THE INFLUENCE OF TEAM CHARACTERISTICS ON ORGANIZATIONAL ROUTINES IN THE TECHNOLOGY IDENTIFICATION AND EVALUATION

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ABSTRACT

Routines have become a central construct in organizational theory and strategic management as they are important in creating organization`s core competencies. Due to the automatic repetition of previous practices, organizational routines determine who is doing what, how, when, and on what terms in a particular situation. Thus, organization`s behavior is postulated being routinized. As the traditional view of organizational routines strengthens the stable and inertial impact of routines, changes in routines have mostly been traced back to external effects. Nowadays, routines are seen as generative systems, with interactions between the ostensive and performative aspects, as routines are performed by social interacting individuals. Therefore, the emotional aspect of routines should be especially considered. Hence, recent studies increasingly stress the importance of endogenous effects on routines. As there are only a few empirical studies in this area so far, this study aims to provide further insights that address this research gap by analyzing the link between internal organizational factors and the ostensive and performative part of a routine. For this purpose, the paper analyzes team characteristics such as size, diversity, experience, transactive memory, and team empowerment, as well as project importance and the uncertainty prevailing in the field of technology identification and evaluation (TIE), since TIE is faced with rapidly changing conditions and a large amount of new information. Statistical results strengthen the necessity for the distinction between the ostensive and the performative part of a routine, that is central to this study: The ostensive part of a routine is effected by situational factors, whereas the performative part is mainly affected by individual characteristics such as experience, transactive memory, and the risk-aversion of individuals. Finally, it should be mentioned that the field of TIE is dominated by experience and expertise, which implies a high level of formalization and job specificity that is necessary to ensure evidence-based and transparent decision-making.

Key words: Organizational Routines, Team Characteristics, Technology Identification and Evaluation

INTRODUCTION

Nowadays, the capability of firms to compete depends on their ability to keep on introducing new products, improve their manufacturing processes, and exploit new technologies (Becker, Lazaric, Nelson, & Winter, 2005; Becker & Zirpoli, 2009). Therefore, this study focuses on the field of technology identification and evaluation (TIE) as this field is characterized by fast-changing conditions and a large amount of information from many sources. As the TIE is of strategic importance, outdated processes, knowledge, or routines can induce poor management and decrease the technological capability of the firm; therefore, the regular challenge of existing routines is essential. As organizational routines have a coordinating power over interactions and the use of knowledge within firms, efficient routines could imply a competitive advantage for a firm, and

deficient routines a disadvantage (Becker & Lazaric, 2009; Witt, 2011). Due to the automatic repetition of previous practices, organizational routines determine who is doing what, how, when, and on what terms in a particular context or situation (Witt, 2011). Thus, to a large extent an organization`s behavior and repertoire of capabilities can be explained by its routines (Nelson & Winter, 1982). Routines further provide an understanding of what "change really is" at the organizational level as if "behavior continues to be guided by the same stable and familiar routines," "no change" is given (Becker et al., 2005, p. 776). Thus, performance variations in the operating routines in response to variations in familiar input signals involve changes in organizations. Further, routines help to identify the pathways and mechanisms by which exogenous sources of change can have an impact on the organization's behavior. Therefore, organizational routines are a central unit to analyze organizational change, as considering routines makes it possible to "zoom in" on micro-level dynamics, and thus identify the driving forces of change (Becker et al., 2005). As research on organizational routines is mainly focused on their development, especially at the individual level, and their replication, there is still no consensus concerning the influencing factors and their impact on the functional and dysfunctional parts of a routine (Abell et al., 2008; Becker, 2005b; Felin & Foss, 2005). Thus, this study aims to provide further insights into this research gap by analyzing the link between team characteristics and the ostensive and performative parts of a routine. It considers the team that is responsible for conducting the identification and evaluation of new technologies. The paper is structured as follows: First, there is a short overview of the term "organizational routine," primarily focused on its emergence. Next, essential team characteristics that might have an impact on organizational routines are discussed and research hypotheses are derived. In the following section, the operationalization and methodology of this study are described, before the results of the regression analysis are presented. The findings are summarized and subsequently discussed, having regard to previous scientific work and referring to the context of TIE. The paper concludes with the limitations of the study, and it gives direction for further research.

ORGANIZATIONAL ROUTINES

Definition and Characteristics of Organizational Routines

Although routines have been central to the field of economic and social theories for over 30 years, there is little consensus on what routines are and how they effect organizations (e.g., Felin & Foss, 2004). Over time, numerous ambiguities about the understanding of routines exist. Ranging from "ways of doing things" (Winter, 1986) to wider overall definitions, such as heuristics, organizational processes, organizational memory, and truces (Levitt & March, 1988; Nelson & Winter, 1982), up to routines have effectively become identical to the organization itself (Foss, Heimeriks, Winter, & Zollo, 2012). Feldman and Pentland (2003) have provided a core definition of organizational routines that is supported by the majority of researches: A routine is "a repetitive, recognizable pattern of interdependent actions, involving multiple actors" (p. 105). A routine`s documentation by a set of formal procedures or rules, however, essentially is not part of the core definition (Feldman & Pentland, 2003). Further, routines are considered as dispositions of behavior, possibilities, or capabilities, but not, however, as anchored unreflective behavioral patterns.

To understand recent approaches towards routines, it is essential to follow the research on organizational routines of the last decades. Many of the current approaches refer to the study by Nelson and Winter (1982) who set routines at the center-stage of their analysis. Due to their

increasing popularity, as routines have been taken to explain social practices in organizations (Reckwitz, 2002), a wide range of different interpretations in the literature prevails (Becker, 2004; Cohen & Bacdayan, 1994; Jones & Craven, 2001). Eearlier scholars provided three dominant metaphors. First, organizational routines are compared to individual habits, as individuals in an organization are understood as its arms and legs. Habits require no thought, wherfore, Avni-Babad (2011) described routines as automatic sets of sequential actions. Second, routines are likened to genetic material as routines in evolutionary theory play the same role that genes play in biology (Nelson & Winter, 1982). The third metaphor links organizational routines to programs or standard operating procedures (Feldman & Pentland, 2003; Nelson & Winter, 1982). In accordance with these remarks, the traditional view emphasizes the structural and stable aspect of routines within organizations. Their functional character is briefly summarized in the literature review by Becker (2004): Routines in the organizational context enable coordination and control (e.g. Gersick & Hackman, 1990; Louis & Sutton, 1991; Nelson & Winter, 1982). Further, routines foster truce and provide some degree of stability as expectations about the behavior of others can be formed that reduce uncertainty (e.g., Baumol, 2002; Hodgson, 1988). They economize on limited cognitive resources and are able to bind even tacit knowledge (e.g., Hodgson, 1999; Knott, 2003; Winter, 1994). In sum, routines are considered as recurrent interacting patterns (behavioral patterns) (Dosi, Teece, & Winter, 1992; Gersick & Hackman, 1990; Winter, 1964), and rules or standard operating procedures (cognitive regularities) (Cohen, 1991; Cyert & March, 1963; Egidi, 1996).

Cohen and Bacdayan (1994) described routines as a "two-edged sword," (p. 555) as they allow efficient coordination of actions, but they also introduce the risk of highly inappropriate responses. Hence, subsequent research has stressed dysfunctional performances of routines, as they are seen as rigid, mindless, and explicitly stored (Cohen, 2007; Pentland et al., 2011). This might lead to inertia within organizations, in turn leading to inflexibility and demotivation of its members.

In contrast to this, according to the current prevailing dynamic view of routines, they are considered to have the potential for development and change (Feldman & Pentland, 2003; Pentland & Rueter, 1994). The approach that regards routines as dynamic systems is based on research that have tried to look into the routine; rather than treating the routine as a black box. This view is based on the criticism of the work of Nelson and Winter (1982) that treats routines as dispositions or genotypes, and also as behaviors or phenotypes. That is a contradiction in terms, as they conflate (genotypic) factors such as a computer program or an individual skill (phenotypic) with factors such as a repetitive pattern of activity or individual performance. Cause and effect are therefore the same (Hodgson, 2003). Hodgson (2003) illustrates this aspect by mentioning a difference between a computer program (genotype) and the computer's output or action (phenotype). According to this, routines are understood as behavioral dispositions (Hodgson & Knudsen, 2004a; Hodgson, 2003), which means routines are considered to offer potentialities, probabilities, or opportunities to express a certain behavior in a specific situation.

As the recent literature on organization and management theories focus increasingly on individual behavior and social practices to explain organizational performance (e.g., Feldman & Pentland, 2003; Geiger & Koch, 2008; Schatzki, 2007), routines are central to many of these studies as they are seen as social practices (Cohen et al., 1996; Feldman & Pentland, 2003) performed by individuals (Feldman, 2000). While focusing on the transformation process from inputs to outputs (Pentland & Feldman, 2005; Salvato, 2009) individuals performing the routine, and thus, the emotional aspect of

routines (e.g., Salvato & Rerup, 2011) are emphasized. In this context, Feldman and Pentland (2003) provided a new theory of organizational routines based on the relation between structure and action referring to Bourdieu (1990). The so-called dualistic approach proposes the idea that routines embody a duality of structure and agency, which could be explained by understanding routines as generative systems (e.g., Feldman & Pentland, 2003; Pentland et al., 2011; Vromen, 2011). This means that an underlying mechanism generates the interdependent patterns of actions that are recognized as an organizational routine. In practice, it seems as one routine generates performances that can be recognized. However, in the field of research, it is understood more as a collection of apparent performances from which an underlying routine may be deduced (Pentland, Haerem, & Hillison, 2009). Thus, structure is produced and reproduced through the actions taken by individuals, and the actions are constrained and enabled by structure (Giddens, 1984). Therefore, the distinction between the underlying structures and the observable behavior have to be made (Feldman & Pentland, 2003; Vromen, 2011).

The approach of Feldman and Pentland (2003) pays attention to the distinction between structure and agency by dividing the routine into its "ostensive" and "performative" part. The ostensive part embodies the abstract idea of the routine (structure), while the performative part consists of the actual performances "by specific people, at specific times and places, that bring the routine to life" (agency) (p. 94). Thus, both parts are necessary to constitute what is currently understood as a routine (Feldman & Pentland, 2003). The distinction between the observable behavior (performative part) and the underlying dimension (ostensive part) is therefore also central to this empirical study. Organizational routines are patterns that are constituted through the interaction of these both parts (Feldman & Pentland, 2003; Pentland & Feldman, 2005; Rerup & Feldman, 2011; Zbaracki & Bergen, 2010). Understanding these interactions, where performances create and recreate the ostensive aspect and the ostensive aspect constrains and enables performances (Feldman & Pentland, 2003), is necessary for appreciating routines as a source of change.

In detail, the *ostensive aspect* of a routine is the ideal or schematic form of a routine, which means it is the abstract, generalized idea of the routine, or the routine in principle (Feldman & Pentland, 2003; Kaiser & Kozica, 2013; Pentland, 2011). Ryle (1949) described the ostensive parts as "know that". They shape the perception of what the routine is and give structure to a routine, and they might be seen as largely stable (Feldman & Pentland, 2003). Routines without an abstract pattern cannot be recognized or reproduced (Pentland, 2011). Generally speaking, it is the individual cognitive idea or interpretation of a routine that is different between individuals (Feldman & Pentland, 2003, 2008; Kaiser & Kozica, 2013). The *performative aspect* of a routine is evident in the specific repeated pattern of actions that the agents generate in response to each problem. Thus, it is defined as "specific actions performed by specific individuals at specific times," and over time (Feldman & Pentland, 2003, p. 101). Ryle (1949) refer to the performative parts as "know how." Based on the theory of practice (Bourdieu, 1990), the performative aspect of routines is described as inherently improvisational, which means that to a certain degree the particular courses of action chosen are always, to some extent, novel. Improvisation and different interpretations of the same abstract pattern lead to differences in performances, depending upon the interests of the individual or the specific context (Feldman, 2000; Witt, 2011). Even routines that have been engaged in by the same people many times need to be adjusted to changing contexts (Feldman & Pentland, 2003). The emergence of organizational routines with particular regard to the aspect of planned and spontaneous routines is considered further in the next section.

Emergence of Organizational Routines

An attempted solution is likely to result from (1) *technology* (e.g., software) or other technical artifacts (D`Adderio, 2008), (2) *design* to implement rule-based processes, (3) *institutional rules* or norms for fulfilling the required standards (e.g., accounting standards), and lastly (4) *experience* as previous problem-solving affects how similar problems are solved (Amburgey, Kelly, & Barnett, 1993). Summarizing, it can be seen that besides the performing individuals, the higher-level management also influences the emergence of routines. The extent to which management is formally involved in the emergence of routines can thereby range from the complete design and implementation of a routine (planned routines) to the entirely informal, unplanned, and spontaneous emergence of a routine without anyone designing it (spontaneous routines).

Planned routines are characterized by stereotypical behavior based on rules and directives, arising from within the organizational hierarchy and found in written documents that, however, just provide the basis of actions and are not the action itself (Giddens, 1984; Zimmerman, 1971). Even if organizational routines are deliberately planned and formally implemented by management, formal directives do not automatically translate into performed routines (Cohen & Bacdayan, 1994). The functionality of managerial designed routines is likely to be affected in two ways. Firstly, highly appropriate routines may have low functionality if the compliance of organizational members is low. Secondly, even if the routine is highly complied with by the organization`s members, the functionality of poorly designed routines is likely to be low. This might lead to different routines spontaneously emerging from actors that better suit the intended purpose (Witt, 2011). Hence, *spontaneous,* informal routines are not deliberately planned; rather, individuals become engaged on an increasingly habitual basis. Thus, the influence of management on the process tends to be marginal, as the members coordinate themselves through iterated interaction to produce procedures that minimize their individual efforts at the expense of achieving organizational goals, where this is not controlled by the management and serves their interests (Witt, 2011).

As these observations show, once organizational routines exist, they save on the scarce resources required for the managerial attention to checking, planning alternatives, and instructing organization`s members. However, even if the managerial resources can be made available, a successful switch in functional routines cannot be guaranteed as members of an organization or a sub-group (team) spontaneously and sometimes by chance choose sequences of interactions and adhere to them in recurrent situations (Witt, 2011). This might also be reflected by the approach of Feldman and Pentland (2003) who emphasize, that a change in one aspect (ostensive or performative) does not necessarily lead to a change in the other one. Hence, overestimating the importance of the ostensive aspect often leads managers to underestimate the importance of the adjustments and improvisations that people undertake to make the routine work. In case, people pursuit individual interest that are not aligned with the organizational strategy, that may result in highly inappropriate responses to specific situations (Cohen & Bacdayan, 1994). As organizational routines may generate functional as well as dysfunctional performances (see also section 2.1), it is further essential to analyze the influencing factors on routines.

ORGANIZATIONAL EFFECTS ON ROUTINES AT TEAM LEVEL

Effects on organizational routines can be external or internal in nature (Feldman & Pentland, 2003, 2008). These effects can lead to an intended change, especially one induced by management

decisions, or a spontaneous change, or even a new routine. Changes caused by the management that are planned with the intention of achieving organizational goals, which can be delivered by specifying performances or establishing incentives for the actors involved (Feldman & Pentland, 2008). This rational kind of change is mainly caused by environmental changes, such as competition, technological change, and changing customer needs (Feldman & Pentland, 2003; Howard-Grenville, 2005; Pentland et al., 2011). According to the traditional view, which emphasizes the stable and inertial impact of routines, changes in routines can mostly be traced back to external effects mostly appear in terms of environmental turbulence, which means changes in technology, the market, and regulations (e.g., Cohen et al., 1996; Lazaric, 2011). However, as routines are nowadays seen as generative systems, recent studies have increasingly focused on the internal effects (Feldman & Pentland, 2003; Pentland et al., 2011). This study also concentrates on internal factors that may affect organizational routines. Routines are performed by individuals who think self-reflexively, care, and feel (Feldman, 2000). Thus, the functionality of a routine depends on how effectively the coordination of the members involved is oriented towards attaining organizational goals rather than private interests such as convenience, effort minimization or competence disputes (Becker, 2005a; Salvato & Rerup, 2011; Witt, 2011). Hence, the decision-making ability of organizational members depends on their human capital (skills, knowledge, experience, cognitive capacities) as well as their individual goals, beliefs, and interests (Becker, 2005a; Felin, Foss, Heimeriks, & Madsen, 2012). This shows routines might be affected in different ways, such as by abstract patterns that include managerial rules and procedures, or by the behavioral patterns of individuals performing the routine. Hence, as represented in the literature, interpretation and understanding, experience and learning, and decision-making influence routines at team level (e.g., Burns & Scapens, 2010; Cohendet & Llerena, 2008; Felin et al., 2012; Pentland et al., 2011). Therefore, these categories are discussed in detail in the next section and the concrete influencing factors and the research hypotheses are derived.

Hypotheses

Interpretation and Understanding

A central characteristic of routines is their collective nature (e.g., Becker, 2004; Cohen & Bacdayan, 1994; Felin et al., 2012; Vromen, 2011), as only multi-agent collectives such as groups and organizations may have routines (Vromen, 2011). This receives further support from the definition of Feldman and Pentland (2003) that also explicitly emphasizes the involvement of multiple actors in performing a routine. Therewith, the emotional aspects and social interactions of the actors have gained importance in the recent literature (Feldman & Pentland, 2003; Feldman, 2000; Salvato & Rerup, 2011; Witt, 2011). (Inter-)action is constantly motivated by the will and intention of individuals. Consequently, the enactment of routines is highly influenced by resistance, engagement in conflict, as well as interests and role perceptions of individuals (Feldman, 2000) that interpret the same issue differently (Burns & Scapens, 2010; Felin et al., 2012). In this context, many studies have emphasized the role of individuals in endogenous change in routines (e.g., Becker et al., 2005; Becker, 2004). Feldman (2000) called this the "internal dynamic of routines," (p. 614) which involves participants' reactions to the outcome of previous iterations of the routine. This change might be incremental, as only a few "components" of routines change at a time, such as the rhythm of recurrence or the participants involved. Further, individuals combine elements of past repertoires of

particular routines or actions from other sources to deal with present situations, whereby a particular combination may affect future understandings of what the routine is. Therefore, routines develop in a path-dependent manner over time (Feldman, 2000). The opportunity to produce a variation in a routine is provided by the actors may freely transfer the abstract structure of a routine into their performances. Thus, selection occurs within organizational routines as people "sometimes vary the performances that the ostensive aspect of the routine guides [them to], refers to, and accounts for" (Feldman & Pentland, 2003, p. 113).

There is always a necessity for interpretation that follows individual interests and experiences (Becker, 2005b; Egidi, 1996; Feldman & Pentland, 2003; Kaiser & Kozica, 2013). Different interpretations of the performance of a routine may lead to discussion between the members. Therefore, shared understandings are important to organizations, since although they rely on the planning of significant routines, interpretation is an essential element in their implementation (Witt, 2011). This means discussions reflecting on results might lead to variations in the performance of routines. Based on these remarks, current empirical studies give evidence that involving more actors in a team leads to variations and changes in behavioral sequences (Miller, Pentland, & Choi, 2012). Hence, it can be assumed that the larger the team, the more interpretations and thus differences in performance exist. Further, the repertoire of behavioral sequences is even wider if previous experiences and information from individuals are included in any particular performance of the routine. Thus, the variety of interpretations, discussions, and interactions in teams of a larger size leads to a greater variety of behavioral performances. Therefore, the first hypothesis states:

> **Hypothesis 1a:** *Larger teams will present a greater variety of performances (performative aspect).*

The next hypothesis is also based closely on the previous remarks as it aims at diversity of teams. Performance and interpretation of a routine`s abstract pattern are influenced by individual skills, beliefs and interests of actors involved (Becker et al., 2005; Burns & Scapens, 2010; Pentland, 2011). Hence, differences in individuals` backgrounds concerning cultural, technical, or social aspects may induce a wider range of interpretations. Diversity based on differences of age, culture, and gender, as well as the interdisciplinarity of team members, may lead to a wider range of behavioral performances as a greater number of different environmental influences may come into play due to the heterogeneity of views, beliefs, and interpretations. In the field of technology identification this is expected to be of particular importance as technological information is presented by different sources (e.g., members, customers, suppliers, patents, media channels, as well as newspapers, journals, internet, exhibitions or conference presentations) in different situations. Therefore, it is important to comprehend a great variety of information in order to identify potential technologies. This might be explained by the fact that prior knowledge and socialization influence individual`s cognitive categories (Wisniewski, 1995), allowing individuals to access and exploit relevant knowledge for both known and novel items (Ross & Makin, 1999). Routines are, therefore, important in the process of acquiring, interpreting, selecting, and organizing information (Matlin, 2005). Heterogeneous teams can be obstructive in some situations of fast decision-making, that might be practical especially in the process of technology identification. However, to benefit from a heterogeneous repertoire of interpretations and views, it is important not to restrict the variety by formal rules and procedures. Further, it might be argued that organizations that are aware of the

advantages of heterogeneous teams do not restrict the variety of performances by formalization and rules. Hence, the next research hypothesis states:

> **Hypothesis 1b:** *For more highly diversified teams there is less formalization (ostensive aspect) in order to benefit from teams` heterogeneity.*
> Experience and Learning

Nelson and Winter (1982) referred to organizational routines as the organization's genetic material, some of which are explicit (bureaucratic rules), while some are implicit in the organization's culture. Accordingly, a company provides a special context in that by interacting with the external environment, selected explicit and implicit knowledge is further stored in routines to be made available to future generations as routines are even able to store the tacit components of knowledge. Further studies have tehrefore referred to routines as the organizational memory and repository of organizational capabilities (e.g., Cyert & March, 1963; Dosi, Nelson, & Winter, 2000; Nelson & Winter, 1982; Winter, 2003; Zollo & Winter, 2002). Repositories of organizational capabilities preserve the past, which is why they have often linked to path-dependency or inertia in previous studies. However, routines also shape the future development of firms, as they can include the learning and improvement of firms caused by the interaction of explicit and implicit types of knowledge evolve over time (Spender, 1996a; Winter, 2000; Zollo & Winter, 2002).

Routines play an important role in decisions in recurrent situations (Athay & Darley, 1981). Experiments show that repeated decision-making with an increased availability of information leads to the manifestation of path dependence as actors take prior experience into account when making decisions (Betsch, Haberstroh, Glöckner, Haar, & Fiedler, 2001). Prior knowledge has an even stronger impact on choices when time pressure increases, since the likelihood of defaulting to routinized responses increases. Further, the routine responses that are rehearsed most often are chosen (Becker, 2004; Cohen & Bacdayan, 1994). As earlier experiences are included in actual routine performances, several authors have mentioned the important effect of actors` experiences in the context of organizational routines (e.g., Burns & Scapens, 2010; Cohendet & Llerena, 2008; Pentland et al., 2011). Experiential learning gained from performances shapes the ostensive aspect of a routine in that way that memories shaped by individuals' experiences give rise to the ostensive aspect, that in turn guides subsequent performance (Feldman & Pentland, 2008; Miller et al., 2012). Incomplete learning may thus lead to incomplete ostensive parts. Figure 1, which is taken from Miller et al. (2012), visualizes the "iterative relation between individual`s performances within organizational routines and their ostensive understandings" (p. 1538).
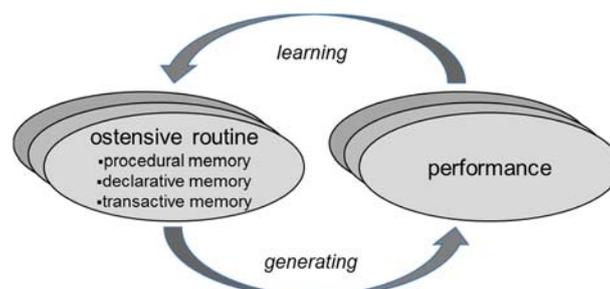

Figure 1: Routine formation (Miller et al., 2012)

In examining routines in hospital, Reagans, Argote, & Brooks (2005) referred to three different forms of memory in organizational routines: Procedural, declarative, and transactive. Procedural knowledge, or "know-how" (Singley & Anderson, 1989), has a significant tacit component, as only skilled practitioners can carry out these procedures successfully. Individuals demonstrate their procedural knowledge by performing tasks without being consciously aware of it while acting, nor can this knowledge fully be articulated (Polanyi, 1962). Therefore, this kind of knowledge cannot be transferred readily from one person to another (Miller et al., 2012). Declarative memory contains beliefs and images, including descriptions, stories, and propositions - it can be recalled simply by thinking. Individuals draw upon declarative knowledge to make sense of situations as they interpret situations and infer appropriate responses. In short, declarative memory stores "know-what." Previous research has affirmed the importance of both procedural and declarative memory in establishing and performing organizational routines (Lazaric, 2008). Recent studies, such as Miller et al. (2012), treat individual skills as procedural knowledge (know-how) and understandings of task sequences (knowing what to do next) as declarative knowledge. Hence, declarative memory refers exclusively to past task sequences learned by individuals through experience. Procedural and declarative memory, together with transactive memory (considered separately in the next section) build upon individual`s experiences and in turn generate further performances. As people form procedural memory, repetitive actions are assumed to reduce the variety of performances (Cohen & Bacdayan, 1994).

Organizations are made up of heterogeneous individuals who are entrusted to solve repeated problems that require the completion of a series of tasks for resolution. Individuals possess disparate skills and awareness of the tasks required to solve problems, and they each have transactive and declarative memory capacity. Over time, routines take form as repeated patterns of action that displace searching in response to problems (Miller et al., 2012). Thus, the performative aspect of a routine is evident in the specific repeated pattern of actions that agents generate in response to each problem. As the specific actions take place, the individuals involved as well as their understandings vary, as the context varies from one episode to another. This means successful and productive behavioral patterns are stored, and may even replace existing behavioral patterns. Thus, the adaptive nature of routines can be explained by individual interpretations or decisions based on information that may be gained through one or more of the connections made among individuals responsible for the multiple elements that compose the routine. Information is exchanged at each connection so that individuals learn about other members' tasks and their perceptions of the routine. Further, the imitation of sequences from other members may be studied and assimilated into the existing repertoire. Therefore, learning inspires performances, as at each step what has been learned is likely to influence how people act (Feldman & Rafaeli, 2002). Because all routines contribute to the cumulative process of knowledge creation and allocation, learning implies a modification of routines, as routines change in response to experience (Cohendet & Llerena, 2008). Cohendet and Llerena (2008) distinguished two characteristics of variation: Generating solutions based on the mechanism of trial and error learning and the integration of behavioral sequences of familiar alternatives from one's own repertoire or those of others. To solve problems, behavioral patterns are chosen that fit most aspects of a particular situation and are taken into a particular routine. Turner and Fern (2012) gave evidence that experience influences routines, as a higher level of individual experience is a source of stability and variability in routine performance. It has been shown that teams or individuals with greater experience generate fewer random sequences and

instead turn to approved behavioral patterns more often. Further, more experienced individuals are more likely to respond to contextual change than less experienced individuals (Felin et al., 2012). In short, greater experience, mainly induced by the repetition of actions, determines variety in routine performance (Pentland et al., 2011). Hence, the second research hypothesis supports the link between experience and the performative part of a routine:

> **Hypothesis 2a:** *The more experienced team members are, the less the variety in their behavioral performances (performative aspect).*

According to the study by Miller et al. (2012), learning to perform a routine efficiently and strongly depends more on the rate at which agents remember other agents' skills than on their rate of remembering task sequences. These authors emphasize that sequences quickly become apparent but it is much harder and takes extensive research to discover who knows what (Miller et al., 2012). Therefore, it is important to consider the transactive memory system of a team in the context of routine performance. The transactive memory of a team is built while team members learn how to access knowledge outside themselves. Thus, a team`s transactive memory provides more information than any individual could remember alone (Moreland, 2006; Wegner, Erber, & Raymond, 1991), and it is defined as a combination of the knowledge possessed by each team member and a collective awareness of who knows what (Wegner, 1987).

Motivated to address problems they cannot solve alone, individuals search for help by contacting other team members or remember the contacts that were helpful in the past (Nebus, 2006). The transactive memory of a team forms over time (Wegner, 1987), as individuals verify where skills reside within an organization through direct interactions with skilled individuals or through referrals by others (Hollingshead & Brandon, 2003; Palazzolo, Serb, She, Su, & Contractor, 2006). The transactive memory is therefore essential to the performance of routines and costly to develop. Learning who knows what is an efficient response to the limited capacities of individuals' procedural memories as it enables access to a knowledge base that it would be impossible for any individual to remember and retrieve. Transactive memory might therefore be described as "'know-who" (Miller et al., 2012; Moreland, Argote, & Krishnan, 1996) as it links individual tasks to required competencies that are embodied in identifiable individuals and give rise to shared understandings of where the expertise to accomplish particular tasks resides within an organization (Brandon & Hollingshead, 2004). Communication (especially face to face) is essential to the learning associated with building transactive memory and aids subsequent retrieval (Hollingshead, 1998; Lewis, 2004; Liang, Moreland, & Argote, 1995; Moreland et al., 1996; Moreland & Myaskovsky, 2000). Further, experience from working together on practical problems enhances the ability to locate expertise (e.g., Faraj & Sproull, 2000; Littlepage, Robinson, & Reddington, 1997). Transactive memory is often discussed in the scientific literature on group decision-making or innovation, as the transactive memory system helps groups make effective and efficient decisions. Groups with a strong transactive memory efficiently identify and use relevant knowledge and thus are able to move rapidly from one task to another (Wegner, 1995). Further, it is argued that in teams with a strong transactive memory the cognitive load on each member is reduced (Akgün, Byrne, Keskin, Lynn, & Imamoglu, 2005). Hence, the transactive memory system might help teams develop a common understanding and meaning that forms into the collective knowledge in the mind of each team member (Dayan & Elbanna, 2011). Thus, a team`s transactive memory might lead to a lower variety

of individual random sequences, as team members know who has expertise in performing the specific task. Therefore, Hypothesis 2b states:

Hypothesis 2b: *The larger the team`s transactive memory, the lower the level of individual behavioral performances (performative aspect).*

Decision-making

Routines (especially the performative part) imply the decisions of the members involved to react appropriately in a particular situation, based on the ostensive part. However, in this context, it is important to consider the extent to which teams or team members are allowed to react and make decisions on their own at all. In this section, the empowerment of the team and project uncertainty will be considered sequentially as they can affect routines in the context of decision-making. A culture of failure or a member`s willingness to figure out new approaches can be highly influenced by the willingness of top management to bear risks (Kohli & Jaworski, 1990). As the literature concerning empowerment and routines is scarce, the findings of Kohli and Jaworski (1990), who examined the influence of top management's risk-aversion on an organization`s market orientation, should be taken as a basis for further discussion. The findings of this study provide support that market orientation appears to require a certain level of risk-taking on the part of senior managers, and a willingness to accept that occasional failures of new products and services are a normal part of business life. If senior management is not willing to bear risks, employees at the lower levels of an organizational hierarchy are unlikely to want to respond to market developments with new products, services, or programs. In short, top managers' risk-aversion seems to have a negative effect on the responsiveness of the organization (Kohli & Jaworski, 1990). In other words, the study finds that if top management demonstrate a willingness to take risks and to accept occasional failures, junior managers are more likely to propose and introduce new offerings in response to changes in customer needs (Kohli & Jaworski, 1990). This could be very important for TIE, as individuals who are responsible for the identification and evaluation of new technologies have to figure out new approaches and responses to changing customer needs. Therefore, the results from the study of Kohli and Jaworski (1990) also matter in the field of TIE.

If top management is risk-averse and intolerant of failure, a tighter set of rules that formalize and standardize jobs might be established, so individual performances are restricted. This can be especially to the disadvantage of new technology identification. By contrast, where management is more willing to take risks and accept occasional failures employees are freer to perform tasks individually and their job is not so formalized. Top management's risk-aversion and the empowerment of teams are therefore closely linked, as teams can have greater empowerment in performing tasks if management is willing to take risks and the organizational culture is tolerant of failures. Therefore, team empowerment might influence routines in that the variety of performances is assumed to be greater when top management is less risk-averse, as team members are willing to try out new approaches and responses. Further, greater willingness to take risks implies a lower level of rules and procedures. An open culture about failure might be important in the field of TIE as new technologies often run a high risk of failure. However, in order to stay innovative, it is important that teams conducting TIE should identify new approaches to problem solving and not be restricted by strong formalization and given procedures. In the context of TIE, it might be assumed that in companies with a department conducting TIE, the responsible team is mainly empowered to do its

business independently. This implies less formalization of the tasks given by the management. The following hypothesis might conclude:

Hypothesis 3a: *Higher empowerment of the team conducting TIE implies less formalization (ostensive aspect).*

Besides the empowerment of the team, level of uncertainty might also affect team members' decisions. Uncertainty is defined as the absence of information (Downey & Slocum, 1975). A high level of uncertainty therefore mainly prevails when the likelihood of each outcome from a set of possible outcomes is unknown. In the field of TIE, this might be due to the fact that new technologies often run a high risk of failure due to high uncertainty and limited or missing information about future technologies. A much stronger form of uncertainty is the so-called "pervasive uncertainty," which refers to situations where neither the possible outcomes nor their associated probabilities and payoffs are initially known, and situations are structured poorly so that possible outcomes remain unknown despite any increase in information (Becker & Knudsen, 2005; Becker, 2004; March & Simon, 1958). Uncertainty (or risk) can therefore be reduced by increasing the amount of information available to the decision-maker (Luce & Raiffa, 1957); however, "pervasive uncertainty" cannot readily be addressed as increasing the amount of information might even increase the uncertainty, as ambiguity in the interpretation of the information might evolve (e.g., Becker et al., 2005; Weick, 1979).

The need for a distinction between uncertainty and "pervasive uncertainty" is important due to increasing turbulence of markets and technologies (Becker & Knudsen, 2005). The field of TIE is particulalrly faced with these effects when making choices, and they induce situations of uncertainty, stress, and time pressure. As discussed in section 3.1.2., prior knowledge and experience have a strong impact on choices. The impact is even stronger if time pressure increases, and therefore prior knowledge and experience can even overrule new evidence (Betsch, Fiedler, & Brinkmann, 1998). Thus, several studies (e.g., Betsch, Haberstroh, Molter, & Glöckner, 2004; Cohen & Bacdayan, 1994; Garapin & Hollard, 1999) have emphasized that time pressure and uncertainty are central problems in decision-making. According to Garapin and Hollard (1999), time pressure increases the likelihood of routine choices, even when the inadequacy of a routine has been indicated before making the choice. Similarly, Bröder and Schiffer (2006) showed that individuals tend to persist in using their decision routines even when they are no longer optimal, and even when the individuals recognize the appropriate strategy at the beginning of the task. Briefly, time pressure provokes a tendency to avoid effortful validation processes, to rely on recognition and familiarity, and to select simple strategies. Hence, time pressure fosters routine maintenance approaches (Betsch et al., 2004). With increased uncertainty it might be assumed that the decision-making of groups or individuals is increasingly influenced by time pressure or other constraints such as stress, and that individuals will not only fall back on routinization, but will also have a preference for the routine responses that are rehearsed most often. Increasing routinization in decision-making is therefore seen as an uncertainty reducing strategy (Becker & Knudsen, 2005). As Heiner (1983) pointed out, "greater uncertainty will cause rule-governed behavior to exhibit increasingly predictable regularities, so that uncertainty becomes the basic source of predictable behavior." In summary, the findings of Gittell (2002) and Becker et al. (2005) show that routines are increasingly effective for coping with uncertainty. In situations of pervasive uncertainty, the routinization of decision-making is increased as this will decrease the decision maker's experience of pervasive

uncertainty (Becker & Knudsen, 2005; Becker et al., 2005). The model of Hodgson & Knudsen (2004b) demonstrates routines helping rational decision makers to cope with uncertainty when they try to achieve coordination. In conclusion, with high project uncertainty, decision-making in TIE is expected to be more highly routinized in handling uncertainty and achieving results. Research hypothesis 3b is aimed at this:

Hypothesis 3b: *Projects with higher uncertainty imply increased organizational formalization (ostensive aspect).*

Closing this section, Figure 2 illustrates the research model and depicts the research hypotheses.
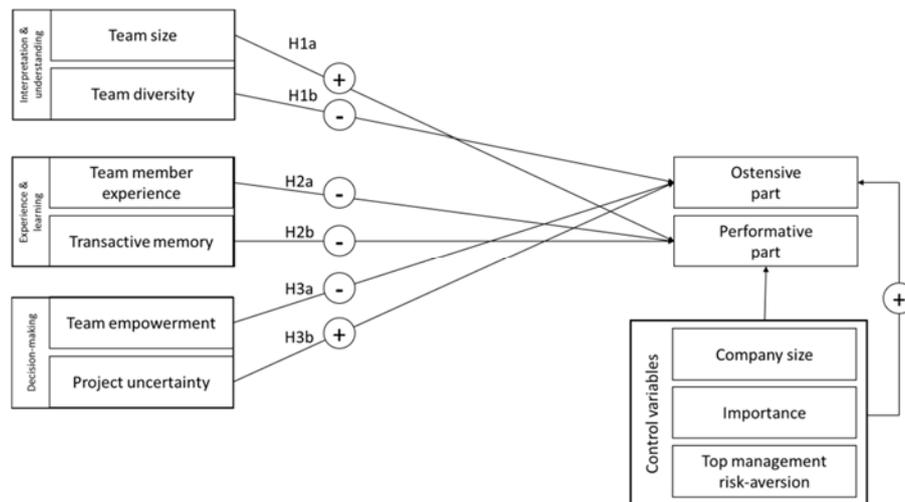

Figure 2: Research model

RESEARCH DESIGN AND METHODOLOGY

Sample

In order to test the hypotheses with reliable information, online questionnaires were distributed to a subgroup of managers with expertise in the specific area of TIE, for example, R&D executive, innovation manager, and head of technology. They were identified from an internet search and a business network database by their current position.

Operationalization

Independent Variables

All measures used in this study are drawn from existing literature (all items are presented in the Appendix). For all of the variables, high values signify a high characteristic for the respective item. Descriptive results and reliability coefficients for each construct are presented in section 5.1. To measure *team size*, the average number of employees conducting TIE was counted. Respondents stated a minimum of one person and a maximum size of 30. *Diversity* of team was measured by a 7-point rating scale from 1 = *completely homogeneously* to 7 = *completely heterogeneously* for team structure with regard to gender, nationality, age, experience, interdisciplinarity, team affiliation, level of hierarchy, and educational background. The scales for *transactive memory system* of a team, *team empowerment,* project *uncertainty* and team members` *experience* are taken from the study of

Dayan and Elbanna (2011). Cronbach`s alpha was higher than 0.7 in all cases, with exception of team members` experience. This variable was therefore calculated by multiplying the two items, which are mutually dependent. The justification for this might be that if there are people in the team who have brought with them a wealth of information gained from prior assignments within the company (item 2), there might be a critical mass of experienced people on the team who had addressed similar problems before (item 1).

Control Variables

Finally, a number of additional factors were controlled as they might have affected the ostensive and performative aspect of a routine. Company size as measured by the number of employees in total was included, as larger companies tend to have a stronger formalization due to a higher level of hierarchy and complexity than smaller organizations (e.g., Caplow, 1957; Grusky, 1961; Mileti, Gillespie, & Haas, 1977). To measure company size a 5-item scale was used: 1 = under 50 employees, 2 = 50 to 249 employees, 3 = 250 to 999 employees, 4 = 1,000 to 9,999 employees, 5 = more than 10,000 employees. Project importance (taken from Dayan and Elbanna, 2011) was included, since the more important the project is for the organization, the more rules and formalization might be applied by the management to ensure the team conducting TIE acts according to organization`s agenda. Further, the extent of formalization and rules, as well as team members` capabilities in trying new approaches, depends on top managements` risk-aversion (taken from Jaworski and Kohli, 1993). Top managers' risk-aversion induces a negative effect on the responsiveness of the organization, as employees are not likely to propose and introduce new offerings in response to problems (Jaworski & Kohli, 1993). Therefore, a highly risk-averse top management might set rules to a greater extent, and thus try to contain individual performances that might be innovative.

Dependent Variables

The distinction between the *ostensive* and *performative* aspect is theoretical in nature, thus, there are no existing scales that measure this. By using factor analysis, the variables for the ostensive and performative aspect were inductively build, based on existing scales used in previous research that describe the main issues of the parts: Formalization relating to the ostensive part and the variety of performances relating to the performative part. Both scales are taken from the study of Dewar, Whetten, & Boje (1980) who provided scales for measuring the degree of task routineness (technology routineness) and formalization (job specificity). In sum, nine items were included in the factor analysis, item 4 of the "routineness" scale ("there is something different to do every day") was excluded from analysis to improve results. The KMO statistic was 0.790, so the model is more than acceptable for using factor analysis ($\alpha = 0.720$). The extracted factors explain 52.69% of the dispersion. As rotated factor analysis shows, two factors can be built as the first six items had a high loading on factor 1 (32.47%), whereas the last three items had a high loading on factor 2 (20.21%). The items loading on the first factor relate to given job descriptions and rules concerning the task and their documentation. As schematic procedures characterize formalization in organizations, this factor constitutes the ostensive aspect. Higher values imply higher formalization in terms of given rules and procedures, meaning in turn that the interpretations of individuals are restricted. Regarding those items that load highly on factor 2, they assess the variety and modality of tasks. Thus, the second factor describes the performative part of a routine. In this case, high values for the performative aspect imply a wider range of different performances.

RESULTS

Descriptive Results

Table 1 presents the means, standard deviations, Cronbach`s alphas, and correlation coefficients of all variables. In total, 178 experts participated in the study. The descriptive results show that the average age of the respondents is 47.5 years, with a range from 27 to 71 years and an average working experience of 6.5 years. Moreover, the results indicate that most of the companies operate in the mechanical engineering industry (27.1%), followed by IT/electrics/optics (11.0%), automotive (9.0%), and plant engineering (7.7%), and the remaining companies were from other industries like chemicals, metals, and plastics. The sample covers a wide range of industries, but the so-called high-tech industries are represented most often, as these companies are most likely to have an established department for TIE. Regarding company size, the participating companies had on average 250 to up to 999 employees with a mode of more than 10,000 employees. They generated on average from EUR 250 million to EUR 1 billion revenue.

Table 1: Descriptive statistics, reliability coefficients, and correlations for the ostensive and performative aspect

	N	Mean	Std. dev.	α	1	2	3	4	5	6	7	8	9	10	11
control variables															
1. company size	156	3.04	1.452	-	1										
2. project importance	174	5.09	0.893	0.721	-.050	1									
3. top management risk-aversion	162	3.95	1.018	0.790	-.242**	.169*	1								
independent variables															
4. team size	163	5.76	3.574	-	-.099	.012	.081	1							
5. team diversity	174	4.25	0.888	0.793	.144	.036	.110	.211**	1						
6. experience	176	30.53	9.544	-	.108	.213**	.153	-.022	-.014	1					
7. transactive memory system	174	5.84	0.677	0.778	-.077	.352**	.116	.024	.049	.213**	1				
8. uncertainty	176	3.79	0.635	0.745	.082	-.179*	.004	.021	-.001	.054	-.089	1			
9. empowerment	174	4.61	1.317	0.733	-.078	.260**	.445**	.041	.054	.212**	.292**	-.053	1		
dependent variables															
10. ostensive aspect	163	4.90	1.079	0.783	.202*	.168*	-.080	-.008	-.054	.027	.206**	.040	-.094	1	
11. performative aspect	174	2.61	0.879	0.521	.015	-.161*	-.286**	-.095	-.104	-.260**	-.343**	.036	-.318**	.122	1

Note

* $p < .05$.

** $p < .01$.

Results of Regression Analysis

In order to gain further insights, a regression analysis for the ostensive and the performative aspect was conducted to test the hypotheses. To check for the possibility of problems of multicollinearity, a collinearity diagnosis was subsequently conducted for both models. The Variance Inflation Factor (VIF) values of both models are well below 2 and thus substantially lower than the recommended threshold of 10. Consequently, there is no serious multicollinearity effect. The results of the regression models (missing values are replaced by mean) are presented in Table 2 for the ostensive aspect (left side) and for the performative aspect (right side). First, the regression analysis for the *ostensive aspect* should be analyzed. Model 1 (control variables only) explains only a small share of the variance in the ostensive aspect (R^2 adjusted = 0.055, p = 0.005). The result shows that company size (β = 0.190, p = 0.012) and project importance (β = 0.179, p = 0.017) have a significant and positive influence on the ostensive aspect of a routine, whereas, there is no significant influence of top management risk-aversion. In Model 2 the independent variables of the research model are

integrated; the results for the control variables are just influenced marginally. The included characteristics make a significant contribution over and above Model 1 (R^2 adjusted = 0.129, p = 0.000). The results indicate that empowerment of the team (β = -0.199, p = 0.018) and project uncertainty (β = -0.213, p = 0.011) have a negative and significant influence, whereas, the transactive memory (β = 0.142, p = 0.085) has a significantly positive impact on the ostensive aspect.

The research model for the *performative aspect* provides the following results: Model 1 (control variables only) also explains only a small share of variance in the performative aspect (R^2 = 0.076, p = 0.001). Only top management risk-aversion shows a significant and negative impact (β = -0.266, p = 0.001) on the performative aspect, whereas company size and importance do not have a significant influence. When independent variables were included in Model 2 (R^2 adjusted = 0.192, p = 0.000), the results of the control variables changed only marginally. Further, the transactive memory system (β = -0.217, p = 0.007) and team members` experience (β = -0.129, p = 0.078), have a significant and negative impact on the performative part.

Table 2: Regression results between team characteristics and the ostensive/ performative aspect

ostensive aspect	model 1	model 2	performative aspect	model 1	model 2
control variables			**control variables**		
company size	.190*	.199**	company size	-.055	-.021
project importance	.179*	.154*	project importance	-.121	.025
top management risk-aversion	-.063	-.014	top management risk-aversion	-.266**	-.148†
independent variables			**independent variables**		
team size		.095	team size		-.026
team diversity		-.087	team diversity		-.059
experience		-.078	experience		-.129†
transactive memory system		.142†	transactive memory system		-.217**
uncertainty		-.213*	uncertainty		.125
empowerment		-.199*	empowerment		-.127
adjusted R²	.055	.129	adjusted R²	.076	.192
unadjusted R²	.071	.173	unadjusted R²	.091	.233
Δ R²	.071	.102	Δ R²	.091	.142
model F value	4.439*	3.917**	model F value	5.822**	5.677**
Δ F value	4.439*	3.468*	Δ F value	5.822**	5.185**

Note:

†	p < .10.
*	p < .05.
**	p < .01.

DISCUSSION AND CONCLUSION

This study investigates the influence of team characteristics on the ostensive and performative aspect of a routine. The findings of the regression analyses indicate that each of these aspects are affected by different characteristics and in different ways. Hence, this provides evidence that the future measurement of routines has to consider the distinction between the ostensive and performative aspect, as mentioned in the context of generative systems by Feldman and Pentland (2003). Regarding routines as a whole construct as for example "overall routineness" by Lynch (1974) is therefore no longer the contemporary view. Further, the ostensive and performative aspect cannot be considered to be a continuum. This means that high parameter values in the context of the ostensive part do not in turn imply low values of the performative part. Hence, the future measurement of routines has to consider the different characteristics of the ostensive and performative aspect according to their current definition. Existing scales of routines can mainly be assigned to the ostensive aspect of a routine. This is due to the fact, that they consider

characteristics like job specificity (e.g., Dewar et al., 1980; Hage & Aiken, 1969), job formalization (e.g., Hage & Aiken, 1969; Hall et al., 1967; Pugh, Hickson, Hinings, & Turner, 1968), standardization (e.g., Pugh et al., 1968), hierarchy of authority (e.g., Hage & Aiken, 1969) and centralization of decisions (e.g., Lynch, 1974; Pugh et al., 1968). Whereas, the performative part is mainly described by characteristics like job variety or the individual performance of tasks, thus addressing variances in performance. These kinds of characteristics, which focus on the role of individual human actors and their performances, have only recently been mentioned in the literature (e.g., Feldman & Rafaeli, 2002 ; Pentland, Feldman, Becker, & Liu, 2012). As this literature is theoretical in nature, measurement referring to the performative part is scarce and has not been considered in detail. Merely, only single items from existing scales as the construct of "technology routineness" from Dewar et al. (1980) or the construct of "overall routineness" by Lynch (1974), reflect the aspect of agency and variety in part.

Future measurement of routines is therefore required that focuses on individual aspects (performative part) that fulfill the definition of a routine, according to the current consensus in the literature. It has to be borne in mind that routines are seen as abstract patterns in the literature that are difficult to measure, and therefore only few empirical studies regarding organizational routines exist (Auer-Neuberg, 2011). For this reason, low statistical loadings and reliabilities should be accepted in this case as expedient. Most studies considering the internal and external effects on organizational routines are theoretical in nature (e.g., Becker et al., 2005; Becker, 2004); however, the empirical study of Pentland et al. (2011) implies a greater influence of internal effects on organizational routines than other stimuli. For this reason, the intention of this study was to gain a deeper insight into the kind of team characteristics that might affect organizational routines. At the same time, it differentiated the ostensive and performative part of a routine in a quantitative study, which is also to some extent novel. In the following, the statistical results are discussed according to the previous structure of the study.

Interpretation and Understanding (Team Size and Team Diversity)

Regarding *hypothesis 1a*, the results do not support the assumption that larger teams have a greater variety of performances. As the effect between team size and the performative aspect is marginal and non-significant, hypothesis 1a is rejected. A possible explanation for this finding is that while increasing team size offers multiple benefits, it is also challenging. Companies rely on team decision-making to manage and coordinate organizational tasks (Milliken & Martins, 1996) as teams are generally expected to make better decisions than individuals, and further, decisions made by teams are often more accepted by those who are affected. Hence, team solutions have become important in addressing emerging organizational problems as they are high-quality solutions (Jehn, Northcraft, & Neale, 1999). Within larger teams, tasks can be subdivided across the team members so that each member performs the tasks that fit best with his or her interests and skills. Hence, task specialization is fostered, which improves performance (Moreland & Myaskovsky, 2000; Newell & Rosenbloom, 1981; Wegner, 1987). However, although larger teams have more opportunity for task division, the completed work has to be integrated at the end to fulfill the whole task or project, which requires additional time and effort and might lead to miscommunication and conflicts (Bechky, 2003; Heath & Staudenmayer, 2000; Lawrence & Lorsch, 1986). There has been a large amount of research on effective of team size. Already Bass and Norton (1951), and Gibb (1951), found that as group size increases over the range from two to twelve members, average member participation declines.

However, there are also studies such as that by Ziller (1957) that demonstrate that as group size increases (in this case from from two to six members) the objective quality of the group's decisions increase, though even larger groups are advantageous in effectively designing and utilizing groups. Research does not provide a specific optimum number or range of team size (Hoegl, 2005); studies instead point out that the right team size will certainly depend on the work to be performed (Hackman, 1987). However, the study by Wolfe and Chacko (1983) stated that overall an odd-numbered group of five participants seems to strike the right balance for group creativity, decisiveness, and accountability, with minimal internal administrative problems. As descriptive results of this study show, team size in the TIE ranges between one and 30 members with an average size of 5.76, which might be in line with Wolfe and Chacko (1983). Larger teams can imply challenges involving coordination, motivation, and conflict (Hackman, 2002; Levine & Moreland, 1998). Further, members of larger teams may experience decreased motivation (Staats, Milkman, & Fox, 2012) and there is increased potential for conflict, which may harm team performance (Brewer & Kramer, 1986; O`Dell, 1968). Reflecting the challenges of larger teams, the results show a negative (but non-significant) effect between team size and the performative aspect. To ensure that team members act in line with the organizational agenda and to minimize variety of performances to ensure continuity and comparability in the evaluation of technologies, the organizational rules and procedures increase with team size. However, it can be argued that in larger teams, tasks are more easily divided according to team members' skills and interests (Moreland & Myaskovsky, 2000; Newell & Rosenbloom, 1981; Wegner, 1987); thus, the variety of tasks for every member decreases. Moreover, regarding the results that show a positive but non-significant effect for team size and the ostensive aspect, an explanation could be that larger teams induce higher levels of rules and formalization in order to act to a common standard. As the field of TIE is of strategic importance and due to a lack of rational information, it is important to ensure traceability when identifying and evaluating new technologies. This might be due to a common standard and understanding to ensure efficient and fluent performances set by team members or the management, as the field of TIE places a strong emphasis on standards.

Increasing team size tends to increase team heterogeneity (Bantel & Jackson, 1989; Jackson et al., 1991); therefore, the results on team diversity are next discussed. It should be mentioned that diversity management is seen as strategic management concept in modern literature. According to this, an economic and efficient way of using team diversity can provide competitive advantages (e.g., the approach of Aretz & Hansen, 2002; Schulz, 2009; Sepehri & Wagner, 2002), so the reduction of rules, procedures, and documentation might help in this case. *Hypothesis 1b* suggested that higher team diversity implies lower rules and job specificity. However, there is only a marginal and non-significant negative effect between team diversity and the ostensive aspect. Hypothesis 1b cannot therefore be supported as the result gives little support to the assumption that more highly diversified teams are less subject to rules and guidelines. This might be due to the fact that companies that attach importance to diversified teams, and thus to the interdisciplinary backgrounds, ages, experiences, gender, and so on of the team members, are aware of benefitting from team heterogeneity. Therefore, the organization might not establish a high level of rules and hierarchical formalization to avoid suppressing the ability to perceive a wider range of influences, which is especially important in context of technology identification.

In summarizing the results for understanding and interpretations, it should be mentioned that larger teams induce a higher rate of job specificity to ensure people in TIE act according to the

organizational agenda and goals or benefit from task diversity. This might strengthen the importance of standard procedures for the evaluation of technologies to ensure the comparability of technologies and minimize subjective impacts. However, if teams in the TIE are diversely composed, the organization seems to be aware of benefitting from heterogeneity as a reduced set of rules and job specificity exists. This might be of particular importance in the context of technology identification, as team members interpret information differently depending on their backgrounds (Bechky, 2003), so that a wider range of technological information can be recognized and processed. However, it has to be mentioned that the findings in this context can only be seen as tendencies as the results are not significant.

Experience and Learning (Experience and Transactive Memory)

In *hypothesis 2a*, it was suggested that more highly experienced team members have a lower variety of performances. A marginally negative but significant effect between experience and the performative aspect is given; thus, the results are consistent with the current literature. Hypothesis 2a is therefore supported by the results. In the context of TIE, this might be explained by the fact that highly experienced team members are responsible for more strategic tasks, for example, the identification of new technologies, rather than more operational and routinized tasks such as the evaluation of technologies. The items given by Dewar et al. (1980) concern issues like "having a higher variety of work" and "something new happens every day." Since the identification of new technologies might be a less routinized process than their evaluation, because of the variety of technological information and differences in sources of information, it might be argued that experienced members would rate their job as highly varied. The participants of this study mostly had leading positions in TIE, such as head of technology or innovation, and furthermore had an average working experience of 6.5 years. Hence, the results for the sample for this study reveal that increasing experience induces a decrease in the performative aspect.

Besides team members' experience, it is also important to consider collective awareness of who knows what in a team, the so-called transactive memory. *Hypothesis 2b* suggested that there would be a negative relation between the transactive memory system and the performative part of a routine. The results show a significant negative effect; therefore, hypothesis 2b can also be confirmed. This strengthens previous remarks that, due to a strong transactive memory, each member has specific individual expertise that is known by the other members. Therefore, individuals perform tasks according to their particular expertise. For this reason, the variety of tasks given to each team member might decrease. In this context, it should be further mentioned that there is a significant positive relation between transactive memory and the ostensive aspect. This is interesting, as it seems that the informal status of expert that evolves over time due to experience and the formation of procedural memory, could be formalized by organizational rules. The higher the transactive memory system, the higher the specificity of the jobs. Regarding the ostensive aspect, this implies that "everyone has a specific job to do." Further, aspects of hierarchy and centralization are emphasized by this, as when team members have a specific problem they are expected to go to the same person for an answer. These findings provide support that experience and expertise are highly important in the TIE. The forming of transactive memory is therefore essential in order to have experts performing specific tasks, as labor division seems to be a basic requirement for organizational rules that are implemented in official guidelines.

Decision-Making (Team Empowerment and Uncertainty)

Decision-making in the TIE is often challenging, as the identification of new technologies involves handling a large variety of information sources, which, however, still provide insufficient information about early-stage technologies, whereas technology evaluation is often faced with inadequate or even missing information. Therefore, decisions in the TIE often have to be taken under highly uncertain or complex conditions and thus are likely to run a high risk of failure. Consequently, a team member`s ability to make decisions strongly depends on an organization`s culture of tolerating failure, based on the willingness of top-management to bear risks and the level of uncertainty prevailing for a given project. As the risk tolerance of top management influences team members` empowerment, a greater willingness to take risks might imply a higher level of empowerment; however, the result for *hypothesis 3a* suggests a negative effect between team empowerment and the ostensive aspect. This assumption is supported by the results that show a negative and significant effect for team empowerment and organizational rules and job specificity (ostensive part). Hence, it can be stated that more highly empowered teams have authority to make most decisions concerning the project themselves, and they do not have to consult senior company management since the rules and formalization of their job are consequently less strictly required by the management.

Regarding uncertainty in the context of decision-making, it was pointed out in section 3.1.3 that routinized decision-making is considered to cope even with pervasive uncertainty, and just increasing the amount of information may even increase uncertainty (e.g., Becker & Knudsen, 2001; Becker et al., 2005). Pervasive uncertainty leads to a higher level of stress that in turn induces defaulting to routine responses (Becker, 2004; Betsch, Brinkmann, Fiedler, & Breining, 1999). In short, greater uncertainty causes rule-governed behavior (Heiner, 1983). As uncertainty within decsion-making is a great challenge, routines can offer an important contribution to actors' ability to perform their actions (Becker, 2004; Gersick & Hackman, 1990). Keeping these theoretical aspects in mind, the statistical results for *hypothesis 3b* might be surprising, as they show a negative and significant effect between uncertainty and the ostensive aspect. This finding might indicate that in a case of high uncertainty, the organization seems not to be able to set specificities such as written records of job performances or provide operating procedures to follow. This suggests that the field of TIE is faced with pervasive uncertainty that it is difficult to influence or reduce in any way (Becker et al., 2005). Therefore, in case of high project uncertainty, organizational job specificity decreases. This can be explained by the fact of intuition, as uncertainty is said to increase intuitive processes or the need for them (e.g., Burke & Miller, 1999; Sonenshein, 2007; Weick, 1995). The literature provides further evidence that many managers or employees embrace intuition as an effective approach in response to situations where there are no predetermined guidelines or rules to be followed (Burke & Miller, 1999; Hitt, Keats, & De Marie, 1998). Dayan and Di Benedetto (2011) considered that due to high environmental turbulence, a firm will not be able to make cognitively-based decisions based on "hard" information (since environmental conditions are always changing) and will be forced to rely to a greater extent on intuition. In summary, in cases of high uncertainty team members rely more on their intuition to make decisions than on their cognitive loads (Wegner, Giuliano, & Hertel, 1985), which can be seen as the opposite end of the continuum to rational (cognitive) decision-making (e.g., Dayan & Di Benedetto, 2011; Hough & Ogilvie, 2005; Mitchell, Friga, & Mitchell, 2005; Sonenshein, 2007). Finally, it should be mentioned that in context of

decision-making, job specificity decreases when a high level of uncertainty prevails as intuition represses rational judgment due to a lack of information or changing conditions. Management science provides a pragmatic approach that intuition is an unconscious process based on a decision-maker's knowledge and previous experience (e.g., Barnard, 1938; Burke & Miller, 1999; Simon, 1987). As individuals develop experience, they can internalize their experiences into intuitions (Reber, 1996). Accordingly, individuals with little experience, so-called "novices," may have few intuitions and thus may follow more rational, rules-based rationalist approaches during their novice stage (Dreyfus & Dreyfus, 1986). As they become "experts" by acquring more experience, they use rules-based behavior less and rely more on intuition, which captures previous experiences. Consequently, "experts" are more likely to make intuitive judgments based on their experience and feelings (Dreyfus & Dreyfus, 1986; Sadler-Smith & Shefy, 2004). These remarks explain why there is a decrease in the ostensive apect in situations of uncertainty: More highly experienced teams are more likely to be strongly empowered and tend to act more intuitively, based on their experience and feelings in situations that are highly uncertain.

Summarizing the results of the hypotheses' testing in general, it has to be mentioned that characteristics like company size, project importance, and uncertainty, as well as empowerment show a significant effect on the ostensive part. These are mainly objective and given conditions that are impersonal in nature and cannot be influenced directly by team members. In contrast, characteristics that are more personal in nature and depend on individual attitudes, such as top managements` risk-tolerance or experience and transactive memory, show effects on the performative aspect. Hence, in determining the influences of characteristics on a routine it is necessary to distinguish between the ostensive and performative part of a routine.

Finally, in concluding the discussion by summarizing the remarks on the results for the field of technology identification and evaluation, the results provide evidence that formalization and standardization play an important role in TIE. This can be seen by the fact that job specificity and formalization in the ostensive aspect increases for larger teams. Further, TIE in general is highly dominated by the experience and expertise of team members and their capability to form a transactive memory system. Due to the greater experience of team members and stronger transactive memory, the variety in performances decreases. This suggests that individuals become experts in specific areas and perform the particular (strategic) tasks repetitively, so that the variety of tasks decreases. This kind of informal division in tasks according to individual expertise is taken into account by the organization in its official rules and guidelines in the context of job specificity, as the ostensive part increases when individuals develop a stronger system of transactive memory. In this context, it has to borne in mind that individuals become more important in the context of routines, especially in explaining endogenous changes in routines, as change occurs as participants alter their performances (Feldman & Pentland, 2003). However, it is not only changes in the ostensive part of a routine, which people use as a guide as to what actions ought to be taken or have already been taken, that may change people`s performances. Rather, changes in performing actions effect the structure that in turn constrains and enable further actions, and thus creates, maintains and modifies organizational routines.

According to Feldman & Pentland (2003), selection within organizational routines occurs in two ways: Firstly, people will sometimes vary the performances that the ostensive aspect has set out. Due to the mechanism for guiding, referring, and accounting of the ostensive part, participants

performing a routine are enabled to create variations that other participants interpret as legitimate instances of the ostensive aspect of the routine. Some variations might be intentional as participants want to change the ostensive part of the routine in order to alter the way they do their jobs (Feldman, 2000). Other variations are unintentional as there may be new interpretations of the ostensive aspect or changing features and conditions of the given context (Aldrich, 1999; Feldman & Pentland, 2003). Secondly, through the selection of variations, the ostensive part of the routine is created, maintained, and modified. Thus, an important outcome of engaging in actions is their effect on the structures that constrain and enable further action.

The dynamic of routines is therefore a recursive relationship between understandings and performances (Feldman & Pentland, 2003). Managers are usually empowered to create rules and other artifacts that establish a particular version of the ostensive aspect. Further, managers may also have power to monitor performances and enforce compliance. Thus, the ostensive aspect of a routine is aligned with managerial interests (dominance), while the performative aspect is aligned with the interests of labor (resistance). However, overestimating the importance of the ostensive part often leads to an underestimation of the importance of the adjustments and improvisations undertaken by the people performing the routine. Due to the interaction between the performative and ostensive aspect of organizational routines, many opportunities are given for individuals or groups to produce variations on a routine, select these variations, and retain them as the means of doing this particular routine. As routines are enacted by many people, there are many actors who influence the process of variation and selection (Feldman & Pentland, 2003). Thus, setting the ostensive part of a routine is no longer just given to the management of an organization. Rather, individuals performing the routine produce variations and thus finally establish the ostensive part of a routine. Especially in the field of TIE, individuals should be required to challenge given routines regularly and should not be punished by the organization when generating variety within their performances. Variety in performances might be based on previous experiences and differences in the technical backgrounds or expertise of individuals, which might in turn lead to diversity in information, interpretive schemes, and the goals of the participants. The individuals performing the routine do not all have access to the same information, and further they might not interpret the information in the same way (Feldman & Pentland, 2003). Especially in the identification of technologies, organizations should therefore benefit from diversified teams and team members' ability to produce variety of performances in routines that might shape the ostensive part. Thus, there should be less routinization and rigid rules set by the organization in order to help it benefit from individuals` variety. As the data show, the experience of team members is highly important in the field of TIE. Organizations should consequently profit from team members`experience in that way that team members are free to set the ostensive aspect. According to their experience and variation of performances by trial and error learning, team member perform effective patterns that shape or change the ostensive aspect of a routine that in turn guide performances. Thus, the organization should rather set the general conditions like targets or budgets than set the ostensive aspect that strictly describe how to perform the tasks. Moreover, challenging routines regularly is crucial to avoid becoming stuck in outdated patterns that might lead to a path-dependent inflexibility, or might be predominantly driven by the individual interests of members.

LIMITATIONS AND FURTHER RESEARCH

The limitations have to be borne in mind when interpreting the results of this study. First, the findings support the current understanding of routines as generative systems. However, as previously mentioned in this context, the lack of suitable scales for measuring routines is a major limitation. The constructs chosen in this study for the ostensive and performative aspect can only be seen as a first step towards a quantitative approach to measuring routines according to their current understanding. Thus, the results strengthen the need for further research to develop scales regarding the ostensive and performative part to measure routines more completely.

As already noted in the section on measurement, some constructs, such as uncertainty, and especially, routines, cannot be observed directly as they are latent in nature, and they therefore have to be derived from measurable observable factors. Hence, the reliability of constructs in some cases is low. However, psychological constructs (e.g., experience and uncertainty) are difficult to measure. Further, this research is at an early stage, as in the case of the distinction between the ostensive and performative part of a routine in the context of a quantitative approach. For these reasons, values of reliability below 0.7 (Kline, 2000) or even 0.5 (Nunnally, 1978) might be acceptable. Second, despite the effort to identify potential respondents, the sample covers only 178 participants. As the study is only limited to German companies, the findings can probably not be generalized to other countries, as cultural aspects might influence the emotional and rational aspects. Moreover, information about the industries were rarely given, so statements about reliable differences between each industry cannot be made. Third, the limitations result from evaluation of technology development activities and characteristics, which are based on subjective assessments of experts. Moreover, data about situational characteristics and experiences and the transactive memory of the team conducting TIE are all subjective. As experts are generally in the leading positions in the field of TIE, their responses might be biased due to the fact that they are confronted with more strategic tasks.

Finally, the study can only explain 12.9% of the overall variance for the ostensive and 19.2% for the performative part, which limits the predictive power of the study. Consequently, in order to increase the predictive power, future research should be done primarily on the operationalization of the ostensive and performative aspect, before integrating other variables. The characteristics of the two parts can be derived according to the current definition and literature on routines as generative systems. The ostensive part is characterized by centralization, formalization, rules, norms, and control, whereas the performative part is indicated by the variety of work, individual performance, the variation between individuals, and the consciousness of reflection and modification. Thus, according to these characteristics, constructs and items have to be developed and tested to enable the measurement of routinization. Further, especially in relation to the consensus on the definition of routines, characteristics like collectivity, interdependence, the procedural character of routines, and repetitiveness have to be considered.

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