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A SYSTEMATIC REVIEW ON INFLUENCES OF R&D TEAMS AND THE DRIVING FORCES OF INNOVATION

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Abstract
This study examines the influences of R&D teams on innovation. Examining the influences and innovative performances of R&D teams as the focus of generating new knowledge is inherently difficult. In most cases team members are recruited as dependable sources of information. However, there are indications that team members do not provide a sufficient self-examination to evaluate the R&D team's creative performance by themselves. There are other factors at play. Creativity does however help shape the foundation for R&D performance and organizational prosperity. At the same time, R&D teams have become increasingly self-sufficient units and in many situations only the R&D team members are capable of evaluating their own performances. The research uncovered in this study identifies some of these influences of R&D teams and how these influences impact innovation.

Keywords: R&D, Research Development, Innovation, Creativity, Team Innovation,

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Introduction

Research and development (R&D) is a critical component of most organizations and a significant factor for innovative success. Research and Development often refers to the department within the organization that focuses on ways to optimize their new product development, product offerings, and helping to streamline and improve overall organizational operations (Aram & Morgan, 1976; Gu, Wand & Wang, 2013). Lerner and Wulf (2007) stipulated that R&D investment and expenditures have long been understood to be a key driver of organizational success and economic growth. Profound changes in the R&D sector over the past three decades have attracted more and more consideration as organizations continue to compete in a competitive and saturated marketplace. There is an increasing importance for organizations to maintain a creative R&D team to help stimulate and promote innovative ideas.

Innovation, or the introduction and implementation of new ideas, processes, or products (Chen, Farh, Campbell-Bush, Wu & Wu, 2013), is central to an organizations' capability to stay competitive. Like creativity, innovation captures the development of new or novel ideas or procedures; however, effective innovation goes beyond creativity. Innovation also requires "championing and implementation of the ideas or procedures" (Simon, Gupta, & Buchanan, 2011, p.303) that must be carried to fruition by the research and development teams in order for organizations to maintain long term sustainability in the market.

The R&D discussion was a dominant feature of the innovation landscape for most of the twentieth century as firms began to notice the importance of R&D teams, creative concepts, and innovative products to maintain a strategic competitive advantage (Diaz, Gonzalez, & Saez, 2013; Gu, Wang, & Wang, 2013; Liu, Keller, & Shih, 2011). This environment in which innovative activity takes place is characterized by a great deal of dynamism and complexity. Sanchez and Herrera (2010) postulated that "continuous changes in technology, in customers and competitors, mean that firms have to renew themselves continuously in order to survive and in many cases, those changes take the form of seeking new ways of carrying out their activities, which include innovation activities" (p.340).

The startling realization however, is that even with the understanding that research and development remains an imperative function for successful organizations, the success rate of R&D is low. It has been noted that approximately "one out of 3,000 raw ideas reaches substantial commercial success across most industries" (Zheng, Khoury, & Grobmeier, 2010, p.266). This is an even more substantial reason for organizations to focus on R&D teams since they typically shoulder the mission of carrying out major innovations for their organizations and communities. The identification of key factors that can foster and sustain R&D teams' innovation carries significant implications for strategic practices that target enhancing organizational competitiveness.

R&D teams differ from other teams because of the time-lagged, sporadic, and nonmarket nature to their outputs (Daily, 1978; Harris & Lambert, 1998; Zheng et al., 2010). This coupled with the notion that R&D tasks usually involve a high risk of failure and frequently experience

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disruptions, delays, and setbacks creates an environment that must be given sufficient attention. These R&D teams normally consist of professionals that have distinct characteristics in goal orientation, value systems, need structure, and behavioral patterns (Hirst & Mann, 2004; Kim, Min, & Cha, 1999). All of these properties pose unique challenges to organizations seeking to redefine and establish productive and efficient R&D teams.

As competition increases in the market, companies continuously search for ways to improve the success of their R&D endeavours, particularly in times of economic crisis or organizational restructuring. Kratzer, Holzle, and Gemunden (2010) argued that up to now, a major percentage of R&D endeavours have been carried out by teams of professionals. These teams are widely known to handle issues more effectively than individuals and have proven to be a major source of creativity. Furthermore, Kratzer et al. (2010) stipulated that "creativity shapes the foundation for low or high degrees of R&D performance and organizational prosperity" (p.109) so it is imperative that companies monitor the creative performance of their R&D teams to help with innovative success.

At one time, R&D was considered to be a unique, creative and unstructured process that was difficult, if not impossible, to control (Aram & Morgan, 1976; Ishikawa, 2012). The control techniques used in other business functions were considered inappropriate for the R&D function because control was supposed to harm creativity, and because of the uncertainty of R&D outcome. Therefore, in many organizations, the consideration given to R&D teams was limited to periodic departmental reviews focusing on technological achievements (Jaffe, 1988). However, more recently, Bertrand and Mol (2013) validated that "there has been a major change in organizational attitudes toward the administration of R&D teams and innovative concepts to improve the organization's position in the market" (p.753). Although companies still presume that R&D team processes have several characteristics that distinguish them from other business processes, they no longer consider innovative success unattainable. As a result, there is a growing acceptance of the need to manage R&D team process and, as part of this, to measure R&D performance and success (Bertrand & Mol, 2013; Hsieh & Lee, 2010).

Across the individual and team levels, innovation emerges from creative development of new, useful ideas and the implementation process of converting ideas in tangible realities. As such, it is important to understand drivers of innovation across various levels. Scholars point toward motivation as an especially critical driver of individual and team innovation, as employees need to personally and collectively direct significant effort to generate and implement new processes, procedures, or products (Eisenbeiss & Boerner, 2010; Sanchez & Herrera, 2010; Diaz et al., 2013). Interestingly though, researchers have identified different motivational antecedents of innovation at both the individual level and team level with the organizational R&D team environment.

Purpose

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The purpose of this paper is to examine what are the influences of R&D teams on innovation. In doing so, some focus will be given to "team innovation" and "team effectiveness". The study will also focus on what the drivers and relationship characteristics are that influence R&D teams and their relationships to the innovation process. More specifically, the research attempts to determine what some of these influences of R&D teams consists of and how these influences impact innovation.

With respects to a rapidly and consistently changing environment, this paper presents a theoretical framework on how R&D teams can be an integral component of the innovation process. A conceptual framework will be provided that focuses on the influences of R&D teams on innovation. It is important to note that a team perspective may be incorporated to help highlight and define the results of the decisions made by the R&D unit.

Theoretical Framework

This review focuses on the influences of R&D teams, team collaboration, and the influences that R&D teams have on innovation. In order to bring perspective to the research, and the critical importance of the collaboration among R&D team members, the *Social Exchange Theory* will be examined and utilized. The Social Exchange Theory (Homans, 1954; Blau 1964) is concerned with intrinsic rewards and "is among the most influential conceptual paradigms for understanding workplace behavior" (Tsai & Cheng, 2012, p.1071). More specifically, a social exchange deals with intangible social costs and benefits (i.e. love, respect, and knowledge) and a social exchange does not guarantee that there will be a reciprocal outcome because there are no rules or agreements that conduct the interaction. Liao (2008) stipulated that trust and other interactions such as loyalty and commitment provide the basis for social exchange and is a key element in the emergence and maintenance of social exchange relationships with teams and amongst team members.

Seminal scholars (Blau, 1964; Emerson, 1976) postulated that the intangible social benefits deriving from relationships within teams help to reduce complex decision making essential for creative and innovative thought processes. When team members trust in one another and in their leaders, they tend to have more confidence to achieve better long-run outcomes with cooperative behavior. Chen et al. (2013) established that greater team cooperation results in higher support for innovation climate in their teams by encouraging members to collaborate and to assist each other with idea development and implementation. The team members experience social exchange relationships with their colleagues, direct supervisor, and their organization during this process. These relationships have cognitive, emotional, and behavioral implications whereby employees reciprocate the socio-emotional benefits they receive in hopes to achieve the team's innovative vision.

Karanges, Beatson, Johnston, and Ling (2014) examined Social Exchange Theory in team environments and identified "internal communication as a key driver of employee engagement and helped to enhance the sharing of information to create a sense of community and trust among each team member" (p.333). Developing a sense of community and trust through internal communication involves establishing and maintaining relationships between an organization,

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supervisors, and the team members. Karanges et al. (2014) stipulated that while employees experience many relationships within their workplace, most team member interaction is commonly referred to as social exchange relationships. These favorable social exchange relationships are essential for achieving organizational and individual goals and objectives as each individual and/or group is interdependent on the other. This collaboration helps create a positive team atmosphere conducive for open exchange of ideas and innovative freedom in team discussions.

Social exchange theory is also a prominent theoretical paradigm for understanding not only workplace relationships (Tsai & Cheng, 2012) and employee attitudes (Misra, 2011) but also offers a lens to explore social exchange relationships that lead to productive team engagements. Karanges et al. (2014) identified three (3) main drivers of team engagements:

(1) Opportunities for employees to openly express their views and ideas upwards,
(2) Employees feeling well-informed about what is happening within their organization,
(3) Employees sensing that their manager is committed to greater team collaboration.

The theorized relationship between internal communication and employee engagement is believed to operate through social exchange, whereby employees feel obligated to return the favorable benefits they receive.

To further expand on this theoretical framework, the Social Exchange Theory can also be complimented with *Chen and Kanfers Multilevel Theory* (2006) of team motivation. The combination of both theories helps to articulate how individual and team factors drive proactive motivation and innovation across various levels. Chen and Kanfer (2006) proposed that motivational states drive individual effort allocated toward objectives, but they highlighted further that, parallel to individual-level motivational processes, team-level motivational states (i.e. members' shared cognitions and beliefs pertaining to the team and its task environment) contribute to members' collective effort directed at accomplishing innovative team goals (Chen et al, 2013; Karanges et al., 2014). Chen and Kanfers (2006) Multilevel Theory specified that:

(a) individual inputs and team motivational states uniquely shape individual motivational states,
(b) team motivational processes and individual members' performance influence team performance and collaboration, and
(c) Individual motivational processes contribute to team performance less directly, through members' performance on individual roles in the team.
(d)

These perspectives help to explain how and why team-level motivational states drive innovative behaviors, and how, in turn, individual-level innovativeness emerges to impact team-level innovative performance and collaboration.

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Literature Review

The literature review examined several significant areas pertaining to organizational decisions on R&D teams and innovation. The literature review focused on Research and Development (R&D), R&D teams, and Innovation. As stated in the purpose, this research attempted to determine what some of the influences and relationship characteristics of R&D teams consisted of, and how these affected innovation.

Relationship between R&D and Team Effectiveness

Mihalache, Jansen, Bosch, and Volberda (2012) posited the idea that search and decision making processes jointly influence innovation and are important opportunities for developing new products and services, but the attributes of R&D teams influence how firms capitalize on these opportunities. More specifically, Mihalache et al. (2012) confirmed "two major attributes that had moderating roles in R&D teams" (p.1484): informational diversity (i.e. the heterogeneity in knowledge bases and perspectives, influence of idea generation regarding the usefulness and potential applications and alternatives to competent decisions) and shared vision (i.e. the collective perception of the value of knowledge generated through potential conflicts regarding the implementation of competing opportunities). Both attributes shape how organizations perceive the value of the opportunities and creative ideas raised by R&D team members and how they interact in implementing various alternatives.

Similarly, Hsieh and Lee (2012) stipulated that "individual members in R&D teams had a higher propensity to group their ideas together to collectively enhance a shared cognitive context based on common experiences and mutual understanding" (p.992). There was a greater likelihood for R&D teams to interact between team members while working on different functions to help understand the content of the other members' works. It is through this process of sharing information and experiences with the group that the members learn from each other, and have an opportunity to develop themselves personally and professionally. Chen, Hsu, and Huang (2010) further validated that diverse cognitive styles, backgrounds and risk-taking propensities impact different team compositions and had significant moderating effects on the R&D team cooperation. Therefore, it would be considerably important for organizations to select and develop appropriate R&D team members who are more cooperative and willing to make innovative and creative decisions in the best interests of the company and the other group members.

Tang, Shang, Naumann & Zedtwitz (2014) analyzed data collected from 30 R&D teams to find that "R&D teams can promote team identification through establishing a good team reputation and by making salient the differences from other teams" (p. 285). It follows that managers should strive to carefully examine and control those factors that are associated with group formation, especially in the early stages of group formation – for example, team logos and intergroup competition, proximity and shared goals. In addition, Krishna and He (2015) surveyed

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75 R&D teams to determine that leader and peer coaching were instrumental in enabling an R&D team in a highly adaptive environment were able to maintain focus on achieving results. More specifically, they found the "core roles a leader plays include coaching, developing, and mentoring the team, and this has been shown to have a positive impact on team performance" (p. 880).

Hoisl, Gruber & Conti collected data form 88 R&D teams with 2,359 qualifying outcomes to garner insights on team diversity-performance in extreme settings and how they should be optimally configured. They found "an inverse U-shaped relationship between the diversity in experience of R&D teams and team performance in hypercompetitive settings" (p. 1475). More specifically, while diversity enhanced results up to a point, at some level too much diversity resulted in the team becoming less congruent. They also determined that more diverse R&D teams were more effective in large organizations than they were in small organizations. At some point, too much diversity negates the benefits that diverse background and expertise may offer mostly due to the difficulties of communication and coordination. Additionally, in larger companies, a multicultural team leader that has a high global identity is better able to promote innovative goals through their ability to enhance team communications (Lisak, Erez, Sui, & Lee, 2013, p. 656).

Diaz et al. (2013) expanded on the finding of Chen et al. (2010) and established that gender diversity within the R&D team composition was also an influential attribute that needed to be considered. Following this argument, Diaz et al. (2013) proposed that diversity among team members, but more specifically, "gender diversity – the mix of women and men and the dynamics generated when they work in a team –favors innovation and encourages R&D teams to develop projects that involve drastic changes" (p.150). The literature observes that having women within teams improves soft management skills and decision-making processes, and enhances creativity and innovation. Furthermore, "interest in technology has grown among women who now tend to have a better education and higher expectations of work and career" (Diaz et al., 2013; Padgett & Moura-Leite, 2012) that might enable them to redefine the gender stereotypes that have previously precluded them from work in this area.

Another relationship characteristic of R&D teams that extends beyond team composition is the ability to "collaborate radically" (Simon, Gupta, & Buchanan, 2011, p.302). Simon et al. (2011) stipulated that the most creative and productive R&D teams find the richest insights at the intersections between discipline and perspective. In other words, pulling deeply from the experiences of every member and aiding in these opportunities is a characteristic of a formidable and productive R&D team. Simon et al. (2011) posited that radical collaboration consisted of the following:

- *Co-habitation* – sharing space to promote team member encounters
- *Persistent Knowledge* – finding ways to share and keep present all the interesting things that the team is finding and discovering

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- *Brainstorming* – placing a compact challenge in front of a diverse range of talent and encouraging everyone to think expansively
- *Group Involvement* – having the entire team involved in decision-making and discussions to create more robust ideas, fewer design flaws and an easier product to support.

During these moments of collaboration, a great R&D team will not only generate more ideas, but also help build small thoughts into big ideas or share evidence to encourage a better path before investing more into the product or service.

Influences of R&D Teams on Innovation

Examining several of the key relationship characteristics between R&D and teams, further review of the literature can help determine what influences of R&D teams can have on innovation. Zheng et al. (2010) stipulated that R&D teams' ability to create and innovate depends not only on their individual characteristics, but also their work environment within which the leader has an influential role. The role of leadership in developing innovation is recognized globally (Eisenbeiss & Boerner, 2010; Stoker, Looise, Fisscher, & De Jong, 2001; Zheng et al., 2010). Certain leadership practices have been identified as more prominent in motivating individual creativity and team innovativeness, but more importantly, leadership has also been seen to create an innovative climate in which employees became loyal to the organization.

Wang, Ellinger, & Wu (2013) collected data from 268 senior R&D project team members to suggest "individual characteristics and traits cannot fully explain the entrepreneurial opportunity recognition process . . . it is critical for high technology firms to invest in developing and enhancing employees' entrepreneurial opportunity recognition ability" (p. 249).

Eisenbeiss and Boerner (2010) expanded further on the study of leadership and determined that research on innovation suggested that team members creativity and innovative thinking can be best stimulated by providing employees with high levels of autonomy and high degrees of intellectual freedom. Eisenbeiss and Boerner (2010) validated that as "R&D team innovation encompassed both idea generation and idea implementation, team creativity can be regarded as the ideation component of team innovation" (p.365). Furthermore, the concept of innovation can be assessed as R&D teams combined the quantity of developed and implemented ideas and their quality in terms of novelty, magnitude, radicalness and effectiveness. It has also been acknowledged that R&D team members may need a high degree of decision autonomy on procedures, resources and time schedules in order to develop and test creative ideas to enhance the innovation process. Misra (2011) additionally recognized that having high degrees of autonomy is part of a researchers' professional identity. Under moderate levels of leadership, R&D team members should still be driven by intellectual curiosity, strong motivation of regulation processes, enjoy developing their own vision for the future, and set themselves long-term objectives.

Chen et al. (2013) explored an even deeper concept and recognized that situational variables (i.e.

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leadership and the work environment) could indirectly contribute to individual motivation leading to increased team innovation. Chen et al. (2013) extended their research to include R&D team members "suggesting that innovative performance resulted from proactive behaviors by which members of R&D teams strived to bring about change to themselves and/or their environment" (p.1020). The study further theorized that proactive motivational states by team members (i.e. individuals' beliefs regarding their interest in and capacity to bring about innovative change in their work environment) improved team collaboration and the drive to increase creativity in original ideas. Stoker et al. (2001) validated similar findings in their earlier research that analyzed the relation between leadership behavior and R&D team outcome variables, such as team innovation effectiveness and satisfaction. Among the more powerful findings in both research studies confirmed that individual-level antecedents of proactive motivation in R&D teams is the individual's propensity to promote change and take action to influence innovation and the environment (Chen et al., 2013; Stoker et al., 2001). Proactive members in R&D teams are more likely to anticipate issues, initiate action, effect change, and persevere in their goals – all attributes that promote innovation.

Thamhain (2003) also conducted a study focusing on the organizational environment and argued that the most striking findings are that many of the factors that drive innovation from R&D teams are derived from the human side. Organizational components that satisfy personal and professional needs seem to have the strongest effect on innovative performance of R&D teams. Thamhain (2003) verified that "the statistically most significant drivers are social influences derived from the work itself that impact innovation" (p.303). It was determined that people who find their assignments professionally challenging, leading to accomplishments, recognition and professional growth, also seem to function more effectively in an R&D team setting. A professionally stimulating environment also seems to lower communication barriers and conflict and enhances the desire to succeed and creatively share thoughts and information. Furthermore, it strengthens the collective awareness of R&D team members of possible environmental trends and the personal desire to respond to these challenges effectively (Jin & Sun, 2010; Liu et al., 2011).

Pirola-Merlo (2010) corroborated the research conducted by Thamhain (2003) and examined extensively the "R&D innovative team climate". Using the West's (1990) model of team climate and innovation, Pirola-Merlo (2010) established that many of the tasks performed by R&D teams are "temporal cycles of goal-directed activities that typically require innovation" (p.1077). Pirola-Merlo's (2010) expanded version of West's (1990) model of team climate and innovation consisted of the following four (4) dimensions that helped define the construct of R&D innovative team climate:

(1) vision (team members share clear and valued objectives);
(2) participative safety (a non-threatening environment where members can influence discussions and decisions);

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(3) task orientation (concern with achieving excellence through high-quality work and critical appraisal); and
(4) Support for innovation (valuing innovation and supporting work practices aimed at achieving innovation).

Conceptually, R&D projects are not just a single instance of innovation, but rather a series of innovation-requiring episodes. Additionally, after studying 33 R&D teams over a 9-month period, Pirola-Merlo (2010) determined that "innovation is viewed not only as an outcome, but also as an antecedent or mediator of outcomes in temporally, subsequent episodes within a project" (p.1078). Because these episodes embracing R&D projects tend to require innovation, it is plausible to determine the amount of effort and shared vision within R&D teams that may be necessary.

Guidance for the R&D Team

One of the most influential sources of research and development has been the Defense Advanced Research Projects Agency (DARPA). Their list of successful innovations includes the internet, motion-sensing micro machines, unmanned aerial vehicles, micro-electromechanical systems (MEMS), stealth technology, RISC computing, global positioning satellites, and revolutionary prosthetics (Dugan & Gabriel, 2013). One of the agencies most influential directors, George Heilmeier, came up with a set of questions that he used as a filter for any program brought to his office with he termed his "catechism." (Weinberger, p. 247)

The set of questions credited to Heilmeier that anyone proposing a research project or product development effort should be able to answer are still used by DARPA today:

- What are you trying to do? Articulate your objectives using absolutely no jargon.
- How is it done today, and what are the limits of current practice?
- What's new in your approach and why do you think it will be successful?
- Who cares? If you're successful, what difference will it make? What are the risks and the payoffs?
- How much will it cost? How long will it take? What are the midterm and final "exams" to check for success? (Heilmeier, 1975)

The guidance set forth by Heilmeier is a good example of leadership setting the tone for R&D activities by setting clear guidelines. This is a major influencing factoring on how the team operates and provides the foundation for first phase of our conceptual model.

Conceptual Model

The following conceptual model provided offers a visual perspective on the various components surrounding the purpose of this study. As the visual depicts, there is essentially three (3) phases to the purpose of this study. The first phase (phase I) helps identify and examines the influences and factors of R&D teams. The second phase (Phase II) focuses on the relationship that R&D

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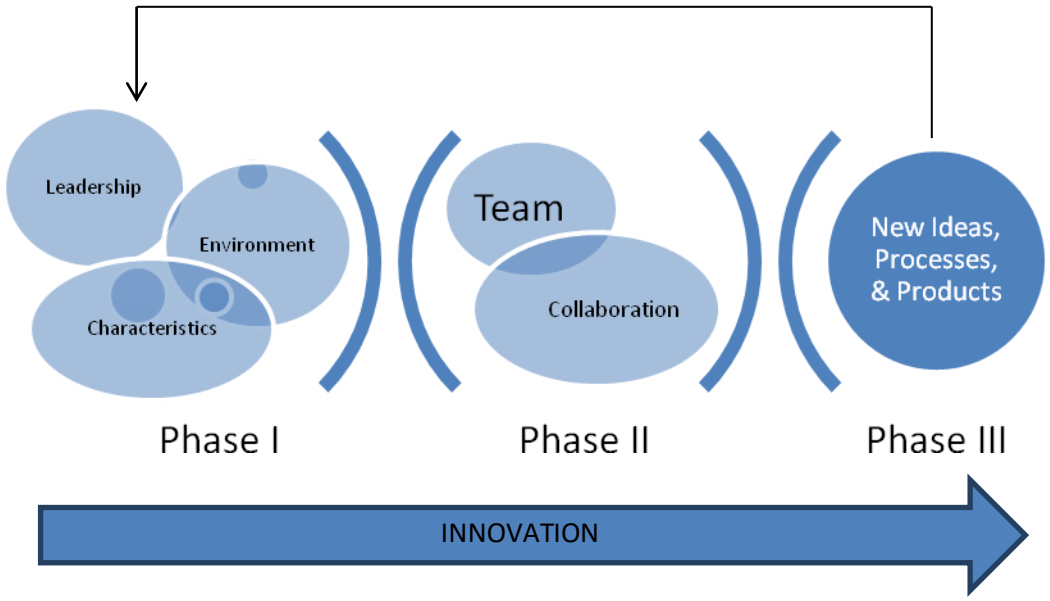
has with team effectiveness and camara FEEDBACK eating and necessitating a level of team collaboration amongst the R&D team members. The third phase (Phase III) focuses on the impact that the influences and drivers from the first two phases has on innovation. This paper examined some of the major influencing factors of R&D teams:

- ***Leadership*** which includes both individual and team members
- ***Environment*** which includes both external and internal factors; and
- ***Characteristics*** which include team member characteristics as well as team formation and creativity (Chen et al., 2013; Misra, 2011; Simon et al., 2011).

These influences can be individual or team oriented, but team members ultimately need to collaborate with one another as they share knowledge and vision to create efficient and productive innovations.



As the literature review and existing research indicates, R&D teams encounter a number of influences that potentially impact innovation. The arrow illustrates the impact of innovation

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beginning with greater R&D team collaboration that originates from the types of influences and/or factors surrounding the team members. R&D team collaboration can lead to increased creative activities, ideas, and enhanced team engagements. R&D teams can continue to improve team creativity by focusing on team internal operations such as understanding task challenges, developing internal communications and engaging in mutual cooperation. Organizations can also clarify organizational policies of team operations, helping to establish effective leadership skills and team member specialty skills (Eisenbeiss & Boerner, 2010; Liu et al, 2011). Good internal and external team functioning is important for improving team collaboration. R&D teams have traditionally been considered ideal for success that includes close camaraderie, trust, and a solid process for working well together to create effective, creative, and innovative solutions.

Discussion and Contribution

R&D teams differ from other teams because of the time-lagged, sporadic, and nonmarket nature to their outputs (Daily, 1978; Harris & Lambert, 1998; Zheng et al., 2010). R&D teams consist of professionals that have distinct characteristics in goal orientation, value systems, need structure, and behavioral patterns (Daniel & Davis, 2009). R&D tasks usually involve a high risk of failure and frequently experience disruptions, delays, and setbacks (Chen et al., 2013; Kim et al., 2011; Thamhain, 2003). All of these factors create unique challenges to organizations. For example, some argue that leadership is redundant because R&D teams usually consist of autonomous knowledge workers, while others believe that leadership is an essential part of an R&D team since even self-managing teams need leadership. These are one set of factors that influence R&D teams and can become an integral component in innovation decisions.

The results presented in this research also highlight the importance of the environment of R&D team activity. It was shown that task and team characteristics affect both problem solving and productivity in R&D teams. Zheng et al. (2010) stipulated that more importantly, it was shown that these contextual characteristics individually influence the relationship between collaborative problem solving and team creativity. This was especially true for team cohesiveness and task interdependence. These findings encouraged the development and use of the Social Exchange Theory to assist in the relationships between team compositions, processes and productivity moderated by team and task characteristics.

The finding of this study has interesting contributions in practical realms. The findings highlight the importance of having a diverse R&D team to favor changes of innovation results and therefore, the potential of a diverse approach to reduce homogeneity within decisions and help foster innovation (Sanchez & Herrera, 2010). Management can embrace the idea that diversity leads to better performance, more creative ideas, and higher potential for successful innovation. There is also the direct impact and benefit to R&D professionals in several ways. First, the findings suggested that leaders of innovative R&D teams have demonstrated a combination of

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internal and external factors. Mihalache et al. (2012) posited that a dual focus needs to be fostered in developing R&D team members. The research pointed to the fact that because innovation in science, technology, and application involves solving processes that no one has solved before, the R&D team member's role in expanding external social capital for knowledge and thought transmission, collaboration, and resourcing becomes as important as the internal decision making practices (Gu et al., 2013; Jin & Sun, 2010). While the internal orientation of team members are incorporated into many development and assessment processes, the external orientation of R&D team members also need to be more fully considered in the decision making process for innovation.

Limitations and Future Research

There are various limitations to this review and room for future research to expand on this study. The initial results and findings are limited in transferability to other studies by the nature of design and research methodology of this review. The absence of a defined environment and the void of a dominant industry increased the variability of the outcome. The research spoke in generalization and was not representative of a specific organizational environment, allowing for the various forms of innovation to become exponentially abundant. Another limitation to the overall study cantered on the behavior strategies and the possible antecedents of these strategies within R&D teams. The interpretation of team member behavior was left as a myriad of possibilities due to the limitations of the research being conducted.

Taking into account these limitations, there are several possibilities for future research. An initial study can be conducted to define a dominant organization and a specific work environment to bring more focus to the results being interpreted. This allows future ongoing studies a definable and measurable template to gauge all other results. There can also be further analyses on external organizational factors and the strategies identifying various forms of innovation that a firm may pursue or encounter. Another complimentary study should focus on the diversity of R&D team compositions. A great deal of interest can be derived from understanding the specificity of ethnic identity and cultural diversity in making team decisions that impact the creative nature and openness to sharing innovative ideas in the organization.

Conclusion

This review set out to examine what were the influences of R&D teams on innovation. The research identified several key influences and drivers of R&D teams ranging from leadership, to the environment, to team characteristics. The impact on innovation stemmed from greater R&D team collaboration that originated from the types of influences and/or factors surrounding the team members. The use of *Social Exchange Theory* as a theoretical framework to observe how these relationships integrated proved insightful. The theoretical framework was complimented by *Chen and Kanfers Multilevel Theory* to better help explain the outcome of team decisions from an internal team composition perspective. This study demonstrated a potential contribution to the management profession with the hopes that future research will continue bringing forth more knowledge and more practical implications to R&D teams and innovation.

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As the seminal works of literature on R&D teams and innovation (Aram & Morgan, 1976; Daily, 1978) expressed the need for collaboration, understanding and multiple perspectives to problem solving, this should certainly be taken into consideration when making management decisions that impact innovation for the organization. The increasing influences in organizations both internally and externally have created an absolute need to find effective ways to communicate within R&D teams and produce creative and innovative ideas. As the current research shows, establishing relationships amongst leadership, internal and external environments, and team composition helps the creative process and proves to be successful. In order to compete in changing and unpredictable business environments, it is the skill and creativity of the R&D team members, which provide a competitive edge to the organization. Organizations have to make sure that R&D team members have these creative skills to perform effectively and create innovative products and efficient overall processes.

References

Aram, J. & Morgan, C. (1976). The role of project team collaboration in R&D performance. *Management Science, 22*(10), 1127-1138.

Bertrand, O. & Mol, M. (2013). The antecedents and innovation effects of domestic and offshore R&D outsourcing: The contingent impact of cognitive distance and absorptive capacity. *Strategic Management Journal, 34*(1), 751-760. doi: 10.1002/smj.

Chen, G., Farh, J., Campbell-Bush, E., Wu, Z., & Wu, X. (2013). Teams as innovative systems: Multilevel motivational antecedents of innovation in R&D teams. *Journal of Applied Psychology, 98*(6), 1018-1027. doi: 10.1037/a0032663.

Chen, H., Hsu, W., & Huang, Y. (2010). Top management team characteristics, R&D investment and capital structure in the IT industry. *Small Business Economics, 35*(1), 319-333. doi: 10.1007/s11187-008-9166-2.

Daily, R. (1978). The role of team and task characteristics in R&D team collaborative problem solving and productivity. *Management Science, 24*(15), 1579-1588.

Daniel, L. & Davis, C. (2009). What makes high-performance teams excel? *Research Technology Management, 52*(4), 40-46.

Diaz-Garcia, C., Gonzalez-Moreno, A., & Saez-Martinez, F. (2013). Gender diversity within R&D teams: Its impact on radicalness of innovation. *Innovation: Management, Policy, & Practice, 15*(2), 149-160.

Dugan, R. & Gabriel, K. (2013). Special Forces Innovation: How DARPA Attacks Problems. *Harvard Business Review*, 91(10), 74.

Eisenbess, S. & Boerner, S. (2010). Transformational leadership and R&D innovation: Taking a curvilinear approach. *Creativity and Innovation Management, 19*(4), 364-373. doi:10.1111/j.1467-8691.2010.00563.x.

Gu, Q., Wand, G., & Wang, L. (2013). Social capital and innovation in R&D teams: The mediating roles of psychological safety and learning from mistakes. *R&D Management, 43*(2), 89-102.

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ISSN: 2456-3676

Harris, R. & Lambert, J. (1998). Building effective R&D teams: The senior manager's role. *Research Technology Management, 41*(5), 28-35.

Helimeier, George (1975). The Helimeier Catechism. Retrieved from https://www.darpa.mil/work-with-us/heilmeier-catechism

Hirst, G. & Mann, L. (2004). A model of R&D leadership and team communication: The relationship with project performance. *R&D Management, 34*(2), 147-160.

Hoisl, K., Gruber, M., & Conti, A. (2017). R&D team diversity and performance in hypercompetitive environments. *Strategic Management Journal*, 38(7), 1455-1477.

Ishikawa, J. (2012). Leadership and performance in Japanese R&D teams. *Asia Pacific Business Review, 18*(2), 241-258. doi: 10.1080/13602381.2010.532907.

Jaffe, A. (1988). Demand and supply influences in R&D intensity and productivity growth. *Review of Economics and Statistics, 70*(3), 431-438.

Jin, L. & Sun, H. (2010). The effect of researchers' interdisciplinary characteristics on team innovation performance: Evidence from university R&D teams in China. *The International Journal of Human Resource Management, 21*(13), 2488-2502. doi: 10.1080/09585192.2010.516599.

Karanges, E., Beatson, A., Johnston, K., & Lings, I. (2014). Optimizing employee engagement with internal communications: A social exchange perspective. *Journal of Business Market Management, 7*(2), 329-353.

Kim, S., Lee, B., Park, B., & Oh, K. (2011). The effects of R&D, technology commercialization capabilities and innovation performance. *Technological & Economic Development of Economy, 17*(4), 563-578. doi: 0.3846/20294913.2011.603481.

Kim, Y., Min, B., & Cha, J. (1999). The roles of R&D team leaders in Korea: A contingent approach. *R&D Management, 29*(2), 153-165.

Kratzer, J., Holzle, K., & Gemunden, H. (2010). How the network positions of R&D team managers and members affects their evaluations of creative performance. *Creativity and Innovation Management, 19*(2), 107-118. doi:10.1111/j.1467-8691.2010.00556.x.

Krishna, R., He, H. (2015) Managing Team Innovation in the Research and Development (R&D) Organization. *Therapeutic Innovation & Regulatory Science*. 49(6), 877-885.

Hsieh, L. & Lee, P. (2011). A study of the relationship among team governance mechanisms, team leaning activities and R&D performance. *Northeast Region Decision Science Institute*, 987-996.

Lerner, J. & Wulf, J. (2007). Innovation and incentives: Evidence from corporate R&D. *The Review of Economics and Statistics, 89*(4), 634-644.

Liao, L. (2008). Knowledge-sharing in R&D departments: A social power and social exchange theory perspective. *The International Journal of Human Resource Management, 19*(10), 1881-1895. doi: 10.1080/09585190802324072.

Lisak, A., Erez, M., Sui, Y., & Lee, C. (2016). The positive role of global leaders in enhancing multicultural team innovation. *Journal of International Business Studies*.47(6), 655-673.

Vol. 4, No. 02; 2019

ISSN: 2456-3676

Liu, Y., Keller, R., & Shih, H. (2011). The impact of team-member exchange, differentiation, team commitment, and knowledge sharing on R&D project team performance. *R&D Management, 41*(3), 274-288.

Mihalache, O., Jansen, J., Bosch, F., & Volberda, H. (2012). Offshoring and firm innovation: The moderating role of top management team attributes. *Strategic Management Journal, 33*(1), 1480-1498.

Misra, S. (2011). R&D team creativity: A way to team innovation. *International Journal of Business Insights & Transformation, 4*(2), 31-37.

Padgett, R. & Moura-Leite, R. (2012). The impact of R&D intensity on corporate reputation: Interaction effect of innovation with high social benefit. *Intangible Capital, 8*(2), 216-238. doi: 10.3926/ic.336.

Pirola-Merlo, A. (2010). Agile innovation: The role of team climate in rapid research and development. *Journal of Occupational and Organizational Psychology, 83*(1), 1075-1084. doi: 10.1348/096317909X480653.

Sanchez-Gonzalez, G. & Herrera, L. (2010). The influence of R&D cooperation on innovatory effort. *Innovation: Management Policy & Practice, 12*(3), 337-354.

Simons, T., Gupta, A., & Buchanan, M. (2011). Innovation in R&D: Using design thinking to develop new models of inventiveness, productivity and collaboration. *Journal of Commercial Biotechnology, 17*(4), 301-307.

Stoker, J., Looise, J., Fisscher, O., & De Jong, R. (2001). Leadership and innovation: Relations between leadership, individual characteristics and the functioning of R&D teams. *International Journal of Human Resource Management, 12*(7), 1141-1151.doi: 10.1080/09585190110068359.

Tang, C, Shang, J., Naumann, S., & Zedtwitz, M. (2014). How Team Identification and Expertise Identification Affect R&D Employees' Creativity. *Creativity and Innovation Management*. 23(3), 276-289.

Thamhain, H. (2003). Managing innovative R&D teams. *R&D Management, 33*(3), 297-311.

Tsai, M. & Cheng, N. (2012). Understanding knowledge sharing between IT professionals – An integration of social cognitive and social exchange theory. *Behaviour & Information Technology, 31*(11), 1069-1080. doi: 10.1080/0144929X.2010.550320.

Wang, Y., Ellinger, A., & Jim Wu, Y. (2013). Entrepreneurial opportunity recognition: an empirical study of R&D personnel. *Management Decision,* 51(2), 248-266.

Weingerger, Sharon. *The Imagineers of War: The Untold Story of DARPA, the Pentagon Agency That Changed the World*. New York: Knopf, 2017.

Zheng, W., Khoury, A., & Grobmeier, C. (2010). How do leadership and context matter in R&D team innovation? A multiple case study. *Human Resource Development International, 13*(3), 265-283. doi: 10.1080/13678868.2010.483816.