Preliminary pointers towards improving the work environment in CSIR laboratories: Remarks from an empirical study

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This paper reports the findings of an empirical study of work environment in the Research and Development (R&D) laboratories under the Council of Scientific and Industrial Research (CSIR), India. Cases from three national laboratories under the CSIR have been considered for this study. The paper has two sections. The first section refers to the work climate of scientists in R&D laboratories and the second one refers to the functioning of work groups in these laboratories. The work described in the paper attempts to explore the factors affecting the motivation of scientists in their work situations and also the factors affecting the overall satisfaction of the scientists with their work groups. The results of the present investigation have important implications for the management of R&D organizations and the overall effectiveness of such organizations.

EXAMINATION and evaluation of work environment in Research and Development (R&D) laboratories enable one to formulate strategies that can improve the behavioural aspects in institutional functioning and effective organizational performance. In this paper we report the findings of an empirical study of the factors affecting motivational levels of scientists working in the laboratories under the Council of Scientific and Industrial Research (CSIR), India, and the factors contributing to the overall satisfaction of these scientists with their work groups.

The set of studies on factors affecting the work environment of R&D organizations forms an important subset of a larger body of literature on the management of these organizations. Tuttle *et al.*[1] have focused on assessing the job satisfaction of research scientists. Tagiuri[2] has carried out a study aimed at determining key factors in the work system of R&D managers that are vital for minimizing their dissatisfaction level. Litwin and Stringer[3] have focused on the consequences of organizational climate for individual motivation, thus supporting the general idea that climate encompasses both organizational conditions and individual reactions. They have sought to define organizational environments in terms of nine work-climate dimensions: structure, responsibility, reward, risk, warmth, support, standards, conflict and identity.

Work-climate: The concept

Work-climate portrays organizational environments as being rooted in the organization's value system, but tends to present the social environments in relatively static terms, describing them in terms of a fixed (and broadly applicable) set of dimensions. Thus, the climate is often considered as relatively temporary, subject to direct control, and largely limited to those aspects of social environment that are consciously perceived by organizational members. Researchers on work climate have also shown their concern about the impact that organizational systems have on groups and individuals[4,5] alike. They have placed due emphasis on the categorization of observable practices and perceptions into analytic dimensions defined by them[6].

Menon and Shamanna[7] have indicated that the interpersonal relationships that prevail within an organization are influenced by the nature of the work in that organization. Interpersonal relationships can affect productivity and this can modify the satisfaction an employee derives from his job. Sherman and Olsen[8] have examined differential characteristics of organizational climate and the relationship between various dimensions of organizational climate and performance across stages of the project life-cycle in R&D organizations.

Job satisfaction could be viewed as a positive attitude towards one's work which results from many specific job-related experiences[9]. Lambert[10] has found that jobs that provided employees with the opportunity to do a variety of tasks which were personally meaningful promoted job satisfaction, job involvement and thereby intrinsic motivation. Kline and Boyd[11] have reported that for middle managers and vice-presidents of a company, job satisfaction was related more frequently to the dimensions of organizational climate rather than its structure. Sharma and Bhaskar[9] have considered recognition and appreciation as important determinants of job

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satisfaction, in their study of engineers in a public-sector undertaking in India.

Strength of motivation is a factor influencing the performance of research teams. A number of studies have shown that intrinsic motivation is conducive to creativity than extrinsic motivation[12]. However, several extrinsic motivators may operate as supports to creativity: reward and recognition for creative ideas, clearly-defined overall project goals, and frequent constructive feedback on the work. Pelz and Andrews[13], in their study using data from more than 1300 American scientists, found that the ratings of the respondents on dedication to their work showed significant positive relationships to both ratings of performance and actual output of scientific products for scientists from widely different disciplines and laboratories. They have also observed that the performance of the scientists increased when tasks like decision-making and goal-setting were carried out in a participative fashion.

R&D is no longer an individual effort. It is largely a team contribution. Study of the factors that motivate a research team for better performance is therefore important for R&D management theory and practice. Amabile *et al.*[14] have studied the work environment surrounding project teams in a large company. They have found that nominated high-creativity projects were significantly higher in job satisfaction rating on six work environment factors – freedom, positive challenge, supervisory encouragement, work-group supports, organizational encouragement and sufficient resources while they were significantly lower in job satisfaction rating on two work environment factors – organizational impediments and excessive workload pressure than the nominated low-creativity projects. In addition, the high creativity projects were higher on the two outcome scales assessing creativity and productivity. Harris and Lambert[15] have probed the role of senior managers in building effective R&D teams.

Innovation, as a process, is the creation of new products or services or enhancement of existing products or services, or the creation of organizational processes that have a significant impact on a person, group, organization, industry or society[16] at large. In an innovative organization, team building and effective teamwork are recognized as significant variables in the effectiveness of the organization. Some of the important factors that have been found to be associated with innovations include tolerance for calculated risks[3,17], levels of lateral communication[18], communication external to the organization, support from senior management[19,20], and high levels of autonomy and decentralized decision-making[17,19,20]. This is more so in the case of R&D organizations where the primary work for technology development is normally carried out in the research units. In his study, Klenke[21] has observed that Boeing has employed teams to reduce engineering costs, while Microsoft and Apple have used teams to enhance product design, innovation and creativity. The essence of teamwork is synergy, that is, what might be accomplished by functioning as a team is more than what could be accomplished by a collection of individuals. Teams are interactive, collaborative units that are behaviourally integrated[22]. A team's performance includes both individual contributions and what has been called a collective work product. A cohesive work product is what the team members must accomplish together; it reflects the joint, real contributions of the team members[21].

Pelz and Andrews[13] have found that the performance of scientists was high when they experienced a sense of belonging to a group, headed by a competent leader. The positive effects of leadership are mediated through the supervisor's ability to provide optimal work organization and stimulating working climate. Higher managerial levels in a technology-based R&D organization demand strong interpersonal as well as technical skills. Quoting from a few earlier studies, Jain and Triandis[23] have observed that in the high-innovation groups, the supervisors were more active participants in the informal organization. They were especially helpful to group members for critical evaluation, administrative aid, and help in thinking about technical problems. In addition, group members were more helpful to these supervisors for providing technical information, to aid in thinking about technical problems, critical evaluation, and original ideas. Brown *et al.*[24] have carried out a study involving 44 members of 14 project teams who worked on the same computer-simulated project. According to the results of this study, technical expertise appears to have been valued more highly in the high-performing groups than in the low-performing groups. They have also observed that groups assigned to a technical task with a measurable outcome are most likely to start off on the right foot, if they focus on the task right from the outset.

The present study

We report here, part results of a larger study on scientists' perception on the work environment in R&D organizations functioning under the CSIR, which is an autonomous society under the Societies' Registration Act, 1860 with the Prime Minister of India as its ex-officio President. The Governing Body is the highest policy decision-making body of the CSIR. The Director-General is its ex-officio chairman. The CSIR Headquarters at New Delhi coordinates the activities of the laboratories. The Council enters into bilateral agreements in the fields of pure as well as applied sciences with scientific organizations of various countries. The CSIR has in its fold 42 national laboratories and a number of field stations working in different fields of R&D spread all over the country.

Based on the results of an earlier pilot study, a questionnaire was designed for use in this study. Three research laboratories belonging to different Coordination

Councils of CSIR, namely Central Food Technological Research Institute, Mysore, Indian Institute of Chemical Technology, Hyderabad, and National Chemical Laboratory, Pune (represented in the study as Lab-1, Lab-2 and Lab-3 respectively) have been selected for the study. The scientists were chosen using systematic random sampling, with every third scientist from the standard random list. In all, 208 scientists from the three R&D laboratories had participated.

The dimensions of work environment have been divided into two categories: (1) related to the work groups, and (2) related to the overall organizational system. There were nineteen questions related to eight work climate factors in the first part of the questionnaire: human resource primacy, communication flow, decision-making practices, technological readiness, senior scientists' influence, junior scientists' influence, goal clarity, and motivational conditions. The second part of the questionnaire was on work-group processes containing nine questions related to eight factors: coordination, group decisions, knowledge of the job, information sharing, motivation to achieve objectives, group adaptability, confidence and trust, and overall satisfaction with the work group.

For analysing the first part of the questionnaire, cluster analysis has been used to determine those organizational factors that form a cluster with the factor 'motivational conditions'. The aim was to find out the significant factors that need to be tackled along with the concern for motivation, so that the scientists could achieve an optimum level of satisfaction. For the second part, stepwise regression has been carried out to find the key factors that contribute significantly to the overall satisfaction of the scientists with their work groups.

Results

Table 1 presents key background information of the respondents. There is not much difference in the average age of the respondents. It is also clear that the participants had sufficient experience (17–21 years), of which a significant part is in the laboratories (14–18 years). Overall, respondents of Lab-3 had comparatively less average age, less total service record and less service in the laboratory. It appears that a large number of respondents have started their career in their respective laboratories only.

The response to the questionnaire was subjected to cluster analysis, with motivation as the central factor (three laboratories separately). Our aim in this analysis was to understand the factors necessary to provide a climate that will motivate the scientists in their work situations. The three factors found common in the three laboratories are: human resource primacy, communication flow and decision-making practices. In addition to these three factors, goal clarity has been found to be important in Lab-2 and Lab-3, and technological readiness in Lab-2, as factors related to motivation. It is surprising that items related to the organizational policies, the nature of work itself, etc. have not been observed as motivational forces. Perhaps the scientists are satisfied with these factors or they do not consider these factors to be important enough in activating themselves towards the performance of their tasks.

The general inference is that in case the management of an R&D organization wishes to activate and motivate the scientists to put up a better performance, it is imperative that a suitable system of decision-making involving scientists at different levels, and a proper system of communication – upward, downward and parallel across the entire organization, be developed.

Better communication systems can help scientists to update knowledge in their area(s) of interest, and can improve productivity. Better awareness will be useful for overall effectiveness of the laboratory functioning. The main purpose of communication network is the organization and processing of information. In R&D laboratories, only a small percentage of all idea-generating information comes from the scientific literature. In his study, Allen, (quoted by Jain and Triandis[23]), has found that even in the problem-definition stage, personal contacts provide more than five times the number of messages supplied by written sources. Therefore, communication through personal contacts is a crucial aspect of the innovation process.

Table 1. Background information of respondents

Background data	Lab-1 ($N = 64$)	Lab-2 ($N = 62$)	Lab-3 ($N = 82$)
	(Figures in years)		
Age			
Mean	45.13	43.95	41.53
SD	7.49	8.25	9.45
Length of service			
Mean	21.02	18.74	16.91
SD	7.72	8.76	9.83
Service in laboratory			
Mean	17.92	16.44	14.39
SD	8.52	8.79	9.84

Table 2. Stepwise regression of overall work group satisfaction

	Significant factor	R^2	R^2 change
Lab-1 ($N = 64$)	Information sharing	0.62	
	Group adaptability	0.76	0.14
	Making group decisions	0.84	0.08
Lab-2 ($N = 62$)	Confidence and trust	0.49	
	Group adaptability	0.61	0.12
	Making group decisions	0.70	0.09
Lab-3 ($N = 82$)	Confidence and trust	0.62	
	Coordination	0.79	0.17
	Making group decisions	0.86	0.07

Good communication and suitable decision-making practices in a laboratory are crucial for job satisfaction of scientists. If the top management of R&D laboratories wishes to motivate its scientists, adoption of steps like decentralization of the decision-making system and developing a climate where people feel free to participate, at least on those issues that affect themselves and their work environment, is essential.

In order to understand the factors and forces that contribute significantly to the overall satisfaction of the scientists with their work groups, stepwise regression was carried out and results are presented in Table 2.

Scientists from Lab-1 have perceived three key factors – information sharing, group adaptability and making group decisions – as explaining the variance in their overall group satisfaction. Therefore, if any action to increase the group effectiveness is considered, then the management must develop a system in which the relevant information is shared with the concerned scientist(s). Group decisions are made in a participatory style, and some sort of training in group adaptability is imparted to them. For Lab-2, the significant factors are: confidence and trust, group adaptability and making group decisions. A new factor for this laboratory is confidence and trust among the group members. Thus, the scientists desire that for effective performance of the group, a higher degree of trust leading to a high degree of cooperation among the members of a given work group is a necessity. Yet another new factor that has been observed for Lab-3 is coordination among various functions performed by the groups. This is perhaps more so due to the interdisciplinary and multidisciplinary nature of modern R&D.

Conclusions

The main objective of the study was to get some preliminary pointers towards a greater understanding of the work environment in R&D laboratories of CSIR. Work environment has been seen as consisting of two parts: one related to the organizational variables and the second related to the group variables. The factor 'motivational conditions' has been found to form a cluster with four factors – human resource primacy, communication flow, decision-making practices and technological readiness. Therefore, any attempt to increase the motivational levels of scientists should incorporate improvement in their working conditions, evolving better communication systems, carrying out regular upgrading of technology, and in adopting decision-making practices that should involve scientists at all levels.

Analysis of stepwise regression indicates that there are three significant factors that contribute to the variation in overall satisfaction of respondents with their work groups. These are information sharing, group adaptability and making group decisions. Thus, in order to build team spirit among a group of scientists, due emphasis must be allotted to these three variables. A higher level of information sharing within and among the different work groups, adaptability of these groups with the changing priorities of the concerned laboratory, and general participation of scientists in decision-making at various levels of the laboratory would also help the process of improvement of the overall climate within a laboratory. The results of this study could serve as a preliminary guide to improve the general work environment within the laboratories, specifically within the work groups. Though in the present study the sample size is not too large and only three CSIR laboratories have been considered, yet the significance of this endeavour should not be lost sight of. The top management of the R&D organizations should consider these recommendations in right earnest which would go a long way in achieving a more effective R&D performance.

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