BI Norwegian Business School – Preliminary Master Thesis Report

Programme:
MSc In Leadership and Organizational Psychology

Title:
Communication as antecedent of enacted complexity and team performance

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Summary

Building on recent theoretical and methodological developments in organizational studies focusing on organizational routines (Hærem, Pentland and Miler, 2015; Hansson, 2018), this thesis aim to examine the relations between team communication, enacted complexity and performance in complex settings. The preliminary thesis describe how we plan to investigate whether team communication-patterns and content determine enacted task complexity and performance, using data on team communication and teams' routines from a lab-setting.

Introduction

In today's organizations, teamwork is widely used and teams are often considered a flexible structure that can deal effectively with complex situations and problems (Stachowski, Kaplan & Waller, 2009). Salas, Dickinson, Converse, and Tannenbaum (1992) define teams as "a distinguishable set of two or more people who interact dynamically, interdependently, and adaptively toward a common and valued goal/object/mission, who have each been assigned specific roles or functions to perform, and who have a limited life span of membership" (p. 126-127). Organizations usually set up work in teams with the idea that teams will make better decision that individuals. The increased use of teams in organizations is based on the belief that teams are especially proficient in responding to dynamic and complex situations (Burke et al., 2006), and that teams are able to tackle tasks too complex for any individual (Cooke et al., 2000).

Nevertheless, studies find that many teams fail to make good decisions, especially when they are geographically distributed and solving tasks in uncertain environments (Gilson et al., 2015). One reason could be because working in teams introduces an additional layer of cognitive requirements that are associated with the demands of working effectively with others (Cooke et al, 2000). A team's understanding of any complex and uncertain situation is influenced by the knowledge that the team possesses (Cooke, Stout, & Salas, 1997; Stout, Cannon-Bowers, & Salas, 1996). The shared knowledge possessed by effective teams has been frequently referred to as shared knowledge, shared mental models or shared cognition (Blickensderfer, Cannon-Bowers, & Salas, 1997; Converse et al., 1993; Converse, Cannon-Bowers, & Salas, 1991; Klimoski & Mohammed, 1994; Kraiger & Wenzel, 1997; Robertson & Endsley, 1997; Sarter & Woods, 1991; Stout, et al., 1996).

To get a shared understanding of the task and situation, team members needs to coordinate and communicate their activities with others who are working towards the same goal (Cooke et al, 2000). Further, communication is a fundamental component of how information is processed at the team level (Salas, Cooke & Rosen, 2008). Several studies have showed the importance of communication on team performance (Foushee & Manos, 1981; Jarvenpaa et al.,

1998; Jarvenpaa & Leidner, 1999; Kayworth & Leidner, 2002; Sexton & Helmreich, 2000; Maznevski & Chudoba, 2001; Stachowski et al., 2009). Orasanu and Fischer (1992) emphasize how the degree to which a team establishes shared mental models of a problem and the degree to how this is made explicit through communication is crucial for team effectiveness in solving the problem. Thus, the effects of team-communication on performance is apparent in the organization science-literature.

This paper build on the stream of research focusing on organizational routines as a core construct for understanding organizations (see e.g. Becker 2005; Waller, Gupta & Giambatista 2004). While prior research on routines have focused on routines as a source of mindless repetition and inertia, newer conceptualizations of routines have argued that routines can also be a source of flexibility (Feldman & Pentland 2003) and enable improvisation (Barrett 1998).

Although organizational routines as a concept have been around for a long time (e.g. Cyert & March, 1963; March & Simon, 1958), quantitative research on routines have proven complex and have not gained much attention (Hodgson 2008; Pentland, Hærem & Hillison, 2010). However, recent lines of research benefitting from technological innovations and increased use of big data have developed various methods to try to capture the routine-concept quantitatively (e.g. Gaskin et al., 2011; Gaskin et al., 2014; Pentland et al., 2010). Using pattern recognition techniques, Hansson (2018) found support for a relation between routine-dimensions and performance mediated by enacted task complexity. This paper seek to follow up on Hanssons (2018) research by leveraging the research method and investigate the role of communication as an antecedent of enacted task complexity. The researched question proposed, is:

What is the relationship between team-communication, enacted task complexity and performance?

Theory

In this part of the paper we will underpin our research question, describe the hypothesis and describe the methodology used in this paper.

Routines

Organizational routines have been conceptualized in a range of ways, with Nelson and Winter's (1982) evolutionary approach as one of the more popular ones, dominating the field. Nelson and Winter presents the routine as a 'gene' resulting from a once satisfactory solution to problem that is repeated with little consciousness and is highly stable. If the routine fails to produce a satisfactory outcome, a routine is abandoned and it is replaced by another routine.

Feldman and Pentland (2003) challenged Nelson and Winter's conceptualization of routines, arguing that routines can be a source of flexibility and change as routines cannot be understood without acknowledging the agency of the actors performing the routine. Their 'performative' approach suggests that the term routine refer to both the structure of the routine (its ostensive aspect) and its performative aspect. The interplay between these aspects creates an opportunity for change by continuous selection and retention of actions. Kesting (2006) explains how this may come about by arguing that routines refer to the patterns of action related to the intention of bringing about a formerly known state repeated times. In this way, routines are the actions taken to reach some state again, but the exact actions taken may differ from time to time, hence variation and change.

This paper builds on the 'performative' approach and thus adopt Feldman and Pentland's definition of organizational routines as *"repetitive, recognizable patterns of interdependent actions, involving multiple actors"* (Feldman & Pentland, p. 96, 2003). Following the 'performative' approach, Pentland, Hærem and Hillison (2010) have argued that since routines cannot be observed on the generative deep level, the surface-level patterns of actions are suggested as level of analysis.

A core construct in studying routines is complexity (e.g. Thompson, 1967; Perrow, 1967; Hærem, Pentland, & Miller, 2015). Hackman (1969), Wood (1986),

and Campbell (1988) developed what have been the most popular framework for describing and analyzing task complexity. Wood (1986) described task complexity as a combination of the tasks component, coordinative and dynamic complexity. In his theory, component complexity refers to the number of distinct acts needed to perform a task, coordinative complexity refers to the tasks precedence relations and dynamic complexity refers to the degree of changes in the other two aspects of task complexity.

While the term task complexity have been used to describe the task as separated from the task doer, recent research on organizational routines (e.g. Hærem, Pentland & Miller 2015; Hansson 2018) have introduced 'enacted complexity' to acknowledge enactment and sensemaking (Weick, 1995). In this way complexity is not seen as a description of a task separated from the task doer, but rather as the way in which the task doer goes about solving the task. Hærem, Pentland and Miller (2015) argue that as several actors work together on a task, each action serves as an information cue which may spur new actions, and each information cue is subject to interpretation by its observers. Therefore a pattern of actions come about through several interpretations of information cues.

Following the logics of contingency theory, an organization's performance depends on its ability to respond effectively to the requirements of its environment (Lawrence & Lorsch 1967; Thompson 1967). In this way, an organization exposed to a large set of different inputs needs a large repertoire of actions to be able to deal effectively with the inputs from each situation at hand (Feldman, 2000; Weick, Sutcliffe & Obstfeld, 2008). However, the organization also needs to match the requirements of the situation with the optimal actions from its repertoire of actions, which can be a more or less mindful selection process (Levinthal & Rerup 2006). In a stable and transparent situation, the same response can be used each time a similar situation is detected and this selection can be "automated" to increase efficiency (March & Simon, 1958). However, in a complex setting with a wider range of different input and ambiguous causal relationships (Weick, Sutcliffe & Obstfeld 2008), exploring several possible ways of responding to a situation may be necessary to find the appropriate response. The complexity of the routine undertaken is therefore a matter of the *enactment* of the complexity of the situation. Examining and comparing the patterns of action in

an invoice-processing-routine (simple setting) and a crisis-management game (complex setting), Hansson (2018) found support for this model, as increased *enacted complexity* was positively related to performance in the complex setting, but negatively related to performance in the simple setting.

Communication

The extent to which teams are able to adapt to their task environments is key to team performance (Daft & Lengel, 1986; Gilson et al., 2015) and communication is a common, critical, underlying factor (Cramton, 2001). The way we communicate often reveal important aspects of our social interaction and thought processes (Pennebaker, Mehl & Niederhoffer, 2003). The words people use conway a great deal of information about themselves and the situation they are in (Pennebaker et al., 2003). Ricoeur (1976) argued that the ways we describe the events define the meanings of the events and that these meanings help us keep our grasp on reality.

Prior research on communication suggest that the frequency and predictability of communication, and the amount of feedback provided in the communication leads to higher team performance (Jarvenpaa et al., 1998; Jarvenpaa & Leidner, 1999; Kayworth & Leidner, 2002; Maznevski & Chudoba, 2001). Further, research emphasize that successful teams are able to communicate effectively and share crucial information to the solve the problem (Allen, 1977; Ancona & Caldwell, 1992; Bordia, 1997; Brown & Eisenhardt, 1995). Other studies emphasize how higher performing teams exhibits fewer, shorter and less complex interaction patterns (Stachowski et al., 2009). Thus, the literature seems to underpin the importance of communication for team performance.

The traditional view of teams within organizations is changing (Maynard & Gilson, 2014). Many teams are now composed of team members who are geographically dispersed and, as a result of that, communicate via technology (Maynard & Gilson, 2014). These types of teams are referred to as virtual teams. A team is considered more or less virtual based on "the extent to which team members use virtual tools to coordinate and execute team processes" (Kirkman & Mathieu 2005, p. 702), and as tasks become complex and require more coordination between members communication and feedback become more

important (Bell & Kozlowski, 2006). Teams operating in a virtual environment face greater obstacles to share information than teams in traditional contexts (Hightower et al., 1997; McDonough, Kahn & Barczak, 2001). Therefore, at the core of any virtual team process is communication (Powell, Piccoli & Ives, 2004).

Research in this field show how bigger words were negatively correlated to performance, and there was a positive correlation between the number of words used and performance (Sexton & Helmreich, 2000). The same study found a negative correlation between word-count and error. There appears to be a link between the language pilots use and flight outcome measures (Sexton & Helmreich, 2000). Foushee and Manos (1981) also found a overall tendency for aircraft-crews, when facing an uncertain situation, that teams who performed poorer communicated less. This suggests that as expected, communication is needed for teams to perform well.

In addition to the amount and type of communication, there has been an interest in the communication relationship in teams. Fischer and colleagues (2007) studied the communication relationship in teams. Based on earlier research that indicates a relation between amount of talk and interpersonal dominance (Palmer, 1989), they found that in successful teams the communication and control is shared while in unsuccessful teams, one or several team members dominated the conversation and thus the team's actions (Fischer et al., 2007).

Team tasks are performed by individuals who create, through communication, a common understanding regarding the requirement to solve the task and how their work will be coordinated (Maynard & Gilson, 2014). This common understanding is often referred to as shared mental models, team cognitive synchronicity, common ground, mutual knowledge (Krauss and Fussell 1990; Cannon-Bowers et al., 1993; Cramton 2001; Hollingshead 2010). Research indicate there is a positive relation between shared mental models and overall team performance (Cannon-Bowers & Salas, 1990; DeChurch & Mesmer-Magnus, 2010; Johnson-Laird, 1983; Rentsch & Klimoski, 2001). Most of the research on shared mental models suggest that its driven by the team members communication, interaction and training (Kraiger & Wenzel, 1997), and communication has been positioned as critical to the development of shared views in virtual teams (Majchrzak et al., 2004). The individual knowledge and resources

of each team member do not contribute to the common team effort unless they are shared and communicated (Orasanu & Fischer, 1992). Orasanu & Fischer (1992) emphasize that team members needs to communicate to each other how they understand the situation and trough this communication build a common understanding for the problem. In a more recent study, Fischer, McDonnell and Orasanu (2007) found that team task performance was associated with the extent to which team members communicated and shared task-critical information. In this way, communication creates a shared understanding of the current problem situation so that all members have the same understanding of what the problem is, what environmental cues mean, what solution might be tried, and what is expected of various team members (Orasanu, 1990).

Hypotheses

Based on the literature on team communication, enacted task complexity and team performance we have formulated five hypotheses. Shedding light on the way communication relates to enacted task complexity in virtual teams can increase our understanding of the antecedents to enacted task complexity, and thus on team performance in uncertain situations.

As mentioned previously, research on team communication has showed how the amount of communication between team members has a positive relation to performance (Roberts & O'Reilly, 1976; Foushee & Manos, 1981; Sexton & Helmreich, 2000). Further, research on organizational routines show how enacted task complexity is positively related to team performance, in complex situations (Hanson, 2018).

Hærem, Pentland and Hillison (2015) argue that information cues "provide a mechanism through which events are related" (p. 452) and are thus important to the enactment of task complexity. Following this logic, an increased amount of communication among team team-members is expected to increase the number of information cues relevant for the enactment of complexity.

Further, research by Fischer and colleagues (2007) showed how the symmetric relationships between team members positively relates to team performance. As it is hypothesized that a higher amount of team-communication leads to increased enacted complexity, it also expected that the balance between

team-members amount of communication may have an impact on task complexity. A skewed balance of communication between team-members is expected to cause a lack of potentially important information cues from the low-communicating team-members. Therefore, as the crisis-management setting consists of highly dependent processes, it is expected that a balanced communication pattern is needed to provide important information cues about such interdependencies.

Hypothesis 1a: The amount of team communication is positively related to team performance

Hypothesis 1b: This relationship is partially mediated by enacted task complexity.

Hypothesis 2: The balance of communication-volume among team-members is positively related to enacted task complexity.

While hypotheses 1 and 2 explore the amount of and balance of team-members communicative contribution, we are also interested in examining the content of what is communicated. Theories on SMM (shared mental models) have argued that shared understandings and knowledge enable team coordination (e.g. Hollingshead 2010; Burke et al. 2006; Klimoski & Mohammed 1994). This can broadly be broken down into shared mental models of the task (Task SMM) and shared mental models about the team coordination (Team SMM) (Cannon-Bowers, Salas, & Converse, 1993; Maynard & Gilson 2014; Mathieu et al. 2000). In the lab-setting, teams are randomly assigned at the beginning of the experiment and thus teams have not been able to produce SMMs beforehand and therefore have to communicate to build common ground. Based on the SMM-literature, we thus hypothesize that teams building SMMs of the task and the team's coordination efforts will perform better. We expect that this relationship is partially mediated by enacted complexity, as it is expected that building SMMs involves uncovering aspects of the situation and the team's coordinative interdependencies, hence discovering the complexity of the routine.

Hypothesis 3: Team's Task related SMM-communication is positively related to enacted task complexity

Hypothesis 4: Team's Team related SMM-communication is positively related to enacted task complexity

Method

Our research question and hypotheses suggest that our study's design should allow us to assess the type of communication which predict higher enacted complexity, and in turn improved performance from the teams. We study these hypotheses in a controlled lab-setting, simulating a complex situation. The lab simulation enables a controlled environment that allows us to control the material resources, the dependencies and the task-related information each team-member possess from the beginning , and to observe and record all actions, including all communication between the team-members.

The setting for the study is a crisis management computer game developed by Thovald Hærem in cooperation with military officers from the Norwegian Airforce Academy, called MindLab. The randomly selected teams act as counter-terrorist teams with the primary task of defending a set of oil-rigs in the North Sea. They do this by detecting the presence of unidentified objects, identify whether the objects are friendly or not, and intercept unfriendly objects before they enter a critical area. Each team plays three rounds of the game, with different scenarios each time. In each round, each player on the team has a limited amount of time to familiarize themselves with their team members complementary resources and information, and then perform key counter-terrorism tasks.

All team members have access to a common operational picture on their computer screens. This operational picture consist of a map showing the different team members, fishing vessels, terrorists (disguised as civilian vessels), the oil rigs and the resources available to the players. Each team member controls two of the three different characters: two Orion planes, two patrol boats, and two frigates. Each of the characters have different characteristics; the Orions have the highest

detection capacity; the patrol boats have the best information search capacity; and the frigates are the only resource capable to attack.

To coordinate the participants have a email box where they can communicate. This chat interface provide the teams with preformatted messages; mission orders, intelligence updates, detection and information search messages and communication between participants. The chat function is the only way team members can communicate.

The scenarios challenge individuals with issues related to team monitoring, information exchange and coordination for a collective team strategy to solve the tasks. MindLab provides a log of behavior where each action is logged as one integer in a sequence array and all communication between team members is logged.

Procedure

Each participant was assigned to a randomized team. Each team played three scenarios, where the same team member was assigned the same character each time. All scenarios were designed to be equally difficult, and have the same amount of friendly and unfriendly objects. The computer program logged all communication within the teams, and all the actions taken by team members throughout the game.

The different scenarios were designed so that each player depends on the information and resources available to the other two team members. At the beginning of each round, each player have very limited information and are unaware of specific critical areas to protect. The information have to be deducted using information distributed among all three team members. In addition, any individual player cannot carry out all three tasks (detection, search, and interception) crucial to the game by themselves. Therefore, each member have to draw on one another's resources and information to complete the task successfully.

Description of variables

Communication-volume: Communication-volume is operationalized as the total number of sentences in a team's email-log. Quantitative approaches to

text analysis have gained increasing popularity over the past half century (Pennebaker et al., 2003). In this study, communication is gathered through the email-function in the crisis management computer game. The LIWC2015 framework (Pennebaker et al., 2015) will be used to measure the volume of communication between team members. Words are chosen as unit of analysis (rather than no of messages or no of sentences or letters), because each word contains information, while each letter in a word does not (usually) bring more information. E.g. writing 'building' rather than 'house' does not add extra information, but is qualitatively different information. However, a sentence or a message may contain more or less information. Therefore the number of words is expected to provide the most useful way to measure amount of communication within the teams.

Communication-balance: To measure the balance of team communication-patterns we count each team's total amount of communication and compare each members relative contribution to the total of the team. As a perfectly balanced team would have each member contributing with 33% of the total, a single individuals communication balance is operationalized as the degree to which the team-members diverge from a 33% contribution. This is measured as the standard deviation from 33%. By calculating the three team-member's average standard deviation from 33% we get the the team's balance-score, where higher numbers means less balanced/ more skewed communicative contributions within the team.

Task SMM: We operationalize Task SMM-communication as the number of sentences deliberately aimed at providing information about the task and environment. This is coded manually. Questions or requests of such information is not included, but answers to request or questions, are. (e.g.: "How many ships are left?" is not counted, but the potential answer "3" in response is counted as this is an act of providing information).

Team SMM: Similar to the operationalization of Task SMM-communication, we operationalize Team SMM-communication as the number of sentences deliberately aimed at providing information about the team's coordination. This includes information about the knowledge and abilities of team-members (e.g. "My ship is too slow to get there in time" or "I can't see the

ships on my radar"), but also commands (e.g. "go further west") and notes on team-members interdependence and meta-communication (e.g. "I can't see the ship when you fly so far away" and "I can't understand what you mean").

Enacted complexity: The measure of enacted complexity is modeled as the network of actions performed by all team members. We base our measure on Hærem, Pentland and Miller's description: "task complexity is indexed by the number of paths in the network of events that lead to the attainment of task outcome" (Hærem, Pentland & Miller 2015, p. 452). Following the method described in Hansson (2018) we count the number of paths in the network and use the log10 transformation to account for the exponential relations between the number of paths and the size of the network.

Team performance: The teams are given points for attacking terrorists before the terrorists attack the oil rigs. Teams also gain points when patrol and frigate resources move close to enemy objects. These two different scores are added to provide an overall team performance score. It is possible to get points subtracted if attacking friendly objects or for attacking objects without having positively identified the attacked objects as terrorist. Over the three different scenarios, the team performance score was calculated as a repeated measure over three scenarios.

Design-considerations

Since the variable 'communication volume' parents the variables 'Task SMM-communication' and 'Team SMM-communication' the analysis is split in two parts, where the first analysis examine hypotheses 1 and 2, and the second analysis examine hypotheses 3 and 4. In this way, the overlap of categories does not pollute the results.

Tentative plan for completion of thesis

Time	**Activity**	**Note**
Fall 2017	Sample data	*Data was sampled from experiment in MindLab fall 2017*
01.02.18 - 01.03.18	Further understand and write theory	*Adjust hypotheses and theory based on feedback on preliminary thesis.*
01.03.18 - 01.05.18	Analyze data	*Prepare data, develop coding-manual, manually code data, test inter-rater reliability and analyze results.*
01.05.18 - 01.07.18	Write results, discussion, implications, limitations, introduction and conclusion	*Revisit theory in light of results*

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