An Integrative Framework of the Tenets of Transactive Memory Systems

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ABSTRACT

Transactive Memory Systems (TMSs) are developed when two or more individuals interact and share information. They form a mutual memory system where they can store the knowledge gained from each other. This is a system of "group think" where individuals in a group learn, store, use, and coordinate knowledge to achieve goals. The current study presents research examining antecedents, consequences, and components of TMSs through a comprehensive framework. 80 of the most significant studies on TMSs between 1985 and 2021 have been explored. The extant work is combined to derive new insights, implications, and areas of future research.

INTRODUCTION

Studies in psychology, information science, and management have surmised the importance of individuals in the creation and exchange of information. These studies have been inspired by the dynamic shared within sports teams, couples, armed forces, and insects such as bees. This concept has then been applied to large organizations that thrive on efficient knowledge transfer for competitive advantage. When two or more individuals interact and share information, they form a mutual memory system where they can store the knowledge gained from each other. While an individual's cache of stored knowledge, both tacit and explicit, may assist in solving problems and enhancing the performance of an organization, a mutual memory system, based on shared experiences and information from multiple sources, can help an organization in more ways than one would expect. Team cohesiveness increases and employee turnover decreases as each individual contributes significantly to the creation of such a system (Paulus *et* al., 2012). This system of "group think" where individuals in the group learn, store, use and coordinate knowledge to achieve goals (Hollingshead, 2001; Wegner, 1986; Argote and Ren, 2012) is known throughout literature as a *transactive memory system*.

The theory of the *group mind* has not been validated so far in the operations management literature. Much of the extant literature attributes group performance to certain environmental factors or characteristics of the group itself (Austin, 2003; Huang & Chen, 2018; Bacharach & Mullins, 2019). However, groups think the same way individuals think. Just as different parts of the human brain assist an individual to perform different actions, different members of a group can contribute uniquely to complete a given task. The group undergoes mental activity to guide its next action. Group behavior can be predicted when researchers understand how groups process and structure information (Wegner, 1987). This is where the role of transactive memory systems (TMSs) becomes evident.
The knowledge of teams within an organization resides inside its work processes, interactions, physical repositories and minds of its employees. The crucial knowledge lying inside the minds of individuals working in the organization can significantly impact the

collective knowledge accumulated to drive individual performance and in turn, team or organizational performance (Cross & Baird, 2000). Individual memory is important for the growth of the organization, but it is concerned with only a single person's perceptions, experience and expertise regarding team or organizational matters. On the other hand, when a network of individuals, who know each other's areas of expertise, communicate with each other and create a transactive memory system (TMS), a more expansive assortment of information is created. It benefits the organization in a far greater capacity than just an individual's memory and information. When this mechanism of sharing becomes more structured and differentiated, sending and requesting information from appropriate individuals becomes easier and more efficient (Palazzolo, 2006). The basic idea is that people develop transactive memory systems through shared interactions about each other's domains of expertise (Wegner, 1987; Brandon & Hollingshead, 2004). In simple terms, these systems contain knowledge of "who knows what and is best at doing what" (Argote, 2015).

TABLE 1: TMS DEFINITIONS OVER THE YEARS

Definition	**Author(s)**
Collective memory systems	Liang *et* al., 1995; Wegner, 1986, 1995; Wegner, 1991; Wegner, 1985
Cognitive structures	Lewis, 2003; Peltokorpi, 2014
Shared divisions of cognitive labor	Austin, 2003; Littlepage, 2008; Zheng, 2012
Specialized divisions of labor	Kanawattanachai & Yoo, 2007; Lewis, 2004; Huang, 2013
Differentiated structures	Argote & Ingram, 2000; Walsh & Ungson, 1991
Group-level social-cognitive structures	Dai, 2016; Kanawattanachai & Yoo, 2007
Mechanisms of interpersonal knowledge transfers	Argote & Miron-Spektor, 2011

The existing literature consistently defines these transactive memory systems in different ways. While early researchers define them as collective memory systems (Liang *et* al., 1995; Wegner, 1986, 1995; Wegner, 1991; Wegner, 1985), contemporary research has used terms such as cognitive structures, shared divisions of cognitive labor, group-level social-cognitive structures, and mechanisms of interpersonal knowledge transfers (Argote

& Ingram, 2000; Lewis, 2003; Lewis, 2004; Littlepage, 2008; Argote & Miron-Spektor, 2011; Zheng, 2012; Huang, 2013; Peltokorpi, 2014).

These transactive memory systems are used to encode, store and retrieve information about each other's domains of expertise, exchanged between members of a group to enhance the performance of the group and more broadly, of the organization as a whole. Deriving from the literature, this study aims to propose a simpler definition of TMS that is more generalizable and inclusive of extant definitions, as follows:

A Transactive Memory System is a collective repository of individual memory systems and interactions between individuals in groups and organizations about the location of expertise, that helps to encode, store, retrieve and communicate relevant shared knowledge.

TMSs can be formed when members with individual expertise come together and share knowledge in order to create a directory about "who knows what". From a supply-chain context, these members can be part of consulting teams, research teams, product development teams, and other cross-functional project teams. The purpose of these teams is to capitalize on the specialized skills of the individual team members (Lewis, 2003). TMSs are increasingly being recognized as important, yet puzzling because researchers are trying to identify ways to improve their effectiveness in varying environmental conditions. Considering their nature, TMSs are expected to survive and perform effectively in complex situations.

However, a TMS can become a black box if organizations are only interested in increasing their performance through its application. How do TMSs ensure synchronicity and continuing flow of information? Does the behavior of its individual members need to be planned or trained? Are members of a TMS ready and open to learning? TMSs are dynamic by nature. When faced with an atypical situation, TMSs might need to perform in non-routine ways to give unique responses. Understanding these mechanisms behind a TMS can help organizations employ resources for its maintenance and upkeep.

Transactive memory systems may learn and develop over time but they still need to be ready to respond at any moment. Dynamic situations can reduce the control that TMSs have over the application of their solutions. Once faced with a distinct circumstance, a TMS needs to store the response in its memory in case such a situation emerges again at any point in time. Since learning is more 'operational' than 'theoretical' for TMSs, they need to constantly configure their efficiency and effectiveness for better performance. This study aims to answer some of the questions mentioned above to better understand transactive memory systems.

LITERATURE REVIEW

Sociologists like Lebon and McDougall have advocated their theory of the group mind where the individual loses his sense of responsibility and personal consciousness when he becomes part of the group. This group or crowd comes to develop its own crowd consciousness and performs non-essential and non-productive activities. On the other hand, Daniel Wegner's theory of transactive memory systems promotes interpersonal knowledge transfer and communication. The group mind is synced with the individual's mind. There is increased within-group accountability and better performance is achieved due to collective group memory (Wegner, 1987).

Even prominent theories of supply chain management such as the knowledge-based view of the firm, organization information processing theory and socio-technical theory have major differences with the theory of transactive memory systems. The knowledge-based view of the firm (Grant, 1996, 2002; Alavi & Leidner, 2001)) considers knowledge as a strategically important resource required to build competitive advantage for an organization. But it studies actions performed at the firm level rather than the individual level. TMS, on the other hand, considers the expertise of individuals within groups and is measured at the group level. The organization information processing theory (Galbraith, 1973) is concerned with the organization constantly coping with information processing needs. Structural mechanisms are required to increase information flow within the organization, so the focus is once again on the organization. However, TMS does not require any external mechanisms for information transfer. Information processing time is decreased due to the presence of the TM directory that is constantly encoded and updated. Socio-technical theory (Bostrom & Heinen, 1977; Kull *et* al., 2013) measures the interaction and interdependency between employees and technology towards better performance of the organization. Unlike the socio-technical theory, TMS is observed at the group level rather than the organizational level. Also, it looks into the interaction between individuals for better TMS and form performance.

Such differences between renowned SCM theories and TMS highlight the need for transactive memory systems to be considered as a separate, standalone theory. Transactive memory systems have been extensively studied for over three decades and much of the work regards the concept to be a theory in itself. However, the standards set for theory building (Bacharach, 1989; Whetten, 1989) call for a deeper investigation of the constructs, relationships, boundaries and functions of TMSs.

A TMS manifests itself through specialization, coordination and credibility of exchanged information. These form the underlying constructs of strong and effective transactive memory systems (Lewis, 2003; Oshri *et* al., 2008; Noroozi, 2013; Chung *et* al., 2015; Wang *et* al., 2018; Ali *et* al., 2019). Transactive memory only exists when a team member comprehends what another person knows and uses it to develop his or her own different knowledge base. Conversely, when members develop a distinct transactive memory system, it causes their information to be differentiated and specialized (Lewis, 2003). This differentiation of knowledge is where the real benefit of a TMS is enacted because, with less overlap in member's areas of expertise, distribution of labor becomes easier and the team can become more efficient (Wegner 1987). Specialization leads to better information

retrieval, preventing redundancy and supplying more access to the range of expertise within the group (Hollingshead, 1998; Noroozi, 2013).

A strong TMS is not only achieved through specialization but also through the extent to which team members believe that the knowledge they gain through exchanges is correct and accurate. If a particular member's area of expertise has been used on several occasions without any issue or threat to accuracy, other group members begin to trust the information and in turn, the member who provides it (Wegner, 1987). That aids in the development of a more credible transactive memory system (Lewis, 2003; Wang *et* al., 2018). A more efficient TMS is one where all team members implicitly coordinate with each other, acknowledge others' strengths and weaknesses, anticipate behaviors within a team, respond appropriately, and make quick adjustments in their own behaviors in return (Chung *et* al., 2015; Lewis, 2003; Ali *et* al., 2019). Groups that have developed a specialized transactive memory find it easier to coordinate and obtain credible information about a particular group member's area of expertise.

Relationships are formed within a TMS through the development of a transactive memory system involving three stages: directory updating, information allocation and retrieval coordination (Wegner, 1987, 1995). These interdependent stages are transactive, meaning that processes impacted by TMSs get constantly updated due to information exchange between members. In the directory updating (encoding) stage, team mates gather information on their counterparts' domains of knowledge and assign each knowledge domain to the specific team member through the "who knows what" information exchange (Wegner, 1987, 1995; Rulke & Rao, 2000). Through this process, team mates take the first essential step towards specialization.

Once the directory containing this information is updated (Oshri *et* al., 2008), team members are better able to store information with the individual who holds relevant knowledge and expertise related to the knowledge acquired. This process improves the learning process and reduces load on the memories of random team mates. In the retrieval stage, group members use the stored information to identify the experts in a required knowledge area. They can then turn to that member to attain the knowledge. Accuracy of this information can strengthen the linkage between members of the team. However, if the information is not accurate, the encoding stage can begin again (Wegner, 1987, 1995).

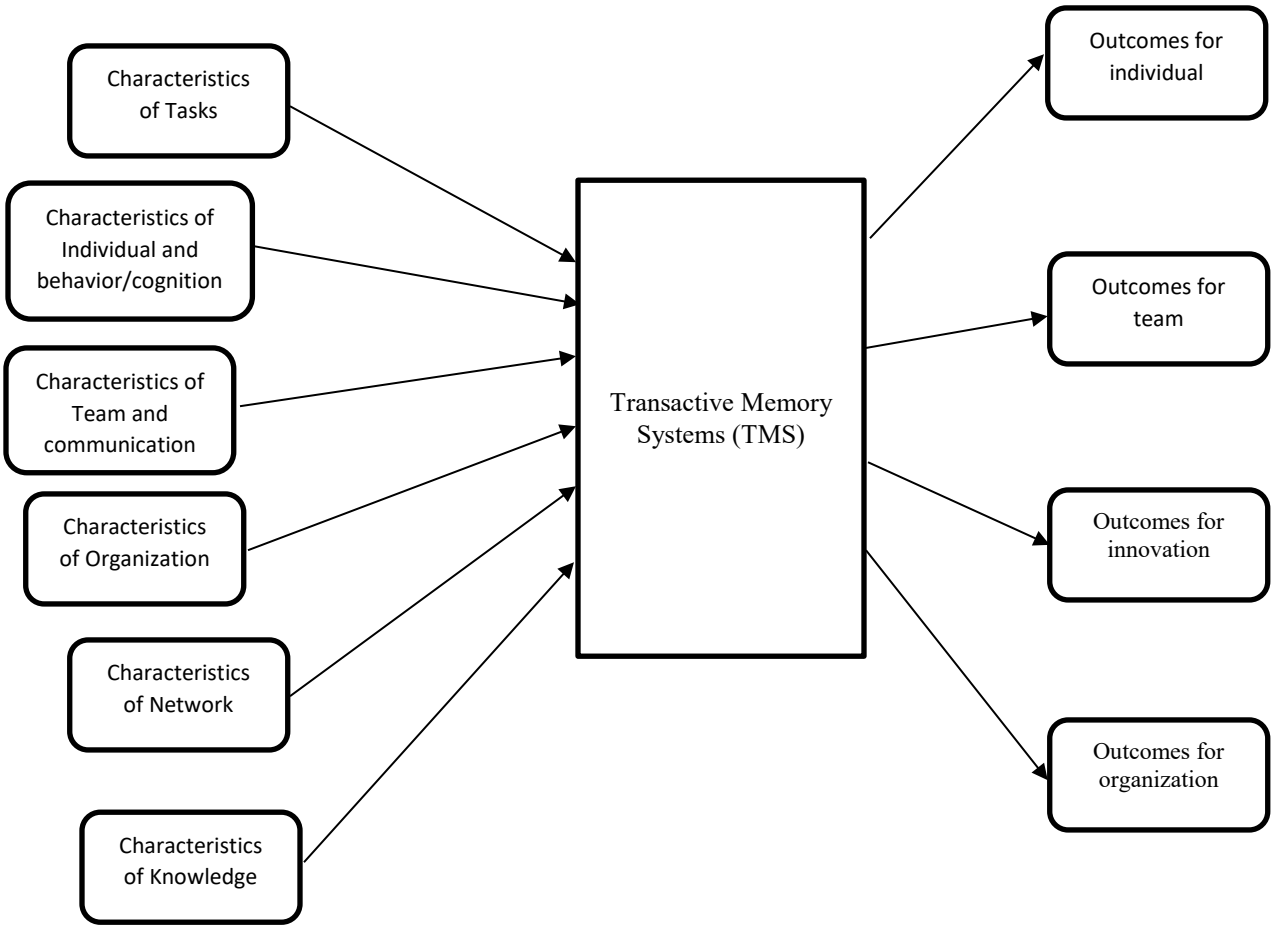
TMSs can enhance the performance of a team or group through the division of responsibility of different kinds of information on different team members by allowing each member to broaden his own knowledge in a specific area while maintaining a directory of other members' expertise. Developing TMSs can also shorten the time needed to search for appropriate knowledge. If each team member knows who to approach for the required knowledge, less time will be wasted in searching for the same. Due to the formation of transactive memory systems which mature with time, team members may be able to better predict and anticipate team behavior, leading to more cohesive and coordinated interactions as well as better performance (Lewis & Herndon, 2011).

TMSs may only be helpful for certain kinds of groups or tasks. Lewis & Herndon (2011) explored criteria for the kinds of tasks that use TMSs to improve performance. They include tasks that require diverse and specialized knowledge, tasks where it is possible to know which members possess expertise, tasks that need complete application of knowledge, tasks where efficient coordination between members is important, and tasks where credibility and accuracy of knowledge is important. The same can be said in the case when the environment for evolution and maturity of TMS turns hostile or the team members start behaving erratically. A transactive memory system only holds when the team members are willing and inclined towards better performance of the team and the organization, as a whole. If members have conflicting goals, no one benefits from the transactions.

TMS FRAMEWORK

Figure 1 summarizes the antecedents and consequences of transactive memory systems in extant research. A more detailed framework can be found in Appendix I which includes mediators and moderators as well. Eighty articles collected between 1985 and 2019 are depicted in this integrative framework. The articles are collectively presented in Appendix II at the end of the manuscript.

FIGURE 1: TMS FRAMEWORK



Classifications of all the constructs in the framework are done on the basis of characteristics of task, individual, team/group, network, organization, or environment. TMS is represented in the center, including various ways it has been operationalized and measured in the existing literature. The framework clearly divides constructs on the basis of unit of analysis to help researchers and practitioners in deciding which aspects of task, individual, team/group, network, organization, and/or environment can impact the formation of a well-structured and efficient transactive memory system. Table 2 depicts the number of articles in various types of studies conducted in the last thirty years.

TABLE 2: NUMBER OF ARTICLES IN VARIOUS STUDIES BETWEEN 1985 AND 2019

Study	Number of articles
Case study	4
Conceptual	17
Field and lab experiments	20
Literature Review	2
Secondary data	1
Survey based	36

ANTECEDENTS OF TMS

Characteristics of Knowledge

Transactions between individuals link their memory systems such that encoded information can be stored and alter retrieved for use. This encoding of information is done by categorizing the location of knowledge expertise in an individual's internal memory as well as externally in objects or other people's memories (Oshri *et* al., 2008; Yuan *et* al., 2010). For a TMS to work, this information of 'who knows what', also known as directory updating, must be developed and organized frequently. That will help in adopting the correct methodologies when faced with a difficult task and maintain the TMS as a well-oiled machine.

Representatives from different knowledge domains work together to accomplish a joint outcome by facing knowledge differentiation and integration tasks (Liao, *et* al., 2012; Oborn & Dawson, 2010). On one hand, specialization is a key characteristic of TMS whereby each expert holds differentiated knowledge about the task at hand; on the other hand, certain common knowledge is required to interpret this differentiated knowledge for better functioning of the TMS (Lewis, 2003; Lewis & Herndon, 2011; Ren & Argote, 2011). A TMS can only be successfully implemented if constituent members share common knowledge of how the group divides the tasks and coordinates differentiated knowledge (Wegner, 1995; Sharma & Yetton, 2007; Lewis & Herndon, 2011).

The existence of a knowledge boundary is determined by how individuals perceive their interactions with others. Differences across different practices, i.e., differences in sense

making cause members to attach meaning to certain phenomena and make assumptions based on their own experiences (Kotlarsky *et* al., 2015; Carlile, 2004). Creation of a shared mental model starts getting complicated if the views of all members aren't streamlined (Canon-Bowers, Salas, & Converse, 1993). Decoding knowledge across the boundaries created by these different interpretations requires individuals to understand the conditions and learn about the sources of different assumptions.

Knowledge sharing can reduce these boundaries and help members recognize each other's expertise (Ren & Argote, 2011). Apart from creating a basis for common knowledge and accurately understanding each other's expertise, sharing of knowledge can increase the team's desire to transform knowledge and coordinate collective tasks (Huang & Chen, 2018). Enhancing interpersonal connections and strengthening social ties can reinforce better knowledge sharing and contribute to the success of a TMS (Jin *et* al., 2015).

Characteristics of Tasks

Even if individuals with specialized expertise spend time together, it is not just the group membership itself that promotes the formation of TMSs. There also needs to be some form of group interdependence to stimulate the development of a TMS (Brandon & Hollingshead, 2004). This interdependence can arise out of a particular property of a task or a reward system (Hollingshead, 2001). When one member's output becomes another member's input, an appropriate task structure can facilitate a smooth transfer. Also, tasks that do not conflict with members' knowledge can motivate them to learn about others' expertise. Divisible tasks can help members allocate responsibilities among themselves and effectively manage division of labor based on skills of each member. Tasks that are not subjective but rather open to interpretation, can encourage member associations in order to find the right person to deal with the task. Engaging in the task with a high level of task orientation (Peltokorpi & Hasu, 2016) can strengthen the TMS structure and refine the transactive processes (Lewis & Herndon, 2011).

Characteristics of Individual and Individual Cognition

Cognitive interdependence is necessary to motivate and sustain transactive memory systems (Brandon & Hollingshead, 2004). This means that members must rely on each other to take responsibility of storing information (Hollingshead, 2001). A certain level of risk exists while members come together and engage in knowledge transfer within a TMS. Trust is extremely important in order to maintain a well-functioning TMS (Robertson, 2012). One can develop trust in other people's skills and abilities but in a TMS, it is equally important that individual members acknowledge others' perceptions of integrity and benevolence (Ashleigh & Prichard, 2012). Such beliefs are stimulated by expectations about others' behaviors and opinions about all matters. If team members do not trust in the integrity of others or in their benevolence towards the team, the goals that the TMS would have otherwise achieved, remain unfulfilled. At some level, team members who trust each other internalize the group's goals as their own and behave in a way that promotes group development (Liao, 2015). Prior shared experiences between the team members helps to solidify this trust (Zhang, 2012).

Researchers suggest that the personality of individuals can influence the outcomes for the team. Effective and forward communication of ideas by an assertive team member can persuade the team in a successful direction (Pearsall & Ellis, 2006). If such an assertive member takes up a leadership position within the group and gains the trust of all members, he/she can improve TMS performance and in turn, team performance. Certain other individual characteristics such as credibility, motivation, willingness to share, absorptive capacity and such others also help in enhancing the performance of a TMS (Hamid & Salim, 2011).

Characteristics of Teams

Communication between team members is extremely important for transfer of information and other resources within a TMS. The interactions that develop due to information allocation and retrieval help to update the transactive memory. Richness and strength of communication help in creating a better TMS (Adelman & Reidl, 2012; Liao, 2015). Perceived communication richness supports team members in figuring out expertise partners for given tasks by allowing communication partners to give feedback on time. Interactions aimed at encouraging knowledge dissemination through good communication quality and collaborative communication practices assists in forming a well-developed TMS (Jarvenpaa & Majchrzak, 2008). Direct communication can help mitigate errors in perception about expertise of members in a TMS (Zhang *et* al., 2010). Communication provides channels for expertise exchange and mechanisms to generate, transfer and retain knowledge (Wegner, 1987).

Team learning processes are formed from co-construction, reflection, boundary-crossing, storage and retrieval behaviors (Oertel & Antoni, 2015; Decuyper, 2010). Apart from individual learning in a TMS, the team as a whole also registers actions that need to be taken in certain situations. These actions help the TMS to perform better if a similar situation suddenly presents itself, and hence fall under team learning. Team composition is also important for the development of a TMS. A team that trains together or has undergone same experiences in the past creates a stronger TMS and definitely performs better (Kahn, 2016). Smaller teams are expected to communicate better since there are lesser number of nodes interacting with each other. On the other hand, a larger team has a greater aggregate expertise, which is a key element of a developed TMS (Lewis & Herndon, 2011).

Characteristics of Organization

Governance decisions of organizations can either harm or help TMSs. The decisions that relate to enhancing joint processes and relationship management functions can be beneficial to TMS development. An organizational climate that supports specialization, building credibility and coordination helps a team within a TMS to achieve its outcomes (Hammedi, 2012). Such organizational climate should reflect a shared perception of the behaviors that are rewarded at the individual level and that at the level of the TMS. Innovation provides the best environment for a TMS to thrive because individuals with unique expertise are banded together, and it is their job to figure out a new product or

service using their specialized skills and abilities. An organization with support for innovation becomes fertile ground for the development of a TMS (Zhang, 1991).

Characteristics of Networks

If individual members in a TMS are connected through a dense network and are able to respond and provide feedback, the TMS develops and succeeds multifold. A centralized network limits direct communication between members; all have to go through the one member who is at the center of the network. This hinders members from learning about each other's skills, and forces them to coordinate in a particular manner, irrespective of their preferences and abilities (Argote, 2018). If membership is stable, networks with high density enable members to establish a strong TMS (Lewis & Herndon, 2011; Wegner, 1987). Strong ties are formed from frequent interaction and reciprocity (Yuan, 2005; Chiu, 2006; Cabeza-Pullez, 2018). Strong ties reduce relationship conflicts and ensure better communication about 'who knows what' in a TMS (Huang, 2018).

CONSEQUENCES OF TMS

Outcomes for Individual

Members' satisfaction with the team, the feeling of psychological safety and trust, and perceptions of future work life (Lewis, 2004; Robertson *et* al., 2012) can impact individual performance. Studies indicate that the relationship between TMS and individual performance outcomes is positive when members experience efficient operations within a team. Since the members' expertise are interdependent, growth in strength of a TMS assures members of the long-term viability of the team.

Outcomes for Team

Performance outcomes for teams in TMS research include financial market share (Kanawattanachai & Yoo, 2007), return on assets, i.e., ROA (Rau, 2005; Yoo & Kanawattanachai, 2001), team evaluation (Austin, 2003), perceived team performance (Bunderson, 2003), perceived team effectiveness and efficiency (Michinov *et* al., 2008; Zhang et al., 2007) and many others. Most of the studies show a positive association between TMS and task performance.

Outcomes for Innovation

Several studies have explored the relationship between TMS and innovation-based performance or new product success (Gino *et* al., 2010; Guo *et* al., 2013). Results from some of these studies have found TMS as a mediator between task experience and team creativity (Gino *et* al., 2010) or team creativity and impact of membership change on creativity (Guo *et* al., 2013). Innovation is evaluated in terms of novelty and usefulness (Miron-Spektor & Beenen, 2015) as well as successful implementation of new ideas and creative solutions (Klein & Sorra, 1996). A transactive memory system helps in idea generation and task selection through its members' understanding of "who knows what"

(Lewis & Herndon, 2011). Recognizing the members who hold a particular expertise and are most likely to contribute then helps in achieving creative performance. Since information is frequently communicated using established routines and stored in the transactive memory of a group, it becomes easier for members to recall the required information.

Outcomes for Organization

Extending the concept of transactive memory to the organizational level helps in advancing knowledge about global strategy and the role played by TMSs in obtaining competitive advantage for firms (Argote, 2015). Not only that, TMS is known to be positively related to decision making efficiency and effectiveness of an organization (Hammedi *et* al., 2012). Improving the communication and coordination process can help a TMS in directly enhancing an organization's project performance (Hsu *et* al., 2012; Li & Huang, 2013).

DISCUSSION AND CONCLUSION

Many researchers suggest that the tasks, which require members to have the same goal, benefit the most from a transactive memory system (Zhang *et* al., 2007; Austin, 2003; Ariff *et* al., 2011; Fitzsimmons *et* al., 2015). However, it can be suggested through the results of this study that groups which engage in sharing knowledge of their expertise may be able to develop transactive memory systems faster than those merely executing ideas because there is more knowledge sharing and interaction between members in the former than the latter.

The basic assumption in TMS theory is that there exists a shared understanding of "who knows what" but many existing studies have oversimplified TMSs, or mildly examined the causes and effects of TMSs. By capturing shared knowledge only as a measurement of TMS, these studies have been unable to fully operationalize TMSs. Interpreting TMS structure as a marker of a TMS has also led to misconstrued results, thereby threatening the validity of many works.

This oversimplification of TMS fails to incorporate the assumptions, boundaries and processes of TMS which form its foundation. Differentiated knowledge, transactive encoding, storage and retrieval processes, as well as the dynamic nature of TMS due to exchanges and interactions, are what distinguish transactive memory systems from other forms of socially shared cognition. The purpose of this article to shed light on the above mentioned aspects of TMS so that researchers and managers can better incorporate them into the operationalization and measurement of TMSs.

Much research has shown that a transactive memory system is primarily developed through interactions between team members. Training for the task that a group is expected to do together can assist in better development of a transactive memory system. When group members are trained together, the team develops a stronger transactive memory system, recalls more information about the process, and makes fewer errors compared to teams where individuals had gone through the same training separately. This shared

struggle ensures that the members of the TMS are comfortable in working together. The synchronicity and continuing flow of information within a TMS is also maintained as the TMS grows stronger. This holds a lot of value for managers who invest in enhancing coordination between diverse and heterogeneous groups of individuals in an organization.

The theory of transactive memory systems has enormous potential in the fields of operations and supply chain management. Several new contexts can be explored in these domains for future research. There can exist differing effects of TMSs on tasks, relationships and processes, especially in the case of conflicts between individuals in a group. Task conflicts should improve TMS by increasing communication and expertise credibility among group members. On the other hand, relationship conflicts might disturb TMS development and functioning because of interpersonal disputes (Peltokorpi & Hood, 2018). Communications that result from process conflict can be beneficial for TMS by helping members to make new associations or rectify current dysfunctional ones (Jehn, 1997). In this way, the effects of task, process and relationship conflicts on TMSs can help researchers understand what negatively affects the formation of these systems.

Proposition 1: Relationship, process and task conflicts impact TMS development in different ways based on the level of communication between members.

In larger networks, people can have fewer chances to establish strong, long-term network ties with all members (Granovetter, 1977, 1985), which influences TMS development and functioning in terms of specialization, coordination and credibility among network members and domain experts. The number of potential links in a network grows so fast that the number of people to which each person could be linked, quickly exceeds each member's cognitive and communicative capacity. As a company starts becoming bigger, it becomes tougher to know all employees. This overwhelms single individuals who hold specialized knowledge and hampers the balance of TMSs. Exploring the effects of such overload can help researchers in understanding how to make TMSs more robust and immune to network effects.

Proposition 2: Increase in nodes within a network can decrease the strength of a TMS.

Yet another area for future research can look into the impact of opportunism in TMS development. Since transactive memory systems heavily rely on the transfer of specialized knowledge across groups, certain members can withhold information for personal gain and display of power. So far, the literature on TMS has explored the positive side of transactions which ultimately result in better firm or team performance. Opportunism differs from conflicts in the sense that the former can include the expectation of rewards for withholding information from other members of the group. It might necessarily build up to a conflict and could more likely take the form of noncompliance towards task completion. This represents the dark side of interactions, something that can bring about a surplus of ideas for future research.

Proposition 3: Members showing opportunism and withholding information about others' expertise can hamper TMS development and in turn, negatively impact firm performance.

One of the most promising topics for future research is supply chain disruptions, which are seen all around the world due to changing economic and political climate, market turbulence, internal threats, communication disruption, resource limits, disease outbreaks or environmental calamity. When an organization faces any internal or external disruption, it tends to do its best to safeguard its assets, be it resources, capital or knowledge. There may be situations where the knowledge transfer in a TMS gets "locked" such that individuals stop sharing what they know due to the strain of the disruption. However, this is exactly the kind of situation that warrants action in the form of sharing of relevant knowledge to resolve the hazardous outcomes of the disruption. Since TMSs thrive on information exchange and team member interactions, investigation of TMS lockdown will be worthwhile to investigate. Buyer-supplier relationships can be used to create an inter-firm TMS in order to resume smooth functioning of the supply chain. Understanding the causes of such an event can help in making TMSs stronger and more resilient for the future.

Proposition 4: Supply chain disruption, while negatively impacting TMS growth, can result in the formation of new TMSs to deal with the changing circumstances.

This study offers insights into the theory of transactive memory systems with antecedents influence a TMS and consequences that result from a smooth-functioning TMS. The objective of the current study was to highlight the mechanisms that drive a TMS and the need for future research in the fields of operations and supply chain management.

REFERENCES

[1] Adelman, L., & Riedel, S. L. (2012). Handbook for evaluating knowledge-based systems: Conceptual framework and compendium of methods. Springer Science & Business Media.

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

[3] Alavi, M., & Leidner, D. E. (2001). Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS quarterly*, 107-136.

[4] Ali, A., Wang, H., & Khan, A. N. 2019. Mechanism to enhance team creative performance through social media: A transactive memory system approach. *Computers in Human Behavior*, 91, 115-126.

[5] Argote, L. 2013. Organizational Learning: Creating, Retaining, and Transferring Knowledge (2nd edn). Springer: New York.

[6] Argote, L., & Guo, J. M. 2016. Routines and transactive memory systems: Creating, coordinating, retaining, and transferring knowledge in organizations. *Research in Organizational Behavior*, 36, 65-84.

[7] Argote, L., & Ingram, P. 2000. Knowledge transfer: a basis for competitive advantage in firms. *Organizational Behavior and Human Decision Processes*, 82(1), 150–169.

[8] Argote, L., & Miron-Spektor, E. 2011. Organizational learning: from experience to knowledge. *Organization Science*, 22(5), 1123–1137.

[9] Argote, L., & Ren, Y. 2012. Transactive memory systems: a micro foundation of dynamic capabilities. *Journal of Management* Studies, 49(8), 1375–1382.

[10] Argote, L. 2015. An opportunity for mutual learning between organizational learning and global strategy researchers: transactive memory systems. *Global Strategy Journal*, *5*(2), 198-203.

[11] Argote, L., Aven, B. L., & Kush, J. (2018). The effects of communication networks and turnover on transactive memory and group performance. *Organization Science*, *29*(2), 191-206.

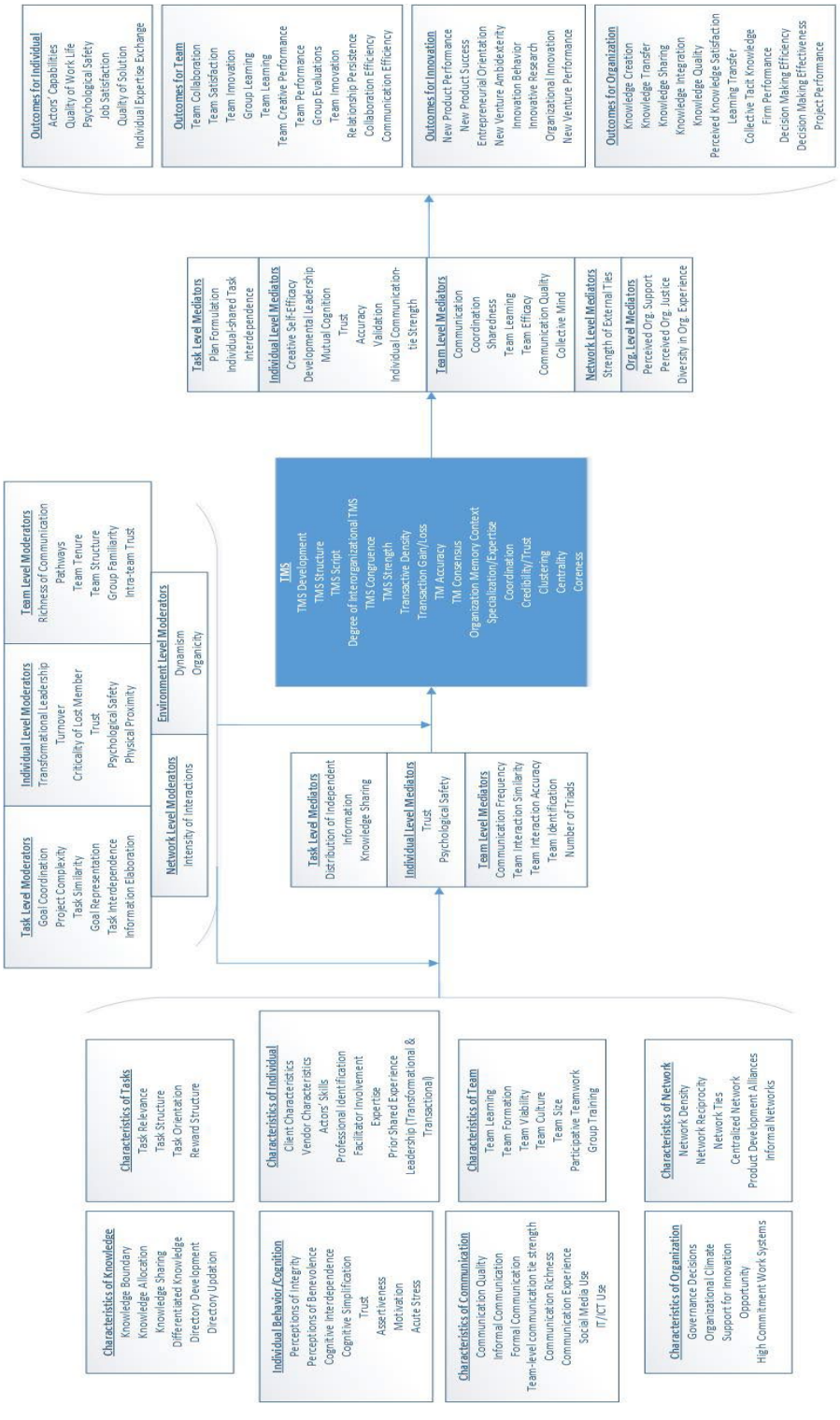
[12] Ariff, M. I., Milton, S. K., Bosua, R., & Sharma, R. 2011. Exploring the role of ICT in the formation of transactive memory systems in virtual teams.

[13] Ashleigh, M., & Prichard, J. (2012). An integrative model of the role of trust in transactive memory development. *Group & Organization Management*, *37*(1), 5-35.
[14] Austin, J. R. 2003. Transactive memory in organizational groups: the effects of content, consensus, specialization, and accuracy on group performance. *Journal of applied psychology*, 88(5), 866.
[15] Bachrach, D.G. and Mullins, R., 2019. A dual-process contingency model of leadership, transactive memory systems and team performance. *Journal of Business Research*, *96*, pp.297-308.
[16] Borgatti, S. P., & Cross, R. 2003. A relational view of information seeking and learning in social networks. *Management science*, 49(4), 432-445.
[17] Bostrom, R. P., & Heinen, J. S. (1977). MIS problems and failures: A socio-technical perspective. Part I: The causes. *MIS quarterly*, 17-32.
[18] Bunderson, J. S., & Reagans, R. E. (2011). Power, status, and learning in organizations. *Organization Science*, *22*(5), 1182-1194.
[19] Cabeza-Pullés, D., Gutierrez-Gutierrez, L. J., & Llorens-Montes, F. J. (2018). Drivers for performance in innovative research groups: The mediating role of transactive memory system. *BRQ Business Research Quarterly*, *21*(3), 180-194.
[20] Chiu, C. M., Hsu, M. H., & Wang, E. T. (2006). Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories. *Decision support systems*, *42*(3), 1872-1888.
[21] Chung, N., Lee, S., & Han, H. 2015. Understanding communication types on travel information sharing in social media: A transactive memory systems perspective. *Telematics and Informatics*, 32(4), 564-575.
[22] Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative science quarterly*, 128-152.
[23] Dai, Y., Roundy, P. T., Chok, J. I., Ding, F., & Byun, G. 2016. 'Who Knows What?' in New Venture Teams: Transactive Memory Systems as a Micro-Foundation of Entrepreneurial Orientation. *Journal of Management Studies*, 53(8), 1320-1347.
[24] Decuyper, S., Dochy, F., & Van den Bossche, P. (2010). Grasping the dynamic complexity of team learning: An integrative model for effective team learning in organisations. *Educational Research Review*, *5*(2), 111-133.
[25] Faraj, S., & Sproull, L. 2000. Coordinating expertise in software development teams. *Management science*, 46(12), 1554-1568.
[26] Fitzsimons, G. M., Finkel, E. J., & Vandellen, M. R. 2015. Transactive goal dynamics. *Psychological Review*, 122(4), 648.
[27] Galbraith, J. R. (1973). *Designing complex organizations*. Addison-Wesley Longman Publishing Co., Inc.
[28] Gino, F., Argote, L., Miron-Spektor, E., & 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), 102-115.
[29] Granovetter, M. S. 1977. The strength of weak ties. In *Social networks*. Academic Press, 347-367.
[30] Granovetter, M. 1985. Economic action and social structure: The problem of embeddedness. *American journal of sociology*, 91(3), 481-510.
[31] Grant, R. M. 1996. Toward a knowledge-based theory of the firm. *Strategic Management* Journal, 17(10), 109–122.
[32] Grant, R. M. (2002). The knowledge-based view of the firm. The strategic management of intellectual capital and organizational knowledge, 17(2), 133-148.
[33] Guo, H., Zhao, J., & Tang, J. (2013). The role of top managers' human and social capital in business model innovation. *Chinese Management Studies*, *7*(3), 447-469.
[34] Hamid, N. A. A., & Salim, J. (2011). A conceptual framework of knowledge transfer in Malaysia e-government IT outsourcing: An integration with transactive memory system (TMS). *International Journal of Computer Science Issues (IJCSI)*, *8*(5), 51.
[35] Hammedi, W., Van Riel, A. C., & Sasovova, Z. (2013). Improving screening decision making through transactive memory systems: A field study. *Journal of Product Innovation Management*, *30*(2), 316-330.
[36] Hollingshead, A. B. 1998. Communication, learning, and retrieval in transactive memory systems. *Journal of Experimental Social* Psychology, 34(5), 423–442.
[37] Hollingshead, A. B. 2001. Cognitive interdependence and convergent expectations in transactive memory. *Journal of personality and social psychology*, 81(6), 1080.
[38] Hollingshead, A. B., & Brandon, D. P. 2003. Potential benefits of communication in transactive memory systems. *Human Communication Research*, 29(4), 607–615.

[39] Hsu, J. S. C., Shih, S. P., Chiang, J. C., & Liu, J. Y. C. (2012). The impact of transactive memory systems on IS development teams' coordination, communication, and performance. *International Journal of Project Management*, *30*(3), 329-340.
[40] Huang, C.C. and Chen, P.K., 2018. Exploring the antecedents and consequences of the transactive memory system: an empirical analysis. *Journal of Knowledge Management*.
[41] Huang, Q., Liu, H., & Zhong, X. 2013. The impact of transactive memory systems on team performance. *Information Technology & People*, 26(2), 191-212.
[42] Jarvenpaa, S. L., & Majchrzak, A. (2008). Knowledge collaboration among professionals protecting national security: Role of transactive memories in ego-centered knowledge networks. *Organization Science*, *19*(2), 260-276.
[43] Jehn, K. A. 1997. A qualitative analysis of conflict types and dimensions in organizational groups. *Administrative science quarterly*, 530-557.
[44] Kahn, S., & MacGarvie, M. (2016). Do return requirements increase international knowledge diffusion? Evidence from the Fulbright program. *Research Policy*, *45*(6), 1304-1322.
[45] Kanawattanachai, P., & Yoo, Y. 2007. The impact of knowledge coordination on virtual team performance over time. *MIS quarterly*, 31(4).
[46] Klein, K. J., & Sorra, J. S. (1996). The challenge of innovation implementation. *Academy of management review*, *21*(4), 1055-1080.
[47] Kull, T. J., Ellis, S. C., & Narasimhan, R. (2013). Reducing behavioral constraints to supplier integration: A socio-technical systems perspective. *Journal of Supply Chain Management*, *49*(1), 64-86.
[48] Lewis, K. 2003. Measuring transactive memory systems in the field: scale development and validation. *Journal of applied psychology*, 88(4), 587.
[49] Lewis, K. 2004. Knowledge and performance in knowledge-worker teams: A longitudinal study of transactive memory systems. *Management science*, 50(11), 1519-1533.
[50] Li, Y. H., & Huang, J. W. (2013). Exploitative and exploratory learning in transactive memory systems and project performance. *Information & Management*, *50*(6), 304-313.
[51] Liang, D. W., Moreland, R., & Argote, L. (1995). Group versus individual training and group performance: The mediating role of transactive memory. *Personality and social psychology bulletin*, 21(4), 384-393.
[52] Liao, S. H., Chang, W. J., Hu, D. C., & Yueh, Y. L. (2012). Relationships among organizational culture, knowledge acquisition, organizational learning, and organizational innovation in Taiwan's banking and insurance industries. *The International Journal of Human Resource Management*, *23*(1), 52-70.
[53] Liao, Y., & Barnes, J. (2015). Knowledge acquisition and product innovation flexibility in SMEs. *Business Process Management Journal*.
[54] Littlepage, G. E., Hollingshead, A. B., Drake, L. R., & Littlepage, A. M. 2008. Transactive memory and performance in work groups: Specificity, communication, ability differences, and work allocation. *Group Dynamics: Theory, Research, and Practice*, 12(3), 223.
[55] Michinov, N., & Michinov, E. (2008). Face-to-face contact at the midpoint of an online collaboration: Its impact on the patterns of participation, interaction, affect, and behavior over time. *Computers & Education*, *50*(4), 1540-1557.
[56] Miron-Spektor, E., & Beenen, G. (2015). Motivating creativity: The effects of sequential and simultaneous learning and performance achievement goals on product novelty and usefulness. *Organizational Behavior and Human Decision Processes*, *127*, 53-65.
[57] Nonaka, I., & von Krogh, G. 2009. Tacit knowledge and knowledge conversion: controversy and advancement in organizational knowledge creation theory. *Organization Science*, 20(3), 635–652.
[58] Noroozi, O., Weinberger, A., Biemans, H. J., Mulder, M., & Chizari, M. 2013. Facilitating argumentative knowledge construction through a transactive discussion script in CSCL. *Computers & Education*, 61, 59-76.
[59] Oborn, E., & Dawson, S. (2010). Knowledge and practice in multidisciplinary teams: Struggle, accommodation and privilege. *Human Relations*, *63*(12), 1835-1857.
[60] Oertel, R., & Antoni, C. H. (2015). Phase-specific relationships between team learning processes and transactive memory development. *European Journal of Work and Organizational Psychology*, *24*(5), 726-741.
[61] Oshri, I., Van Fenema, P., & Kotlarsky, J. 2008. Knowledge transfer in globally distributed teams: the role of transactive memory. *Information Systems Journal*, 18(6), 593-616.
[62] Palazzolo, E. T. 2005. Organizing for information retrieval in transactive memory systems. *Communication Research*, 32(6), 726-761.

[63] Palazzolo, E. T., Serb, D. A., She, Y., Su, C., & Contractor, N. S. 2006. Coevolution of communication and knowledge networks in transactive memory systems: Using computational models for theoretical development. *Communication Theory*, 16(2), 223-250.
[64] Paulus, P. B., Dzindolet, M., & Kohn, N. W. (2012). Collaborative creativity—Group creativity and team innovation. In *Handbook of organizational creativity* (pp. 327-357). Academic Press.
[65] Pearsall, M. J., & Ellis, A. P. (2006). The effects of critical team member assertiveness on team performance and satisfaction. *Journal of Management*, *32*(4), 575-594.
[66] Peltokorpi, V. 2014. Transactive memory system coordination mechanisms in organizations: an exploratory case study. *Group & Organization Management*, 39(4), 444–471.
[67] Peltokorpi, V., & Hood, A. C. 2018. Communication in Theory and Research on Transactive Memory Systems: A Literature Review. *Topics in cognitive science*.
[68] Rau, D. (2005). The influence of relationship conflict and trust on the transactive memory—Performance relation in top management teams. *Small Group Research, 36,* 746 –771.
[69] Ren, Y., & Argote, L. 2011. Transactive memory systems 1985–2010: an integrative framework of key dimensions, antecedents, and consequences. *Academy of Management Annals*, 5(1), 189–229.
[70] Ren, Y., Carley, K. M., & Argote, L. 2006. The contingent effects of transactive memory: when is it more beneficial to know what others know? *Management Science*, 52(5), 671–682.
[71] Robertson, P. L., Casali, G. L., & Jacobson, D. (2012). Managing open incremental process innovation: absorptive capacity and distributed learning. *Research policy*, *41*(5), 822-832.
[72] Rulke, D. L., & Rau, D. 2000. Investigating the encoding process of transactive memory development in group training. *Group and Organization Management*, 25, 373-396.
[73] Walsh, J. P., & Ungson, G. R. 1991. Organizational memory. *Academy of management review*, 16(1), 57-91.
[74] Wang, Y., Huang, Q., Davison, R. M., & Yang, F. 2018. Effect of transactive memory systems on team performance mediated by knowledge transfer. *International Journal of Information Management*, 41, 65-79.
[75] Wegner, D. M., Giuliano, T., & Hertel, P. T. 1985. Cognitive interdependence in close relationships. In *Compatible and incompatible relationships*. Springer, New York, NY, 253-276.
[76] Wegner, D. M. 1987. Transactive memory: a contemporary analysis of the group mind. In *Theories of Group Behavior* (Vol. **9**), Mullen B, Goethals GR (eds). Springer-Verlag: New York; 185–208.
[77] Wegner, D. M., Erber, R., & Raymond, P. 1991. Transactive memory in close relationships. *Journal of personality and social psychology*, 61(6), 923.
[78] Wegner, D. M. 1995. A computer network model of human transactive memory. *Social cognition*, 13(3), 319-339.
[79] Whetten, D. A. 1989. What constitutes a theoretical contribution? *Academy of management review*, 14(4), 490-495.
[80] Yuan, S. T., & Sun, J. (2005). Ontology-based structured cosine similarity in document summarization: with applications to mobile audio-based knowledge management. *IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics)*, *35*(5), 1028-1040.
[81] Zhang, Z. X., Hempel, P. S., Han, Y. L., & Tjosvold, D. 2007. Transactive memory system links work team characteristics and performance. *Journal of Applied psychology*, 92(6), 1722.
[82] Zhang, X., Chen, Z., Vogel, D., Yuan, M., & Guo, C. (2010). Knowledge-sharing reward dynamics in knowledge management systems: Game theory–based empirical validation. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *20*(2), 103-122.
[83] Zheng, Y. 2012. Unlocking founding team prior shared experience: A transactive memory system perspective. *Journal of Business Venturing*, 27(5), 577-591.

APPENDIX I: DETAILED FRAMEWORK OF TMS



APPENDIX II: 80 STUDY TABLE

#	Study	Method	Independent Variable(s)	Moderation (M1) Mediation (M2)	Dependent Variable(s)	Key findings
1	Akgun et al. (2006)	Survey based	TMS	M2: collective mind; M1: environmental turbulence	Team learning, speed-to-market, new product success	The impact of the TMS on speed-to-market is negative when market and technology turbulence associated with the environment is high and that on team learning changes quadratically with respect to the market and technology turbulence.
2	Ali et al. (2019)	Survey based	Social Media (Social, cognitive, hedonic use)	TMS (Specialization, coordination, credibility); Team creative efficacy	Team Creative Performance	The authors develop a mechanism to test the effects of the three dimensions of social media (social, cognitive, and hedonic use) on team creative performance in terms of knowledge management. The analysis reveals that the three dimensions of social media have different effects on TMS. In addition, the dimensions of TMS enhance team creative performance through team creative efficacy.
3	Argote & Guo (2016)	Conceptual	Routines, TMSs	-	Knowledge creation, coordination, retention and transfer	Overviews of research on the two knowledge repositories, routines and TMSs, with particular attention to how they form and change; compare and contrast routines and TMSs in terms of their capabilities to promote knowledge creation, coordination, retention and transfer in organizations.
4	Argote & Ren (2012)	Conceptual	-	-	-	Firms need to include TMS to attain competitive advantages and dynamic capabilities; TMS is a micro foundation of dynamic capabilities and knowledge sharing in organizations can facilitate combinative integration and renovation of an organization's knowledge assets.
5	Argote (2015)	Conceptual	-	-	-	Extending the concept of transactive memory to the organizational level and studying the concept in global firms would advance knowledge about transactive memory systems as well as increase our understanding of global strategy.
6	Argote et al. (2018)	Field experiments	Centralized network	M2: Dyadic Communication frequency, TMSs; M1:Turnover	Performance; Errors	The greater number of direct communication paths enabled fully connected groups with stable membership to develop stronger transactive memory systems (TMSs) and perform better than fully connected groups that experienced turnover.
7	Ariff et al. (2011)	Conceptual	ICT as communication medium	M2: TEP unit, TMS; M1: Task Interdependence	Team Performance	The goal of this research is to explore and describe the formation of TMS in virtual teams. The focus is on the role of ICT as a communication tool to foster TMS formation. This study hopes to provide a deeper understanding of the use of ICT as a communication tool during the formation of TMS in VTs.
8	Ashleigh & Prichard (2012)	Conceptual	Perceptions of benevolence, integrity, ability	-	Knowledge declaration, claims of expertise, congruence between expertise and role allocation, Monitoring and safeguarding behaviors, role redistribution, TMS stability	By using the TM encoding cycle, the model proposes that trust acts as an antecedent of TMSs and that wider perceptions of team members' trustworthiness (benevolence and integrity) also affect the development and maintenance of effective TMSs in teams.
9	Austin (2003)	Survey based	Group's TMS (knowledge stock, knowledge specialization, transactive memory consensus, transactive memory accuracy)	-	Group goal performance, external group evaluations, internal group evaluations	In this study, the author examined the relationship between transactive memory systems and performance in mature, continuing groups. A group's TMS, measured as a combination of knowledge stock, knowledge specialization, transactive memory consensus, and transactive memory accuracy, is positively related to group goal performance, external group evaluations, and internal group evaluations. The positive relationship with group performance was found to hold for both task and external relationship TMSs.
10	Bacharach & Mullins (2019)	Survey based	Transformational leadership, Transactional leadership	M1: Team size, team tenure, market dynamism M2: TMS	Team Performance	Transformational leadership has a stronger relationship with TMS in smaller teams and transactional leadership has a stronger relationship with TMS in less tenured teams. The strength of the relationship between TMS and team performance depends on market dynamism.

#	Study	Method	Independent Variable(s)	Moderation (M1) Mediation (M2)	Dependent Variable(s)	Key findings
11	Brandon & Hollingshead (2004)	Conceptual	Task structure, reward structure, cognitive simplification	Accuracy, sharedness, validation	Construction, evaluation, validation	Task has a major influence on developmental processes; task representation and the task-expertise-person (TEP) unit are the basic constructs involved in transactive memory development, and a dynamic model of how TEP units are constructed, evaluated, and utilized is explored.
12	Brunault et al. (2014)	Survey based	TMS, participative team work	Perceived organizational support, perceived organizational justice	Quality of work life	The level of transactive memory and participative teamwork positively affects nurses' quality of work life (QWL). Participative teamwork and transactive memory were found to be positively associated with nurses' QWL. Perceived organizational support and organizational justice fully mediated the relationship between participative teamwork and QWL, but not between transactive memory and QWL.
13	Cabeza-Pulles et al. (2018)	Survey based	Trust, Collective mind, Network ties	TMS	Innovative university research	Managers of university research groups should promote the development of TMSs to stimulate innovative university research in order to make these groups more competitive.
14	Cao & Ali (2018)	Survey based	Social Media Use at Work, TMS	Absorptive Capacity, Knowledge Creation Capability	Team Creative Performance	Careful investment in social media by an organization can enhance meta-knowledge of "who knows what" within teams; exploring external knowledge alone is not enough: organizations must ensure external knowledge is utilized to create new knowledge to improve team creative performance.
15	Chen et al. (2013)	Secondary data	Knowledge differentiation, knowledge location, knowledge credibility,	Knowledge sharing, Communication quality	Technical achievement	Several TMS dimensions have positive impacts on knowledge sharing behaviors and communication quality. Moreover, communication quality positively influences technical achievement of OSS teams.
16	Chiang et al. (2014)	Survey based	High commitment work systems	TMS	NPD performance	Transactive memory system mediates the positive relationship between the high commitment work system implemented with workers in new product development teams and new product performance.
17	Choi et al. (2010)	Field Experiments	TMS, Knowledge support for KM	Knowledge sharing, knowledge application	Team Performance	IT support in organizations has a positive impact on the development of TMS in teams, and that both TMS and IT support have a positive impact on knowledge sharing and knowledge application. Knowledge sharing has a positive impact on knowledge application, which in turn has a direct impact on team performance.
18	Christian et al. (2014)	Lab experiments	TMS	M1: Lost member criticality; M2: Plan formulation	Team performance	Teams with well-developed transactive memory systems (TMS) will be better equipped to withstand the loss of a member. Those effects depend on which member is absent, such that when a more critical member is lost, the performance benefits of a TMS are reduced. This interactive effect is because of the team's ability to engage in plan formulation.
19	Chung et al. (2015)	Survey based	Formal communication, informal communication	Specialization, coordination, credibility	Travel information sharing	The users' perception of formal communication has a positive influence on the specialization, credibility, and coordination of social media. The perception of informal communication has a positive effect on the credibility and coordination of social media. Three sub-dimensions of TMS affect intentions to share travel information.
20	Comu et al. (2012)	Lab experiments	Facilitator Involvement in virtual project networks	TMS formation	Collaboration Effectiveness	In this study, the formation and maintenance of transactive memory systems (TMS) in two facilitated and two non-facilitated global virtual project networks were investigated, each executing a 2-month project. Using TMS formation and cohesive subgroup formation as a proxy for performance, quantitative evidence was found that demonstrates a negative impact on collaboration effectiveness when facilitators engage in content facilitation in virtual project networks. This paper shows that this negative impact restricts the establishment of TMSs.

#	Study	Method	Independent Variable(s)	Moderation (M1) Mediation (M2)	Dependent Variable(s)	Key findings
21	Dai et al. (2016)	Field expeiments	TMS	Trust, organicity, dynamism	Entrepreneurial orientation	The transactive memory system of a new venture team enhanced their EO and that this relationship was positively influenced by intra-team trust, the structural organicity of a venture, and environmental dynamism.
22	Dai et al. (2017)	Survey based	Product development alliances, TMS of entrepreneurial teams	-	New venture ambidexterity	Product development alliances and the transactive memory systems of entrepreneurial teams contribute to new venture ambidexterity. Moreover, the authors propose that the two mechanisms reinforce one another.
23	Ellis (2006)	Lab experiments	Acute stress	Team interaction mental model similarity, team interaction mental model accuracy	Transactive memory (Through use of directory updating, information allocation, retrieval coordination)	In an effort to extend theory and research on the effects of acute stress in teams, the author examined the mediational role of mental models and transactive memory in the relationship between acute stress and team performance, using information-processing theory as an explanatory framework. Results indicated that acute stress negatively affected mental models and transactive memory, which helped to explain why teams performed more poorly under acute stress.
24	Fan et al. (2016)	Survey based	Level 1: Creative self-efficacy Level 2: TMS	-	Level 1: Innovation behavior Level 2: Team innovation	A multilevel mediation model in which creative self-efficacy partially mediates the relationship between TMSs and the individual's innovative behavior. At the team level, the TMS positively affects team innovation.
25	Fitzsimons et al. (2015)	Conceptual	Opportunity, motivation	M2: Transactive density, Transactive gain/loss, Goal recovery M1: Goal Coordination, Shared goal representation, Realtional Orientation/skills	Relationship persistence	Transactive goal dynamics (TGD) theory conceptualizes 2 or more interdependent people as 1 single self-regulating system. Six tenets describe the nature of goal interdependence, predict its emergence, predict when it will lead to positive goal outcomes during and after the relationship, and predict the consequences for the relationship. Both partners in a TGD system possess and pursue self-oriented, partner-oriented, and system-oriented goals, and all of these goals and pursuits are interdependent. TGD theory states that relationship partners' goals, pursuit, and outcomes affect each other in a dense network of goal interdependence, ultimately becoming so tightly linked that the 2 partners are most accurately conceptualized as components within a single self-regulating system.
26	Hamid & Salim (2011)	Conceptual	Client characteristics, vendor characteristics, TMS (organizational memeory context)	Prior collaboration history, team size, project complexity	Knowledge transfer in IT sourcing	The authors apply positivist approach through operationalization of identified factors that give impact towards Malaysia Public Agencies outsourcing partnership. The present paper attempts to provide an integrated conceptual framework of knowledge transfer with and integration of TMS to facilitate knowledge transfer process which further can be validated.
27	Hammedi et al. (2012)	Survey based	Transformational leadership, Organizational climate	TMS	Decision making effectiveness and efficiency	The degree to which a committee acts as a TMS is positively related to decision-making effectiveness as well as efficiency in a screening context.
28	Heavey & Simsek (2015)	Survey based	Top management team transactive memory	Strength of external ties, dynamism	Firm performance	A novel theoretical account of how the performance implications of transactive memory are shaped by the individual and conjoint influences of a top management team's external social network ties and the rate of dynamism in the firm's competitive environment. In so doing, top management team transactive memory is linked to firm performance through transformation.
29	Heavey & Simsek (2017)	Survey based	Strength of top management team TMS	Diversity in top managers' organizational experience	Firm's pursuit of ambidextrous orientation	While top management teams with well-developed transactive memory systems are able to pursue an ambidextrous orientation, the impact of transactive memory is also shaped by diverse organizational experience and functional expertise within these teams.
30	Hewitt & Roberts (2015)	Survey based	-	-	-	People in romantic relationships can develop shared memory systems by pooling their cognitive resources, allowing each person access to more information but with less cognitive effort. The TMSS-C (an existing measure of transactive memory systems for use with romantic couples), provides a valuable tool that can quickly and easily capture the underlying components of romantic couples' transactive memory systems. It has potential to help how shared memory systems might be associated with other important features of romantic relationships.

#	Study	Method	Independent Variable(s)	Moderation (M1) Mediation (M2)	Dependent Variable(s)	Key findings
31	Hollingshead (2001)	Field experiments	Cognitive interdependence, specialized learning,	-	Transactive memory	Transactive memory is most differentiated when individuals have different expertise and incentives to remember the same information.
32	Hong & Zhang (2017)	Conceptual	TMS	Behavioral intention	Individual knowledge integration	Individual intention has significant and positive impact on knowledge integration directly; specificity and coordination of TMS have significant and positive effect on individual intention directly; the effect of credibility of TMS on individual intention is not significant.
33	Hood et al. (2016)	Field experiments	Positive affectivity, negative affectivity	Psychological safety	TMS	The authors develop a framework for understanding the emergence of transactive memory systems (TMS) in project-based teams characterized by different levels of group level positive affectivity (PA) and negative affectivity (NA).
34	Hsu et al. (2012)	Survey based	TMS	Communication, coordination	Project team performance	Having a mature TMS can effectively enhance performance directly, and indirectly through improving communication and coordination process.
35	Huang & Chen (2018)	Survey based	Knowledge sharing, social network ties	M1: Team psychological safety M2: TMS, knowledge integration	Team performance	Social interaction processes have a positive effect on a TMS; a TMS can foster team performance, but knowledge integration mediates the relationship between the TMS and team performance; and team psychological safety can moderate the relationship between the TMS, knowledge integration and team performance.
36	Huang et al. (2013)	Survey based	Specialization, coordination, credibility	Knowledge quality, perceived knowledge satisfaction	Team performance	TMSs have a positive impact on team performance mediated by knowledge management outcomes. The authors further found that instrumental ties could strengthen the relationship between specialization and knowledge quality, while weakening the influence of coordination on knowledge quality. In contrast, the results showed that expressive ties weaken the relationship between specialization and knowledge quality, while strengthening the influence of coordination on knowledge quality.
37	Jackson (2012)	Case study	-	-	-	Longitudinal investigation of a global engineering consulting firm which used inductive analysis of interview data to map and then develop a conceptual entity-relationship model of organizational memory.
38	Kahn & Williams (2016)	Survey based	Team formation, team size	Social presence, TMS	Outcome	TMS is highly predictive of the likelihood of a team winning a game, and that while past team member acquaintanceship predicted TMS, team size did not. Furthermore, only two dimensions of social presence, copresence and perceived comprehension, were related to TMS. These two dimensions fully mediated the relationship between past team member acquaintanceship and TMS.
39	Kotlarsky et al. (2015)	Survey based	Pragmatic knowledge boundary	Sematic knowledge boundary, syntactic knowledge boundary	TMS development	This research investigates the impact of syntactic, semantic, and pragmatic knowledge boundaries on a team's ability to develop a transactive memory system (TMS)-a collective memory system for knowledge coordination in groups. Results from the survey show that syntactic and pragmatic knowledge boundaries negatively affect TMS development.
40	Kwon & Cho (2016)	Survey based	TMS	Developmental leadership	Organizational Innovation	TMSs were found not to be significantly related to organizational innovation. Results also indicated that transactive memory systems comprise a statistically significant variable that influences developmental leadership. Subsequently, developmental leadership can be considered to be a valid construct in predicting organizational innovation; it can also be seen to fully mediate the relationship between transactive memory systems and organizational innovation.

#	Study	Method	Independent Variable(s)	Moderation (M1) Mediation (M2)	Dependent Variable(s)	Key findings
41	Lazzara et al. (2015)	Survey based	Advanced Technology (telemedical robot)		TMS, Psychological safety, communication efficiency (length of communication, duration of task-based communication)	The aim of this study is to examine the impact of a telemedical robot on trauma intensive care unit (TICU) clinician teamwork (i.e., team attitudes, behaviors, and cognitions) during patient rounds. The findings suggest that there is a significant difference in communication between rounds with and without telemedicine, such that there is more task-based communication during telerounds. Telemedicine increases task-based communication and does not negatively impact team trust, psychological safety, or TMS during rounds.
42	Lee et al. (2014)	Field experiments	Closure over time	Number of transitive triads	TMS development	A negative direct effect of closure over time and a simultaneous positive indirect effect of closure over time on TMS development exists and is driven by a transitive triadic social network structure.
43	Lewis & Herndon (2011)	Conceptual	Task relevance, Task structure, Differentiated knowledge	-	TMS development	Issues concerning how researchers define and conceptualize TMSs are explored, the relationship between TMS measures and the TMS concept interpreted, and the role of task type in TMS research attended to.
44	Lewis (2003)	Field experiments	Specialization, credibility, coordination* (First-order factors)	-	Transactive memory system* (Second-order factor)	Specialized and differentiated team knowledge, members' trust and reliance on others' knowledge, and smooth, coordinated task processes indeed reflect TMSs and that these systems are related to, but distinct from, members' agreement about who knows what.
45	Lewis (2004)	Field experiments	Team members' expertise, frequency of communication, team viability, team performance	Group familiarity	TMS emergence	Teams with more established TMSs benefit from face-to-face communication which means transactive retrieval processes may have been triggered during face-to-face communication. Developing a TMS is critical to the effectiveness of knowledge-worker teams.
46	Lewis et al. (2005)	Field experiments	TMS	-	Group learning, learning transfer	Groups with a prior TMS and experience with two tasks in the same domain had better abstract understanding of the principles relevant to the task domain; the extent to which members maintained expertise across tasks influenced the degree of learning transfer.
47	Li & Huang (2013)	Survey based	TMS (Specialization, Credibility, Coordination)	Team Learning (Exploitative, Exploratory)	Project Performance (Project efficiency, effectiveness)	The findings indicate differential effects of three dimensions of a transactive memory system on exploitative and exploratory learning. Exploitative and exploratory learning are positively associated with project performance. The results also support that the interaction between exploitative and exploratory learning has a positive effect on project performance.
48	Liang et al. (1995)	Field experiments	Group training	Development of TMS	Group performance	Groups whose members get trained together recall more about the assembly procedure and produce better quality end products than groups whose members are trained alone.
49	Lin et al. (2012)	Survey based	Expertise Specialty, Expertise Credibility	Behavioral Integration (Joint decision making, collective mind, expertise integation)	Team Performance	expertise specialty, credibility and their interaction positively affect team behavioural integration. This, in turn, leads to enhanced project team performance.
50	Lio et al. (2015)	Survey based	Perceived Communication Quality, Professional Identification	M2: Team Identification	TMS (Specialization, Coordination, Credibility)	Using the Social Identity Approach, perceived communication quality predicts TMS through team identification. High levels of professional identification compensates for low levels of team identification in predicting TMS.

#	Study	Method	Independent Variable(s)	Moderation (M1) Mediation (M2)	Dependent Variable(s)	Key findings
51	Liu & Zang (2010)	Field experiments	TMS	Team Efficacy	Team Performance	The results demonstrate that team efficacy fully mediates TMS and team performance.
52	Manteli et al. (2014)	Survey based	Governance decisions (business strategy, team structure and composition, task allocation)	-	TMS (Clustering, centrality, coreness)	The results of this study suggest that different governance decisions have a different impact on TMSs. Within the composition and structure of GSD teams, there are boundary spanners (formal or informal) who have a better overview of the network's activities and become central members within their network. The way tasks are allocated among distributed teams is an indicator of where expertise resides.
53	Martin & Bachrach (2018)	Conceptual	-	-	-	The authors incorporate transactive memory system theory to bridge dynamic managerial capabilities theory and networking capabilities theory. In particular, they focus on multi-level relational aspects of dynamic managerial capabilities and networking capabilities in in the context of business relationships in uncertain and changing (i.e., dynamic) network contexts.
54	Mell et al. (2014)	Lab experiments	TMS Structure	M1: Distribution of independent information; M2: Transactive Retrieval, Information Elaboration	Team Performance	The authors predict that centralized Meta knowledge can give teams a performance advantage over decentralized Meta knowledge, because centralized Meta knowledge can allow the central member to function as a catalyst for information exchange and integration. The authors propose this catalyst effect to be contingent on the extent to which the distribution of task information among members poses high coordination demands to effectively integrate members' knowledge.
55	Miller et al. (2014)	Lab experiments	Actors' skills	TMS	Actors' capabilities	The explanation in this study centers on the development of transactive memory, which forms during the initial performances of a routine, as actors search for other actors with the capabilities needed to complete a routine. Variations in the efficiency of routine formation that are inexplicable in terms of action sequences may be readily explained when actor sequences are examined. Transactive memory contributes to the theory of organizational routines by serving as a bridge between individuals' skills and collective capabilities.
56	Nevo et al. (2012)	Field Experiments	IT (technological) Support	-	TMS	This paper focuses on meta-memory, which is at the heart of TMSs. The authors examine what meta-memory is maintained by members of TMSs, whether providing this meta-memory in a technology-mediated environment can lead to transactive memory development, whether IT can realistically provide this meta-memory, and whether different requirements exist for different users and in different stages of transactive memory development.
57	Noroozi et al. (2013)	Field experiments	TMS Script	TMS: Specialization, Coordination, Credibility	Quality of joint problem solution plan, Quality of individual problem solution plan,	This study investigates how TMS script facilitates construction of a TMS, fosters learners' knowledge transfer and convergence, and improves the quality of problem solution plans. Specialization and coordination aspects of the TMS are mediators for the impacts of the script on joint but not individual problem solution plans.
58	Oertel & Antoni (2015)	Survey based	Team learning (Knowledge-based, Communication-based, Communication-based)	-	TMS	The authors analyze the relationships among different team learning behaviors and transactive memory during various phases of team development. The results show that knowledge-based processes (storage and retrieval) play a more important role during early stages of project-based teamwork, followed by a shift to a higher relevance of communication-based processes (reflection and co-construction) in later stages.
59	Oinas-Kukkonen et al. (2010)	Conceptual	-	-	-	The authors review reasons for the increased interest in network analyses in organization studies and information research. They also note the impact of new information technology capabilities for this increase in terms of improvements in analysis techniques, new ways to generate and maintain connections within and between social units, and new social connection-focused IT capabilities. They also review main streams of network-based analyses in information system research.
60	Olabisi & Lewis (2018)	Conceptual	-	-	-	The authors argue that within- and between-team coordination coordination can be facilitated—or thwarted—by boundary-spanning behaviors and patterns of knowledge exchange within and between teams. Their theorizing explains how an existing team TMS can offset the within-team coordination burdens typically associated with boundary spanning and we offer predictions about how these factors interrelate to affect TMS and coordination over time.

#	Study	Method	Independent Variable(s)	Moderation (M1) Mediation (M2)	Dependent Variable(s)	Key findings
61	Oshri et al. (2008)	Case study	Directory updating, information allocation, retrieval coordination	-	TMS	The paper describes the transfer of knowledge between onsite and offshore teams through TMSs (encoding, storing and retrieving processes). The analysis suggests that in order to overcome differences derived from the local contexts of the onsite and offshore teams, some specific mechanisms supporting the development of codified and personalized 'directories' need to be introduced.
62	Pearsall & Ellis (2006)	Lab experiments	Critical team member assertiveness	TMS	Team satisfaction, team performance	In an effort to extend theory and research linking personality to team effectiveness, this study uses the workflow networks literature to investigate the effects of critical team member dispositional assertiveness on team performance and satisfaction. Results indicate that critical team member dispositional assertiveness positively affects team performance and team satisfaction. Results also indicate that both of those effects are due to improvements in the team's TMS.
63	Peltokorpi & Hasu (2016)	Survey based	Task Orientation	M2: TMS; M1: Transformational Leadership	Team Innovation	This study, by integrating team innovation and TMS research, provides a moderated mediation model with a set of hypotheses that link task orientation, TMS, and transformational leadership on innovation in research teams. Hierarchical regression and moderated mediation analyses show that TMS partially mediate the positive relation between task orientation and team innovation. Transformational leadership positively moderated the relationship between TMS and team innovation.
64	Peltokorpi & Hood (2018)	Literature Review	-	-	-	This paper reviews literature on the relationships between communication, TMS, and outcomes in dyads, groups, and teams, and proposes avenues for future research.
65	Peltokorpi (2014)	Case Study	-	-	-	The study findings show that organization design (team-based structure, small unit size), human resource management (HRM) practices (recruitment and selection, training, promotion, and reward systems and performance evaluations), and relational interactions (roles, routines) coordinate organizational TMSs. Organization design and HRM practices as more formal coordination mechanisms also support and provide continuity to relational interactions.
66	Ren & Argote (2011)	Literature review	-	-	-	Examined transactive memory systems and summarized the findings in an integrative framework to show the antecedents and consequences of TMS.
67	Reidl et al. (2012)		Communication richness, communication experience	M1: Team size, culture M2: TMS (Expertise, coordination, trust)	Team performance	In this study the authors answer the question: how communication affects the building of a knowledge management system, more specifically of a TMS as a subset of KMS, in virtual teams. The paper shows the importance of perceived richness and experience of the communication media used and how the team size of a virtual team as well as the culture of the team members influence the relationship between communication and the knowledge management.
68	Robertson et al. (2012)	Survey based	Trust in teammates, Trust in management	Transactive memory	Job satisfaction, Team Performance	The purpose of this paper is to examine, in two studies, whether trust in teammates and trust in management influenced transactive memory and how strongly transactive memory, in turn, influenced perceived team performance and job satisfaction. Findings suggest that trust in teammates predicted transactive memory and transactive memory, in turn, predicted perceived team performance and job satisfaction. Trust in management did not predict transactive memory, but it did predict job satisfaction.
69	Simeonova (2017)	Conceptual	Trust, Informal networks	TMS, Web 2.0 Technologies	Knowledge sharing	The aim of this paper is to advance understanding of interactive knowledge sharing (KS) processes through exploring the role of TMSs and Web 2.0. The use of TMS and Web 2.0 as mediating tools depends on deeper underlying structures/factors embedded within the community, namely, informal networks and trust among people. Informal networks and trust among people support the use and the positive effects of these tools.
70	Spraggon & Bodolica (2017)	Conceptual	Social Ludic Activities (SLAs)	Physical Proximity, Pyschological Safety, Intesity of Interactions, Communication Pathways' Richness	Collective Tacit Knowledge (CTK)	This paper builds upon socially distributed cognition (SDC) and transactive memory systems (TMS) to analyze SLAs' contribution to CTK creation in the workplace. SLAs may facilitate collective members' knowing and learning whereby different solutions are sought and potential tactics to cope with work issues are attuned to changing conditions by the collective members at work. Four moderating factors, namely physical proximity, psychological safety, richness of communication pathways and intensity of interactions, are identified and propositions to conceptualize their role

#	Study	Method	Independent Variable(s)	Moderation (M1) Mediation (M2)	Dependent Variable(s)	Key findings
71	Tang (2014)	Survey based	Communication quality	Benevolence trust, Competence trust; TMS	Team performance	This study empirically tests the relationships between communication quality and TMS, and the effect of TMS on team effectiveness. The results suggest that communication quality has a positive effect on TMS; the link between communication quality and TMS is mediated by benevolence- and competence-based trust; and TMS has a positive impact on team performance.
72	Tollefsen et al. (2013)	Conceptual	-	-	-	As a dynamic, multi-component system, an "alignment system" is responsive to higher-level cognitive states such as shared beliefs and intentions but can also give rise to such shared cognitive states via bottom-up processes. The authors turn to transactive memory and suggest how further research on alignment in these cases might reveal how such systems can be genuinely described as cognitive.
73	Vernham et al. (2014)	Survey based	-	-	-	This study applies the transactive memory theory to a collective inter-viewing situation and explores whether signs of truthfulness emerge through measuring joint memory recall. Couples were interviewed in their pairs about their 'real' or 'fictitious' relationships. Truth-telling pairs posed questions to one another, provided cues to one another, handed over remembering responsibility, and finished each other's sentences significantly more than lying pairs, supporting the idea that real couples have a transactive memory system, unlike pretending couples.
74	Wang et al. (2018)	Survey based	Specialization, credibility, coordination	Knowledge Transfer	Team Performance	This study investigates how TMS dimensions relate to knowledge transfer (i.e., a sub process of team learning), thereby influencing team performance in real organizations. Research findings demonstrate that the associations of specialization and credibility with knowledge transfer are more significant than that of coordination. Moreover, knowledge transfer predicts the variation in team performance and fully mediates the effect of specialization and credibility on team performance.
75	Wegner (1987)	Conceptual	-	-	-	Individual and transactive memory along with their various facets are defined and discussed.
76	Whelan & Teigland (2013)	Case based	-	-	-	In this study, the authors examine whether TMSs act as a collective filter to enable organizational groups to mitigate the potential for information overload. Findings suggest that individuals spontaneously organized without any centralized control to create a collective filter.
77	Yuan et al. (2010)	Field and lab experiments	Individual directory development; team-level directory development, team-level shared task interdependence, team-level communication tie strength	Individual shared task interdependence, individual communication tie strength	Individual expertise exchange	At the individual level, the relationship between directory development and expertise exchange is mediated by communication tie strength and moderated by shared task interdependence. Team-level variables also are significantly related to individual-level outcomes such that individual expertise exchange happens more frequently in teams with well-developed team-level expertise directories, as well as with higher team communication tie strength and shared task interdependence.
78	Zhang et al. (1991)	Survey based	task interdependence, support for innovation, cooperative goal interdependence	M1: TMS of work teams	Team performance	TMS mediates the relationship between team performance and each of the three team characteristics; team members and leaders can improve team performance by communication and task interdependence.
79	Zhang et al. (2015)	Survey based	Degree of interorganizational TMS	Mutual cognition, trust	Team collaboration	The interorganizational TMS (I-TMS) drives group members to be mutually trusting and cooperatively integrate their professional knowledge, which reflects the idea of collaboration that underlies integrated project delivery (IPD). The results in this study suggest that project parties with a low I-TMS degree should engage in frequent interaction to foster mutual cognition and trust and improve team collaboration for IPD.
80	Zheng (2012)	Survey based	Prior shared experience	M2: TMS; M1: Task similarity, Intra-team trust	New venture performance	New ventures often started by founders with prior shared experience have been shown to benefit new venture performance. The author posits that the prior shared experience effect is partially mediated by a team-level cognitive process—TMS that enables founding teams to effectively and efficiently integrate their members' expertise and skills. Two team-level factors—task similarity and intra-team trust further strengthen the effects of TMSs because they provide golden opportunities and strong motivation for team members to utilize their TMSs.