The Conceptual Framework of Factors Affecting Shared Mental Model

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Abstract

Many researchers have paid attention to the potentiality and possibility of the shared mental model because it enables teammates to perform their job better by sharing team knowledge, skills, attitudes, dynamics and environments. Even though theoretical and experimental evidences provide a close relationship between the shared mental model and successful team performance, there has not been much consideration of the factors of the shared mental model that can show a causal relationship between it and team performance. Based on the reviews of existing studies, the purpose of this study is to specify what factors affect the shared mental model. For further research, it is necessary to conduct empirical studies that validate the causal relationship among the identified factors of shared mental models that affect team performance.

Introduction

Salas, Dickinson, Converse, and Tannenbaum (1992) define the term 'team' as "a distinguished set of two or more people: 1) who interact dynamically, interdependently, and adaptively toward a common and valued goal, object, or mission; 2) who have been assigned specific roles or functions to perform; and 3) who have a limited life span of membership." For example, a team in corporate settings consists of two or more persons who have similar knowledge, skills, and backgrounds. Team members have to achieve goals with similar missions and visions of the team to achieve better performance. Even though each team member has a specific role and responsibility, they should work together interdependently.

To become a high performance team, it has been argued that each team member should share various factors such as team knowledge, skills, work attitude, as well as team dynamics and the environment surrounding them. In other words, team members should have a shared mental model that represent information regarding the team members' knowledge, skills, attitudes, and behavioral tendencies to perform better across a lot of different domains (Griepentrog & Fleming, 2003). Terms such as team mental models, shared mental models, shared frames, teamwork schemas, transactional memory, and socio cognition have been interchangeably used by researchers to explain variance in team development, performance, strategic problem definition, strategic decision making, and organizational performance (Klimoski & Muhammed, 1994). In short, the shared mental model can be defined as a representation of shared knowledge regarding the team, the team's objectives, and information of team processes, communication, coordination, adaptation, roles, behavior patterns, and interactions (Klimoski & Mohammed, 1994).

A great deal of research has been done on shared mental models. For instance, Cannon-Bowers and his research colleagues (1993), Kraiger and Wenzel (1997), and Klimoski and Mohammed (1994) have all provided extensive reviews and research on shared mental models. In addition, they have attempted to analyze the relationship between shared mental models and team performance. Numerous studies have shown that a shared mental model improves team coordination and performance (Cannon-Bowers, Salas, and Converse, 1993; Klimoski & Mohamed, 1994). In addition, the shared mental model has potential value as an explanatory mechanism, which helps team members to understand team performance by explaining how effectively team members interact with one another.

Expert research has also shown that team members of high performance teams could often coordinate their behaviors without the need to communicate (Cannon-Bowers et al., 1993). In addition, when team members share knowledge, it enables them to interpret cues in similar manners, make compatible decisions, and take appropriate actions (Klimoski & Mohammed, 1994). A shared mental model also helps team members explain other members' actions, understand what is going on with the task, develop accurate expectations about future member actions and task states, and communicate meanings efficiently. Many studies have been done to

gain a better understanding of shared mental models and the causal relationship between shared mental models and team performance (e.g Cannon-Bowers, Salas, & Converse, 1993; Cannon-Bowers, & Salas, 1998; Cannon-Bowers, Janis & Salas, Eduardo, 2001).

However, there has been little research about what factors the shared mental model comprises. It is important to examine the factors of shared mental models because it is useful to investigate specific relationships between the shared mental model and team performance as well as understand the general characteristics of shared mental models. This study synthesizes the existing studies regarding the factors of shared mental models with alternative views.

Factors affecting shared mental models

Cannon-Bowers and Salas (1997) suggest that team members can use shared mental models to develop team members' "knowledge, skills, and attitudes required for effective teamwork" and the "understanding of facts, concepts, relations, and underlying foundation of information needed to perform tasks." That is, a shared mental model consists of: 1) requisite knowledge that is required for the team's effective task performance, 2) the skills and behaviors that are necessary to perform the task effectively and 3) the appropriate attitudes that promote effective team performance (Cannon-Bowers, Tannenbaum, Salas & Volpe, 1995). These are either specific or generic depending on task and the team.

In addition, a team's dynamics and their understanding of a complex situation at a certain time are also considered as factors of shared mental models (Cooke, Stout, & Salas, 1997; Stout, Cannon-Bower, & Salas, 1996). The dynamics of a team are mainly team interactions that happen among team members to create new ideas and facilitate communication. The environment surrounding the team affects the shared mental model as well as team performance. The outside environment changes the role, tasks, and final goal of the team members so that they have to adapt themselves to new environments by transforming the shared mental model that they used to have.

Based on literature reviews on the shared mental model, five components were identified and selected as main factors. The factors of shared mental models and specific descriptions are as follows.

Factor 1: Team knowledge

Team knowledge consists of two different types of knowledge: 'teammate knowledge' and 'task knowledge'. First, teammate knowledge is the extent of knowledge to which team members know other team members' preference, strengths, weaknesses and tendencies in order to maximize performance (Cannon-Bowers et al., 1993). This type of knowledge should help team members to compensate for one another, predict each other's actions, provide information before being asked, and allocate appropriate tasks or roles according to member expertise. That is, as members become more aware of one another, they can adjust their own behavior in accordance with what they expect from teammates. Knowledge of teammates is probably more useful across a variety of tasks rather than a single task.

Second, task knowledge is closely related in specific knowledge that is needed for conducting the task. In the case of procedural tasks, team members should share task models that are declarative and procedural knowledge for conducting the tasks. Whenever tasks are conducted in unpredictable ways, the value of teammate and task knowledge becomes more important. Cannon-Bowers et al (1993) argued that these two types of knowledge lead team members to better performance in specific tasks by sharing teammates' knowledge and skills as well as task knowledge.

Factor 2: Team skills

Skills refer to the abilities to do things associated with successful job performance, whereas knowledge indicates facts and information essential to performing a job or task. Numerous studies have addressed some types of skills that are needed to function effectively as a part of a team. For instance, Dickinson and McIntyre (1997) identified seven core skills of teamwork: 1) communication, 2) team orientation, 3) team leadership, 4) monitoring team performance, 5) feedback, 6) backup behavior and 7) coordination. These skills are important components for performing tasks successfully. Cannon-Bowers also presents a framework for team competencies in terms of team specific skills and team generic skills (Cannon-Bower et al., 1995).

Team specific skills depend on the particular team and include specific members' ways of dealing with conflicts and team cohesion. Team generic skills are transportable to other teams. These competencies include communication skills, interpersonal skills, and leadership skills. Each skill is not independent, but involves

interactive relationships.

Factor 3: Team Attitudes

Attitude is defined as "an internal state that influences an individual's choices or decision to act in a certain way under particular circumstances" (Cannon-Bowers et al., 1995). This attitude in shared mental model research covers shared belief, shared value, teamwork, team concept, collective orientation, collective efficacy, and shared vision. First, shared belief refers to the category of what we believe in. Team members' shared beliefs help teammates to have compatible perceptions about the task and environment and ultimately reach effective decisions. Sub factors include shared beliefs (Cannon and Edmondson, 2001) and cognitive consensus (Mohammad et al., 2000).

Second, shared values are what we are willing to work for (Carr, 1992). High performance teams have both a clear understanding of the goal to be achieved and a belief that the goal embodies a worthwhile or important result. Then, when everyone is clear on what they value, they can set goals consistent with these values and the team will believe that the goals are worthwhile and important.

Factor 4: Team dynamics

Smith-Jentsch and his colleagues (2001) examined team dynamics, which refer to the understanding of the components of teamwork that are critical for effective performance as well as the relationships between these components. In this study, team dynamics are viewed as the combination of dynamic processes of team coordination and team cohesion. First, team coordination consists of implicit and explicit coordination (Entin, & Serfaty, 1999; Stout, Cannon-Bowers, Salas, & Milanovich, 1999). In explicit coordination, team members communicate to articulate their plans, actions and responsibilities, whereas implicit coordination describes the ability of team members to act together without the need for overt communication. For successful implicit coordination, team members should have a shared understanding of the situation and an accurate understanding of each other's tasks and responsibilities.

The advantages and disadvantages of implicit and explicit coordination depend on the nature of the task and the task environment (Fiore Salas, & Cannon-Bowers, 2001). The ability to coordinate implicitly can provide an advantage to team members during periods of intense task load by reducing the communication overhead needed for coordinated action. Implicit coordination is associated with effective performance if team members have an accurate understanding of each other's needs, responsibilities, and expected actions; and communication may be necessary to build that understanding.

Second, team dynamics include team cohesion, defined as "a dynamic process which is reflected in the tendency for a team to stick together and remain united in the pursuit of its instrumental objectives and/or for the satisfaction of members' affective needs" (Carron & Hausenblas, 1998). Team cohesion includes both the task and social aspects of cohesion. Widmeyer, Brawley, & Carron (1985) pointed out that a conceptual model of team cohesion should be distinguished between the individual/team and task/social cohesion. The four categories of team cohesion are: 1) team integration relating to the bonding of the team as a social unit, 2) team integration relating to the task, 3) individual attractions to the team relating to personal involvement and social interaction with the team and, 4) individual attractions to the team relating to the team task.

Factor 5: Team Environment

For the most part, the team environment - which is external conditions affecting the formation of the shared mental model - includes technology, organization, synchrony and geographic dispersion. First, technology is a mechanism that affects how teams interact (McGrath & Hollingshead, 1994). One example of technology is information technology. Information technology is a means for people to communicate with each other and transfer information through networked computing systems. There are numerous studies showing that information technologies affect dependencies, information flow, and workflow among collaborators in team performance (Grinter et al., 1999; Sproull & Kiesler, 1991).

Second, organizational factors such as culture, structure, and standard procedures also affect team performance. Various studies have addressed that organizations are social systems that affect (and are affected by) how technologies are used (DeSanctis & Poole, 1994; Orlikowski, 1992), all of which can affect the types of dependencies present in a task.

Third, synchrony and geographic dispersion also affect successful team performance. Team performance is affected by time flow in which team performance occurs synchronously or asynchronously. In addition, the place where team performance happens is different by being either co-located (i.e., same place) or

geographically dispersed (i.e., different places). Thus, four-folded modes of team performance occur when synchrony and team location are considered (Bullen & Bennett, 1993). Consequently, synchrony and geographic dispersion need to be considered when studying shared mental models because they can generate different work arrangements with different resulting sets and types of dependencies.

Conclusion: Toward general factors of shared mental models

Shared mental models include knowledge relevant to team work such as knowledge of team member roles, responsibilities, knowledge of teammates' knowledge, skills, abilities, beliefs, preferences, and style as well as knowledge relevant to task work, such as cue-strategy associations, understanding of task procedures, and knowledge of typical task strategies (Cannon-Bowers, et al., 1995). From the review of shared mental models, we identified five main factors affecting successful team performance, which are team knowledge, skills, attitudes, team dynamics, and team environments.
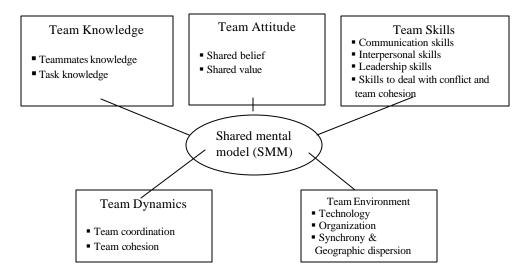

Figure 1. Theoretical Framework of Shared mental model

Discussion and Implication

The existing studies support the general hypothesis that shared mental models can be useful as a measure of team performance. Although shared mental models are strongly predictive of team performance, they have not been clearly defined in terms of the sub factors. The purpose of this study was to identify the factors which affect shared mental models. This study is hypothetical, it is therefore necessary to conduct an empirical study that validates the causal relationship among identified factors and team shared mental models. Also, we need to figure out how these factors impact team performance and how we can best support team performance based on our findings.

Reference

Bullen, C. and J. Bennett (1993). *Groupware in Practice: An Interpretation of work Experiences, in Groupware and Computer-Supported Cooperative Work: Assisting Human-Human Collaboration*, R. Baccker, Editor, 1993, Morgan Kaufman Publisher: CA.p. 69-84

Cannon-Bowers, I.A., Salas, E., & Converse, S. (1993). Shared mental models in expert team decision making. In J. Castellan. Jr. (Ed.), Current issues in individual and team decision making (pp. 221-246) Mahwah, Nj:Erllbaum.

Cannon-Bowers, J.A., Tannenbaum, S.I., Salas, E., & Volpe, C.E.(1995). Defining team competencies and establishing team training requirement. In R. Guzzo & E. Salas (Eds.). Teams: Their training and performance (pp.101-124). Norwood, NJ: Ablex.

Carron, A.V., & Hausenblas, H.A.(1998). *Group dynamics in sport* (2nd ed). Morgantown, WV: Fitness

Information Technology

Cannon-Bowers, J. & Salas, E (1998). *Making decisions under stress: Implications for individual and team training*. Washington, DC: American Psychological Association.

Cannon-Bowers, Janis & Salas, Eduardo (2001). Reflection on shared cognition. *Journal of Organizational Behavior. 22*, 195-202.

Cannon M, Edmondson A. 2001. Confronting failure: antecedents and consequences of shared beliefs about failure in organizational work groups. *Journal of organizational behavior 22*: 161-177

Cooke, N. J., Stout, R. J., & Salas, E. (1997). Broadening the measurement of situation awareness through cognitive engineering methods. Proceedings of the Human Factors & Ergonomics Society 41st Annual Meeting, Santa Monica, CA, 215-219.

DeSanctis, G., & Poole, M. S. (1994). Capturing the complexity in advanced technology use: adaptive structuration theory. *Organization Science*, 5(2), 121-147.

Dickinson, T. L. & McIntyre, R. M. (1997). *A conceptual framework for teamwork measurement*. In M. T. Brannick, E. Salas, & E. Prince (Eds). Team performance assessment and measurement: Theory, methods, and applications (pp. 19 - 43). Mahwah, NJ: Lawrence Erlbaum Associates, Inc

Entin, E.E and Serfaty, D. (1999). Adaptive team coordination. *Human Factors, 41*, 312-325.

Fiore, S.M., Salas, E., & Cannon-Bowers, J.A. (2001). Group dynamics and shared mental model development. In M. London (Ed.), *How people evaluate others in organizations* (pp.309-336). Mahwah, NJ: LEA.

Griepentrog, B.K. & Fleming, P.J.(2003). Shared Mental Models and Team Performance: Are You Thinking What We're Thinking? Paper presented at the 18th Annual Conference of the Society of Industrial and Organizational Psychology, April 11-13, 2003, Orlando, Florida.

Grinter, R.E., Herbsleb, J. D., & Perry, D.E. (1999). The geography of coordination: Dealing with distance in R&D work. In Group ' 99 (pp. 306-315). Phoenix, AZ.

Klimoski, R., & Mohammed, S. (1994). "Team mental model: Construct or metaphor" *Journal of Management, 20*, 403-437.

Kraiger. K., & Wenzel, L. H.(1997). Conceptual development and empirical evaluation of measures of shared mental models as indicators of team effectiveness. In M.T. Brannick, E.

McGrath, J. E., & Hollingshead, A. E. (1994). *Group interacting with technologies: Ideas, evidence, issues, and agenda*. Thousand Oak, CA: Sage.

Orlikowski, W. (1992) Learning from Notes: *Organizational Issues in Groupware Implementation*. In Proc. CSCW'92, Toronto, Nov. 1992.

Salas, E. Dickinson,T. L., Converse, S.A. and Tannenbaum, S. I.(1992).Toward an understanding of team performance and training. In R.W. Swezey & E. Salas (Eds.) Teams: Their training and performance (pp.3-29), Norwood, NJ:Ablex.

Smith-Jentsch, K.A., Campbell, G.E., Milanovich, D.M., & Reynolds, A.M.(2001). Measuring teamwork mental models to support training needs assessment, development, and evaluation: Two empirical studies. *Journal of Organizational Behavior, 2,* 179-194

Widmeyer, W. N.; Brawley, L. R.; Carron, A. V. (1985) The measurement of cohesion in sport teams: The group environment questionnaire London, ON: Sports Dynamics.

Sproull, L., & Kiesler, S.(1991). Connections: *New Ways of Working In the Networked Organization*. Cambridge, MA: The MIT Press.

Stout, R., J., Cannon-Bowers, J.A., Salas, E., & Milanovich, D.M. (1999). Planning, shared mental models, and coordinated performance: An empirical link is established. Human Factors, 41, 61-71.

Stout, R.T., Cannon-Bowers, J.A., & Salas, E. (1996). The role of shared mental models in developing team situational awareness: Implications for training. Training Research Journal 2: 85-116