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Managing team innovation in the Research and Development (R&D) organization: critical determinants of team effectiveness

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Abstract

Teams are the principal vehicle in developing new drug development strategy and executing the tasks required to accomplish those objectives. This project evaluated the key drivers for team innovation performance (defined as outcomes). Team outcomes included new information creation, compression of development time, expansion of image, learning, capability development, growth satisfaction, and overall effectiveness. The two key research questions related to how team innovation performance are assessed in the branded pharmaceutical industry, and what the drivers for optimal team performance outcomes were. Results revealed that while good correlations individually existed between team outcomes (dependent variable) and tested independent variables (autonomy, coaching, climate, proactive personality, empowering leadership, and transactive memory systems), the best predictors identified through multivariate regression analysis were leader and peer coaching and transactive memory systems. The implications of these findings are examined and specific recommendations proposed. The limitations and avenues for further research are elaborated.

Introduction

Cross functional project teams offer the structural and functional vehicle in the R&D process, as they span various functional disciplines and continuum of time and space. These cross functional teams are often composed of critical functional representatives and are chartered with the development of both the strategy and the tactical execution of pre-defined agreed upon deliverables. The members of the team represent their home functions but are accountable to the project leaders or liaisons that interface with broader organization. Each team is governed by a specific scientific management committee that endorses the strategy and monitors the outputs as the project team reaches a predefined milestone. It is at this team level where there is an in-depth analysis of the core strategic issues, the “what” and the “how”, happen.

Membership on teams is primarily assigned by the functional areas. Higher the assigned priority of the product in question, greater is the need on part of functional departments to provide their most knowledgeable and experienced representatives. Leadership of teams is similarly done, and project leaders could come from the assigned functions that are considered core on teams or from an independent senior leadership function. Thus, the type of teams usually conforms to the definition of Clark and Wheelright's (1992) typology. Because of organizational diversity, the team is a good central point where functions interact. The organizational proximity that occurs in teams allows for critical inputs to be shared much early in the process, than may otherwise occur in the absence of these project teams. Moreover, these teams focus on milestone oriented, highly focused and time-sensitive tasks.

While teams are formed by senior management, and have the flavor of top-down hierarchical systems, teams are intended to function autonomously, are expected to be nimble, and expected to self-operate in flexible working cultures. In practice, however, there is large variability in how this is implemented. Depending on the nature of teams, priority of the project, and the complexity of the issues at hand, teams may function independently or with considerable oversight. More experienced the membership, greater is the trust on the team. Thus, transactive memory system (TMS; Wegner, 1987) is a critical determinant of outcomes. More recently, there has been increasing emphasis given to size of these teams, and the increase in the use of subteams to pursue specialized tasks. However, in large companies that are often super-specialized, there are often large pockets of subject matter expertise causing teams to be traditionally large. Therefore, generation, communication, and sharing of tacit knowledge becomes a significant challenge. The socio-cognitive aspects of knowledge sharing and learning become significant. Because teams do not control resources or budget and have to rely on functional departments for resources, there is often a tension between the team and the functions as well as with the oversight committees. Functions may elect to be more overbearing on teams and that may result in teams not being empowered. Thus, team autonomy plays a role in team effectiveness (Breaugh, 1985). Team decisions may be continually questioned, there could be trust issues between the team and the functions, teams and their leaders, or the team leaders and the governance committees. Implicit leader behavior of managing the internal and external networks, and effective boundary management will be key (Wageman *et al*., 2005). Team leadership, whether participatory or empowering or principally through coaching, and the climate under which the team operates all influence team innovation and performance (Cohen and Bailey, 1997). It is essential to fully understand the critical success factors that can contribute to team innovation and effectiveness in the pharmaceutical industry.

Two broad categories of teams, defined by scope and degree of innovation and creativity are investigated in this project. These are discovery and development teams operating within a large pharmaceutical R&D context. Discovery teams are those teams responsible for the design and execution of the strategy leading up to proof of concept in humans, and can span the entire length from target identification and lead optimization until Phase IIA of clinical development and those teams are governed by the drug discovery and early development research committees. These teams can include heavyweight teams (e.g., early development team) and functional (e.g., drug substance and product team) teams. Development teams are those teams responsible for clinical development from Phase IIB through registration and licensure of the product and lifecycle management and are governed by late development research committee. These teams can include heavyweight teams (e.g., product development team) and functional (e.g., preliminary market formulation working group, clinical subteam, regulatory subteam, integrated development and supply teams, etc).

The following drivers for team innovation effectiveness (outcomes) have been specifically investigated:

- Team autonomy
- Leader and peer coaching
- Team climate
- Proactive personality
- Empowering leadership
- Transactive memory systems

Methods

Survey instruments

To test the hypotheses, survey questionnaire testing specific dimensions that have been previously validated were used for rating by team members. The questionnaires were prepared in an electronic survey software (Qualtrics®, licensed by Warwick Business School, Coventry, UK), and distributed electronically to participants. Eligible participants belonged to a large pharmaceutical company, and were a member of a drug discovery or development team, were mostly scientists, engineers, and physicians. Teams that have overall responsibilities of a set of activities within each defined scope of activity and level of the organization, and team members being responsible for defining the scope, developing a strategy, and executing the deliverables were eligible to participate in this survey.

Team members may represent a cross section of the leadership in an R&D organization and may be a member of any department. Each survey respondent was requested to select an active or recently completed project they were a part of as a member of the team. A total of 75 teams with approximately 500-600 members were contacted. To reduce survey fatigue, a single stage survey was used. Because eligible teams need to be cross-functional in nature, they provide a heterogeneous mix of functional and overarching governance, operating in a wide scope of drug discovery and development value chain.

A total of 13 questions, with multiple sub-parts, as part of 7 key dimensions have been adapted from previously validated scales. These dimensions include team outcomes, team autonomy, leader and peer coaching, team climate, proactive personality, empowering leadership, and transactive memory system. Survey respondents were prompted to respond to the degree he or she agreed or disagreed using five- to seven-point Likert scales. The key variables including the reported internal consistency reliability (Cronbach, 1951) are summarized in **Table 2**.

Statistical analysis

All analyses were performed in SPSS version 22 (IBM, licensed from Warwick Business School, Coventry, UK). These analyses included assessing the reliability of the scales used in the study, factor analysis, and multi-variate linear regression for testing the various hypotheses (**Table 1**). Statistical testing of the variables were assessed using a two-tailed test at a significance level of 0.05. No multiplicity adjustment was made.

Results

Of the 75 teams contacted (composed of approximately 400-600 team members that form those teams), only 190 responded from 43 teams (57% response rate). Of these 190 team members, 80 members (42%) were from the discovery phase (from target identification to clinical proof of concept) and 110 (58%) were from development phase (from clinical phase II through registration and lifecycle management). These teams were staffed by scientists, engineers, and technologists, with a wide variation of first degrees to higher doctorates.

Technology novelty is considered quite relevant in new product development, and explains some of the uncertainty and ambiguity teams experience in product development. Nine percent of the respondents indicated there was no new technology involved in the teams, whereas 91% indicated various degrees of technology novelty. Interestingly, only 11% indicated that the technology in use was unproven or non-existing at the start of the project. Eighty percent indicated that the technology was either incremental or pre-existing in some form or another.

Using the Lynn and Akgun (1998, 2001) typology for innovation novelty, 31% indicated the innovation was incremental in nature, 19% indicated it was an evolutionary market project, 41% indicated it was an evolutionary technical project, and 9% indicated it was a radical innovation project.

Using Clark and Wheelwright (1992) typology, 24% indicated the structure was a functional team grouped by discipline, 44% indicated the structure was a lightweight team with a liaison, 23% were part of a heavyweight team with a core group with a project leader, and 9% were on an autonomous team with full control of resources. These findings are in alignment with the broader organizational context, where there is less tolerance to risk and greater control of resources. The team player style using the Parker (1990) typology, showed that a majority of members were collaborators, but only 8% indicated they were willing to challenge authority and be willing to take risks.

Validation of reliability of the scales

A reliability analysis was performed in SPSS to estimate the Cronbach's alpha for each of the dimensions of the survey study. **Table 3** summarizes the values. The reliability analysis confirms very strong Cronbach (Cronbach, 1951) alpha scores for the previously validated scales used in this study, with every scale showing >0.90.

Factor analysis

The method of principal component was used for extraction to determine eigenvalues, communalities, and factor-loading coefficients. All questions under each scale were evaluated separately, retaining components with significant eigenvalues (>1). The method of rotation chosen was direct oblimin, an orthogonal rotation method, because of expected correlations among factors inherent in behavioral and social science research (Costello and Osborne, 2005).

The measures of appropriateness of the factor analysis included the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity. In all dimensions, KMO measures were 0.8 or higher, and the Bartlett's test of sphericity was significant, indicating that there were correlations within the dataset that were appropriate for factor analysis. An examination of communalities in each variable showed that all extracted values were acceptable, indicating reasonable correlation between items. In most cases, one to three factors accounted for a majority (~80%) of the variability in all variables.

Multivariate linear regression

The pre-specified hypotheses were tested using multivariate linear regression analysis in SPSS. Team outcome was identified as a dependent variable. Independent variables included team autonomy, leader and peer coaching, team climate, proactive personality, empowering leadership, and transactive memory systems. **Table 4** summarizes the descriptive statistics for the composite variables.

The means were all within the scale ranges of the individual range, with acceptable standard deviations. The sample size of 80 represents completers in survey responses, with missing data ignored. The test of significance of the model was using ANOVA. There are a total 79 (N-1) degrees of freedom. With six predictors, the regression effect has 6 degrees of freedom. The regression effect is statistically significant indicating that the prediction of the dependent variable, outcome, is better than can be done by chance. **Table 5** is a symmetric correlation matrix that summarizes the standard regression results, namely the correlations of the variables (diagonal of the matrix is not shown).

The prediction model was statistically significant, $F(6, 73) = 16.604$, $p<.001$, and accounted for approximately 58% of the variance of team outcomes ($R^2 = .577$, adjusted $R^2 = .542$). The raw and standardized regression coefficients of the predictors along with their correlations with team outcomes are shown in **Table 6**.

Team outcome was primarily predicted by higher levels of coaching and transactive memory systems. Coaching received the strongest weight in the model, followed by transactive memory systems. Coaching accounts for 9% of the variance of outcome whereas transactive memory systems accounts for 5.5% of the variance of outcome. Interestingly, climate and personality correlates substantially with outcomes and to lesser extent empowering leadership and autonomy, yet in the combination with other predictors are not significant predictors in the model. This is likely because their predictive work is being carried out by other variables in the analysis.

Therefore, the hypotheses that leader and peer coaching (H2) and transactive memory systems (H6) are positively correlated with team outcome have been met. The remaining hypotheses were not met, although as indicated above, all others were positively correlated albeit not statistically significant.

Discussion

Available research has been helpful in identifying key drivers of team effectiveness (summarized in Cohen and Bailey, 1997 and Mathieu *et al*., 2008). However, each organizational context is unique and thus requires a contextually appropriate solution to enhancing team innovation and effectiveness.

In this project, teams are the principal vehicle of the delivery of the main output of pharmaceutical industry research and development, namely innovation outputs of new drugs and new drug products. Contextually, therefore, team innovation and effectiveness performance is a principal feature of team outcomes. This is further measured as a function of information creation, time compression, image expansion, learning, growth satisfaction, overall effectiveness, and capability development (Denison *et al*., 1996). For example, innovation and effectiveness in teams can be measured by new information creation that would result in intellectual property, development time to market and first mover advantage, new learning about a certain product or disease expertise, and successfully developing new drugs and line extensions (Krishna and Wagner, 2010).

While reasonably good correlations existed between the various independent variables and team outcomes, only two determinants turned out to be statistically significant predictors of team outcomes, leader and peer coaching and transactive memory systems.

Baseline evaluations showed that much of the innovation performance in the organization were incremental in nature and used some variations of existing technology. These activities were supported by teams that were highly dependent on resources from outside of the teams to executive their work. In fact, only 9% belonged to an autonomous team with full control of their resources. A relative majority of the survey respondents belonged to teams which relied on the liaison figure on the team. Thus, it is not surprising that leader and peer coaching was a statistically significant predictor of team outcomes. A relative majority of survey participants identified themselves as collaborators, again bringing the context of coaching in positive light.

Because the pharmaceutical industry R&D apparatus is a knowledge intensive organization, it is also not surprising that transactive memory systems were also a key predictor to team outcomes. The collective network of knowledge and experience curves that exists in individuals and groups within the wider organizational context are essential in knowledge encoding, storage, and retrieval (Wegner *et al*., 1985; Wegner, 1987).

A surprising finding in the project is the lack of statistical significance of proactive personality and empowering leadership as a predictor of team outcomes, despite a positive correlation existing between the independent variables and team outcomes. It helps to frame this finding within the wider organizational context. A diagnostic interview conducted with senior leadership in the company revealed that the organization has a risk-averse culture. Part of risk-averse culture relates to decisions on funding and milestone movements of projects to be tightly orchestrated by senior leadership, which could mean that a culture of empowerment may either not exist or appreciated as a positive attribute. In such a case, this may mean that senior leadership is unwilling to relegate decision rights to teams and may partly explain why these variables were not a significant predictor for team outcomes. However, it is also a possibility that there may be colleanarity between these two variables and the peer and leader coaching, which was a significant predictor, wherein their predictive work is being accomplished by peer and leader coaching in the multivariate linear regression model.

A second surprising finding in this study was that team autonomy was not statistically significant as a predictor of team outcomes. This is contrary to an extensive body of published literature which indicates team autonomy strongly correlates with team performance (reviewed in Cohen and Bailey, 1997). However, a key underlying assumption is that autonomy might depend on the degree of task interdependence. Langfred (2005) suggests that there is an optimal level of combination of individual and team autonomy which is highly dependent on the level of task interdependence in a given team. For example, autonomous teams that are tasked with highly interdependent activities may have appropriate level of infrastructure (i.e., coordination and cohesiveness) already in place that contributes to a positive relationship with team outcomes. However, there may be situations where autonomous teams might incur additional penalty, such as coordination costs which may negate the value team autonomy may have as a significant predictor of team performance. This is further supported by the work of Cummings (1977 a, b) that shows that autonomous teams that are less interdependent may actually result in lower performance than teams that perform highly interdependent tasks. Therefore, it is possible that a part of the reason why team autonomy was not significant in this study may relate to the presence of significant coordination costs that may have existed in the teams. Because only a very small number of survey participants identified themselves as members of autonomous teams, it is not clear whether a higher sample size would have yielded a more predictable relationship.

Another surprising finding was that team climate was also not statistically significant as a predictor of team outcomes. This finding contrasts the findings in the literature which argues that climate for innovation is a significant precondition to managing work teams involved in knowledge intensive enterprises (Kivimaki *et al*., 1997; Anderson and West, 1998). It is worthwhile to point out that there were considerable change events in the wider organizational context that created restlessness in the organization. Such activities may have caused a disruption in the overall climate and the boundary conditions under which these teams operated and could explain why team climate was not a statistically significant predictor of team outcomes.

The following sections further discuss the two hypotheses that were met in greater detail.

Leader and peer coaching

The leader and peer coaching instrument used in this study was a subscale of the team diagnostic survey (Wageman *et al*., 2005), and included such characteristics as focus of leader's attention, coaching availability, task focused peer and leader coaching, operant coaching, and interpersonal peer and leader coaching. When reviewing wider organizational context, it is clear that the company had progressed through multiple layers of strategic and transformational change. Thus, a principal role of the leader and peer in a team is sensemaking (Wiersema and Bantel, 1992), and navigating through evolving emergent change while maintaining focus on team tasks and deliverables – an adaptive change, as a failure to do so could be disruptive to the team and its subtle internal dynamics (DeRue *et al*., 2008). Existing committees were decommissioned, and new committees were formed within the wider organizational context. The team members viewed and counted on their leader as well as other members of the team to make sense of the changes around teams and still carry out tasks and deliverables to their overall satisfaction as well as those of their immediate management. The core role a leader plays include coaching, developing and mentoring the team and this has been shown to have a positive impact on team performance (Hackman and Wageman, 2005; Wageman 2001; Wageman *et al*., 2005). The leader ensures each team member has adequate skills and knowledge to perform that role and there is sufficient emphasis on training and coaching of the team members (Kozlowski *et al*., 1996; Zaccaro *et al*., 2001). Because the leader on the teams investigated in this project were largely those who related with other team members in a liaison role and not as senior leadership, any sensemaking behavior leaders exercised was likely not viewed as intrusive by team members (Morgeson, 2005).

Another role leaders have is providing feedback to team members, which helps in increasing team learning behavior. In this regard, the findings in this study are consistent with those examined by Gibson and Vermeulen (2003), with the exception that the leaders on teams examined here were not in a formal contract with team members as to their performance management. Notably, only 9% of survey participants identified themselves as members of autonomous teams, whose leaders have direct accountability to team performance and resource assignments.

Transactive memory systems

The transactive memory systems scale instrument evaluated specialization, credibility, and coordination (Lewis, 2003). The core aspect of this instrument relies on capturing team members' collective expertise, a fundamental element to a knowledge industry as the pharmaceutical industry. Knowledge in the pharmaceutical industry is a core competency, critical to an organization's sustained competitive advantage (Prahalad and Hamel, 1990). Knowledge resource is an inherent dynamic capability (Teece *et al*., 1997), the intangible synergy that ensues when a group of scientists, physicians, and engineers collaborate to solve tangible medical need problems, a requisite for new drug product development.

Transactive memory system was a statistically significant predictor of team outcomes. This comes as no surprise given the knowledge intensive nature of the industry, but is more strongly relevant given the current organizational context. The teams surveyed in this study witnessed change events that resulted in significant disruption of knowledge activities (e.g., as a result of reorganizations and/or mergers and acquisitions), including a mix of planned separations and unintended employee turnover, and elimination of redundant sites. Thus, the knowledge transfer aspect from one project team to another was a significant consideration. Managing that knowledge transfer with minimal loss of expertise was a key organizational goal.

Wegner (1987) defines TMS as "the cooperative division of labor for learning, remembering, and communicating relevant team knowledge". Whereas Wegner originally intended to apply TMS to long tenured employee groups, tenure is not necessarily the principal component of TMS. Rather, the intangible undefined synergy that exists in collective foresight during problem solving in group creativity is also an inherent feature of TMS (Akgun *et al*., 2006; Dayan and Basarir, 2010; Gino *et al*., 2010). Lewis' (2003) defines a TMS as the "active use of transactive memory by two or more people to cooperatively store, retrieve, and communicate information". Both Wegner and Lewis underscore the cooperative cognitive systems that describe the intangible synergy in teams. TMS helps understand how effective teams apply based on known knowledge. TMS was a good predictor of team outcomes, and implicitly, this means that members of higher performing teams specialize in different but complementary domains such that there is a higher order task specific knowledge applied to defined tasks. Another valuable insight gained is when staffing new teams, more the complementarity of the expertise, greater likelihood there is to develop TMS rapidly.

Other authors point out that the TMS is a repository of knowledge that transcends teams, to the wider organizational context (Walsh and Ungson, 1991). However, the teams are tightly integrated within the broader organizational context, at least in the sample examined in this study, so it is assumed that team memory is a good surrogate of organizational memory. This assumption may be limited in cases where the TMS is tightly linked to a mass group of departing employees, and the project team is then replaced as a whole. The work of Lewis *et al*. (2007), suggests that although group performance may vary between partially intact groups and intact groups if there is not an adaptation that occurs to correct inefficient TMS processes.

Conclusions

This research offers key insights for managers when forming and staffing teams.

One is an emphasis on coaching. It is imperative for senior managers to assign individuals to teams who liaise with broader management that are capable of offering coaching and availability for team members to enhance their skills. This is particularly important in a growing hypercompetitive environment which is witnessing continuous strategic change. Thus, a capable leader is one who provides coaching to the team members, as well as helps them reach their growth potential as well as skills that will help with adapting to a continuously changing organizational context. The leader also favorably enables peer coaching. Importantly, the leader should have interpersonal skills that are not viewed as intrusive to team psyche and dynamics. Preferably, a team member who has been on the team as a peer and has evolved leadership skills, and who has gained the wider trust by peers, should be considered as a team leader.

A second area of emphasis is on transactive memory systems. As this is a central driver to team performance, it is imperative to improve adaptation skills of team members. Particularly, in cases where there is anticipated to be a disruption to team membership, effort would need to be given to preserve the inner core of the team so that there is sufficient time available for learning by a new team member. Complete reconstitution of a team would be considered disruptive to TMS processes and thus preferable to avoid.

Limitations and Future Research Directions

One of the limitations of this study was the relatively small sample size. While the response rate was satisfactory, samples were drawn from a single large pharmaceutical company to ensure a single frame organizational context. A relative majority of the survey participants identified with incremental innovation and technology novelty, precluding subset analysis between teams that focused on incremental and radical innovation. Although the study yielded valuable insights on drivers of team outcomes, this precluded more sophisticated analysis including path dependencies and subset analysis of the various dimensions as a function of team structure, innovation type, and technology novelty. One future research direction would be to study the team outcomes in a large diversity of pharmaceutical enterprises, of varying firm size and organizational context.

Because the leaders on the teams investigated in this project were largely those who related with other team members in a liaison role and not as senior leadership inherent in autonomous teams, whether some of the leader behavior was considered intrusive by team members could not be studied (Morgeson, 2005). Thus, a second possible future research direction would be to study the role of senior leaders as team leader, where there is at least a gap of 3-4 managerial tier level difference between leaders and team members.

As indicated above, because the sample size was not large enough to provide balance to the type of team structures, no attempt was possible to relate how TMSs operate in teams of differing team structures. A third aspect to future research on TMSs relate to complete reconstitution of group membership and how that affects team outcomes. This is particularly applicable to mergers and acquisition situations, where a target company is subsumed in the acquirer company infrastructure, and there is a near complete loss of talent either through voluntary or involuntary separations, and there is little to no institutional memory on projects.

A potentially fourth area for future research is to investigate team outcomes longitudinally with two-stage surveys, at more than one snapshots of time. There are stage gate milestones as the drug candidate moves form one phase to another (e.g., discovery to development), and there is a natural transition between one type of team to another. Because the pharmaceutical industry is a slow innovation industry, where the average time span from target identification through marketing can range from 10-15 years (Paul *et al*., 2010), such a longitudinal study would have been impossible to undertake within the constraints of this program, but nonetheless could offer valuable insights to researchers and practitioners.

A final avenue of future research relates to the role of within-team competition in contributing to team knowledge sharing. This aspect was not studied in this project and is worth further study, partly because there is some degree of inherent competition within teams in knowledge intensive organizations and partly because there is contradictory data in the literature that relates to how significantly affected team performance would be (He *et al*., 2013).

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References

Ahearne, M., Mathieu, J., and Rapp, A. (2005). To empower or not to empower your sales force? An empirical examination of the influence of leadership empowerment behavior on customer satisfaction and performance. *Journal of Applied Psychology*, **90**: pp. 945–955.

Akgun, A., Byrne, J., Keskin, H., and Lynn, G.S. (2006). Transactive memory system in new product development teams. *IEEE Transactions on Engineering Management*, **53**(1), pp. 95–111.

Anderson, N., and West, M.A. (1998). Measuring climate for work group innovation: Development and validation of the team climate inventory. *Journal of Organizational Behavior*, **19**, pp 235–258.

Bateman, T.S., and Crant, J.M. (1993). The proactive component of organizational behavior: a measure and correlates. *Journal of Organizational Behavior*, **14**(2), pp. 103-118.

Breaugh, J. A. (1985). The measurement of work autonomy. *Human Relations*, **38**: pp 551-579.

Clark, K.B., and Wheelright, S.C. (1992). Organizing and leading heavyweight development teams. *California Management Review*, **34**(3), pp 9-28.

Cohen, S. G., and Bailey, D. E. (1997). What makes teams work: Group effectiveness research from the shop floor to the executive suite. *Journal of Management*, **23**: pp 239-290.

Costello, A.B., and Osborne, J.W. (2005). Best practices in exploratory factor analysis. *Practical Assessment, Research and Evaluation* **10**(7): pp 1-9.

Cronbach, L.J. (1951). Coefficient alpha and internal structure of tests. *Psychometrika*, **16**, pp 297-334.

Cummings, T. G. (1977a). Sociotechnical Systems: An Intervention Strategy, In *Current Issues and Strategies in Organization Development* (W. W. Burke, ed.). New York: Human Sciences Press.

Public

Cummings, T. G. (1977b). Improving productivity and the quality of work life. New York: Praeger.

Dayan, M., and Basarir, A. (2010). Antecedents and consequences of team reflexivity in new product development projects. *Journal of Business & Industrial Marketing*, **25**(1–2), pp 18–29.

Denison, D.R., Hart, S.L., and Kahn, J.A. (1996). From chimneys to cross-functional teams: developing and validating a diagnostic model. *Academy of Management Journal* **39**(4), pp 1005-1023.

DeRue, D. S., Hollenbeck, J. R., Ilgen, D. R., Johnson, M. D., and Jundt, D. (2008). How different team downsizing approaches influence team-level adaptation and performance. *Academy of Management Journal*, **51**, pp 182-196.

Gibson, C., and Vermeulen, F. (2003). A healthy divide: Subgroups as a stimulus for team learning behavior. *Administrative Science Quarterly*, **48**(2): pp 202-239.

Gino, F., Argote, L., Miron-Spektor, E., and Todorova, G. (2010). First, get your feet wet: The effects of learning from direct and indirect experience on team creativity. *Organizational Behavior and Human Decision Processes*, **111**(2), pp 102–115.

Hackman, J.R., and Wageman, R. (2005). A theory of team coaching. *Academy of Management Review*, **30**, pp 269-287.

He, H., Baruch, Y., and Lin, C.P. (2013). Modeling team knowledge sharing and team flexibility: The role of within-team competition. *Human Relations* **0**, pp 1–31.

Kivimaki, M., Kuk, G., Elovainio, M., Thomson, L., Kalliomaki-Levanto, T., and Heikkila, A. (1997). The climate inventory (TCI) four or five factors? Testing the structure of TCI in sample of low and high complexity jobs. *Journal of Occupational and Organizational Psychology*, **70**, pp 375-389.

Kozlowski, S. W. J., Gully, S. M., McHugh, P. P., Salas, E., and Cannon-Bowers, J. A. (1996). A dynamic theory of leadership and team effectiveness: Developmental and task contingent leader roles. In GR Ferris (Ed), *Research in Personnel and Human Resource Management*, **14**, pp 253-305.

Krishna, R., and Wagner, J.A. (2010). Applications of decisionable biomarkers in cardiovascular drug development. *Biomarkers Medicine* **4**(6): pp 815-827.

Langfred, C. W. (2005). Autonomy and performance in teams: The multilevel moderating effect of task interdependence. *Journal of Management*, **31**: pp 513-529.

Lewis, K. (2003). Measuring transactive memory systems in the field: Scale development and validation. *Journal of Applied Psychology*, **88**(4), pp 587–604.

Lewis, K., Belliveau, M., Herndon, B., and Keller, J. (2007). Group cognition, membership change, and performance: Investigating the benefits and detriments of collective knowledge. *Organizational Behavior and Human Decision Processes*, **103**(2), pp 159–178.

Lynn, G. S., and Akgun, A. E. (1998). Innovation strategies under uncertainty: A contingency approach for new product development. *Engineering Management Journal* **10** (3): pp 11–17.

Lynn, G. S., and A. E. Akgun. (2001). Project visioning: Its components and impact on new product success. *Journal of Product Innovation Management* **18**: pp 374–87.

Mathieu, J., Maynard, M.T., Rapp, T., and Gilson, L. (2008). Team effectiveness 1997–2007: A review of recent advancements and a glimpse into the future. *Journal of Management* **34**(3): pp 410–476.

Morgeson, F. P. (2005). The external leadership of self-managing teams: Intervening in the context of novel and disruptive events. *Journal of Applied Psychology*, **90**: pp 497-508.

Parker, G.M. (1990). *Team Players and Teamwork*. New York: Jossey-Bass.

Paul, S.M., Mytelka, D.S., Dunwiddie, C.T., Persinger, C.C., Munos, B.H., Lindborg, S.R., Schacht, A.L. (2010). How to improve R&D productivity. *Nature Reviews Drug Discovery*, **9**: pp 203-214.

Prahalad, C.K., and Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review,* **May–June**.

Teece, D.J., Pisano, G., and Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, **18** (7), pp 7509-533.

Wageman, R. (2001). How leaders foster self-managing team effectiveness: Design choices versus hands-on coaching. *Organization Science*, **12**: pp 559-577.

Wageman, R., Hackman, J.R., and Lehman, E. (2005). Team Diagnostic Survey: Development of an Instrument. *The Journal of Applied Behavioral Science* **41**, 4, pp. 373.

Walsh, J.P., and Ungson, G.R. (1991). Organizational memory. *Academy of Management Review*, **16**(1), pp 57–91.

Wegner, D.M., Giuliano, T., and Hertel, P. (1985). Cognitive interdependence in close relationships. In W.J. Ickes (Ed.), *Compatible and Incompatible Relationships* (pp. 253–276). New York: Springer

Wegner, D.M. (1987). Transactive memory: A contemporary analysis of the group mind. In B. Mullen & G.R. Goethals (Eds.), *Theories of Group Behavior* (Vol. **9**, pp. 185–208). New York: Springer.

Wiersema, M.F., and Bantel, K.A. (1992). Top management team demography and corporate strategic change. *Academy of Management Journal*, **35**(1): pp 91-121.

Zaccaro, S. J., Rittman, A. L., and Marks, M. A. (2001). Team leadership. *Leadership Quarterly*, **12**: pp 451-483.

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Table 1: Hypotheses to be tested in the team effectiveness study

What tested	Hypotheses
Team autonomy on outcomes	H1: Team autonomy is positively correlated with team outcomes
Leader and peer coaching on outcomes	H2: Coaching (leader and peer) is positively correlated with team outcomes
Team climate on outcomes	H3: Team climate is positively correlated with team outcomes
Proactive personality on outcomes	H4: proactive personality is positively correlated with team outcomes
Empowering leadership on outcomes	H5: empowering leadership behavior is positively correlated with team outcomes
Transactive memory system on outcomes	H6: Transactive memory systems is positively correlated with team outcomes

Table 2: Summary of validated scales and their reliability indices

Variable	Definition	Measurement scale	Internal consistency reliability (alpha)	Reference
Team outcomes	Information creation Time compression Image expansion Learning Growth satisfaction Overall effectiveness Capability development	5-point Likert scale	0.84 0.75 0.82 0.73 0.84 0.76 0.78	Denison, Hart, and Kahn, 1996
Team autonomy	*Global work autonomy scale* Method Schedule Criteria	7-point Likert scale	 0.91-0.92 0.81 0.77-0.83	Breaugh, 1985
Leader and peer coaching	*Team diagnostic survey* Leader and peer coaching subscale	5-point Likert scale	 0.92	Wageman, et al., 2005
Team climate	*Team Climate Inventory* Innovation subscale	5-point Likert scale	0.83-0.94 0.90	Kivimaki et al., 1997; Anderson and West, 1998
Proactive personality	Proactive behavior	7-point Likert scale	0.89	Bateman and Crant, 1993
Empowering leadership	Meaningfulness Participation in decision making Confidence in high performance Autonomy to bureaucratic constraints	5-point Likert scale	0.89 0.86 0.85 0.79	Ahearne, Mathieu, and Rapp, 2005
Transactive memory system	Specialization Credibility Coordination	5-point Likert scale	0.80-0.84 0.81-0.83 0.78-0.83	Lewis, 2003

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Table 3: Cronbach's (Cronbach, 1951) alpha for survey components

Component	Number of scale items	Valid N	Cronbach alpha
Team outcomes	22	163	0.985
Team autonomy	9	182	0.928
Leader and peer coaching	26	169	0.982
Team climate	8	158	0.984
Proactive personality	17	156	0.985
Empowering leadership	12	156	0.993
Transactive memory systems	15	156	0.973

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Table 4: Descriptive statistics

Composite scale	Mean	Std. Deviation	N
Outcomes	3.5278	.38566	80
Autonomy	5.2083	.96239	80
Coaching	3.2577	.49214	80
Climate	3.7063	.60917	80
Personality	5.1735	.86957	80
Empowering Leadership	3.6979	.66116	80
Transactive Memory Systems	3.6433	.28465	80

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Table 5: Summary of the correlations of the variables in the analysis (N=80)

Variable	2	3	4	5	6	7
Outcomes	.386	.579	.571	.538	.469	.583
Autonomy	--	.342	.530	.161	.506	.285
Coaching		--	.452	.345	.628	.260
Climate			--	.495	.572	.535
Personality				--	.305	.600
Empowering Leadership					--	.397
TMS						--

Note: All correlations except that between personality and autonomy (p=.076), autonomy and TMS (p=.005), coaching and TMS (p=.010), and personality and empowering leadership (p=.003) were statistically significant (p ≤ .001).

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Table 6: Summary results for standard regression

Model	Unstandardized Coefficients		*Beta*	*t*	*Sig.*	*Pearson r*	Correlations		sr^2
	b	*SE-b*					Partial	Part	
(Constant)	.231	.411		.562	.576				
Autonomy	.041	.038	.103	1.085	.282	.386	.126	.083	.007
Coaching*	.313	.079	.400	3.948	.000	.579	.419	.301	.09
Climate	.089	.071	.141	1.254	.214	.571	.145	.095	.009
Personality	.066	.045	.149	1.463	.148	.538	.169	.111	.012
Empowering Leadership	-.051	.066	-.087	-.766	.446	.469	-.089	-.058	.003
Transactive Memory Systems*	.432	.140	.319	3.091	.003	.583	.340	.235	.055

Note: the dependent variable was outcomes. R^2 = .577, adjusted R^2 = .542. *p < .05.

sr^2 is the squared semi-partial correlation.

END