable or unfavourable, of their leader that affects their ratings and should not be taken as evidence that these categories are essentially redundant.

R&D Leader Behaviours and Creativity

The componential theory of individual creativity mentions three major ingredients of creativity: expertise, creative-thinking skill, and intr

and learning opportunities are positively associated with work engagement (Bakker, 2010), an important antecedent of creativity (Bakker & Demerouti, 2007) .

Creativity is often enacted in teams and teams that seek information, address their differences of opinion, and question problem-solving assumptions engage in greater learning (Ángel & Sánchez, 2009; Hirst, Van Knippenberg & Zhou, 2009). Leaders, by emphasizing team work, can increase the frequency of interactions between the team members (Mumford, Scott, Gaddis & Strange, 2002) thereby leading to a greater understanding of the problem and to its creative solution (Hoegl, Weinkauf & Gemuenden, 2004). Work groups should be composed of diversely skilled individuals and led by supervisors who clearly set overall goals for projects but allow operational autonomy in achieving those goals (Amabile, 1997). Leaders, through developing and task-oriented behaviors, can ensure that their subordinates have the expertise to carry out their work, and at least minimally sufficient time to consider alternative approaches.

According to Bandura (1997), learning can take place vicariously by modelling and self-control processes. Individuals are more likely to perform a work task after a visual demonstration of a successful behaviour or through the transmission of examples of appropriate rules and thought processes (Shalley & Perry-Smith, 2001). Employees who work under leaders who are expert in their work and who lead by example are bound to be subjected to much more modelling experience that can enhance subordinates' self-confidence and eventually creativity at work.

Implications for Practice

The behaviours identified in this study have important implications for leadership training and development. This list of behaviours can help practitioners who often wrestle with the task of identifying appropriate behaviours that can ensure leader effectiveness. Development of training

modules around these behaviours will lead to better return on

behaviours), and work outcome variables (e.g. creative performance, quality) should be empirically examined. This process of construct validation would improve our understanding of the effectiveness and potential use of this leader behaviour inventory. A greater understanding of R&D leadership has implications for both theory and the practice of R&D management.

CONCLUSION

The apparent differences between the leadership requirements of traditional and R&D environments suggest that traditional measures of leadership may not be applicable to R&D work environments. In this study, we extend behavioural leadership theories to R&D context and develop a leader behaviour scale that can be used to gauge the effectiveness of R&D managers and leaders. The leader behaviours that are found to be important are *task-oriented*, *recognising and inspiring*, *empowering*, *team-building and developing*, and *leading by example*. The identified behaviours can be useful to practitioners who often wrestle with the task of identifying appropriate behaviours that can ensure leader effectiveness in R&D departments. Studies that evaluate comprehensive views of these behaviours and where subordinates are provided an opportunity to rate many leader behaviours will yield information on the behaviours that are most desirable to employees, and those most likely to encourage creative behaviour in R&D contexts. This is the first study of its type and promises to provide significant insights into the management of R&D professionals.

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