Diversity as a Knowledge Resource in Top Management Teams – a Framework for Agent-Based Modeling

Vera Stolarski  
European Business School  
vera.stolarski@ebs-siie.de

Prof. Dr. Meike Tilebein  
European Business School  
meike.tilebein@ebs-siie.de

Abstract  
The current paper reveals and explains inconsistencies in cognitive diversity research regarding diversity effects on top management team information processing as a presumption for team performance. On the one hand diversity constitutes a resource by enlarging the knowledge-pool of the team and therefore potentially contributes to team and organizational performance. On the other hand diversity can act as a barrier and hinder access to the knowledge. The paper refers to limitations of empirical research designs and discusses different simulation approaches as alternative research methods. Following the first steps of a roadmap for using simulation given by Davis et al. (2007) a framework, comprising relevant moderator and mediator variables of the team diversity – information processing relationship, is identified. Finally agent based simulation is acknowledged as method to clarify the team diversity – team performance relationship in future research and further steps of the roadmap are outlined.

1. Introduction

Striving for market success, organizations try to establish heterogeneous top management teams (TMTs) more than ever, enhancing diversity in terms of age, educational background, socioeconomic background and functional experience [20, 32, 46]. According to the upper echelon perspective TMT characteristics like values, experiences and personalities influence TMT interpretations of the strategic situations they face which in turn affect social and psychological processes of the team [19]. These again take influence on team information processing which can be defined as the way teams reflect, perceive, interpret, store, retrieve, transmit and use information [2]. This again is crucial for TMT performance and therefore for the performance of the organization, e.g. for strategy innovations [19].

Hence TMTs can be regarded as the aggregate informational and decisional entity through which competitive moves are made, TMT characteristics are a matter of particular interest in diversity research [20]. The great promise of diversity is an increased knowledge pool, leading e.g. to an extensive range of perspectives and thus potentially enhancing team performance [25, 36]. But still there are several risks associated with diversity, e.g. conflict. Delivering ambiguous results, numerous empirical studies focus on the link between TMT diversity and information processing [25, 27, 31, 32] considering information processing as a presumption for team performance or strategic firm performance. Therefore diversity potentially constitutes a resource, providing an enlarged knowledge pool to a team. But still there are no definite implications for how to benefit from this knowledge resource, respectively how to manage a diverse team successfully.

The current paper suggests to clarify the contradictory diversity debate by applying a simulation model. Following the first steps of a roadmap for using simulation given by Davis et al. (2007) a framework comprising relevant moderator and mediator variables is identified and different simulation approaches are discussed. The current paper is organized as follows:

In section 2 basic concepts of diversity, in particular cognitive diversity that accounts for differences in information processing, and diversity effects are introduced. The occurrence of contradictory findings in empirical diversity research calls for a closer look at potential reasons for the inconsistencies in section 3. Consequently a simulation approach is considered as alternative research method in section 4.1. Following the first steps of the simulation roadmap by Davis et al. (2007) a comprehensive literature review on empirical research in cognitive TMT diversity is provided in section 4.2. Comprising the relevant moderator and mediator variables, a framework for modeling the complex relationship between diversity and information processing is developed. Reviewing state of the art technical literature on simulation methods in section 4.3 reveals agent based simulation as the appropriate approach for modelling team diversity and information processing, for which two examplary computational representations from the literature are described. In Section 5 we summarize and discuss our findings from the first steps towards simulation-based research in the diversity debate and outline the next steps.
2. Theoretical Concepts and Background

2.1 Top Management Team Cognitive Diversity

In former research various definitions and categories of diversity have been utilised. For instance, Simons, Pelled, and Smith (1999) distinguish different kinds of diversity depending on their job-relatedness [38]. They examine three types of job related diversity (functional background, educational level, tenure) and one less job related variable (age). The authors refer to all four variables as “demographics” while other researchers [e.g. 20] define demographic diversity in terms of age, gender, cultural background, and so forth. As deep level differences (e.g. attitudes, or cognitions) are much more potent in group interactions than surface-level demographic differences [21] the current paper focuses on cognitive diversity.

Most aspects that account for cognitive diversity are so called deep level differences, like cognitions, beliefs, and attitudes, opposed to surface demographic differences [21], and cannot be directly measured. Therefore proxies like functional, or educational background, firm tenure, industry experience, and educational level are widely used in empirical research [4, 20, 36].

Functional background diversity represents the range of specialists, e.g. members from marketing, finance, human resources, as well as members from research and development in a TMT. Functionally diverse management teams possess depth in their respective individual areas but not breadth across a range of other areas [4]. Van der Vegt and Bunderson (2005) for example refer to expertise diversity speaking of the range of domains in a team [44].

Firm tenure is defined as the time a person is employed at a certain company. It takes influence on aspects like tolerance, perspectives and attitudes [4].

The concept of experience diversity characterises differences in job or industry experience, which is supposed to take influence on knowledge and knowledge processing capabilities, e.g. availability of schemata facilitating decision making [39].

Educational diversity reflects the balance and breadth in years of school education [5]. Educational levels relate to knowledge structures and information processing. Education enables individuals to understand what they know, predict outcomes, manage time or resources, monitor results and provides problem solving abilities [39]. Thus education takes influence on cognitive structures and mental maps.

2.2 Effects of Diversity on Information Processing

Individual cognitive differences lead to differences in human information processing. Individual information processing reflects how a person perceives, memorizes and uses information [30]. Team-level information processing characterises how teams perceive, interpret, store, retrieve, transmit and use information, and how they come to a decision [2, 19].

Former research revealed ambiguous results concerning the effects of TMT cognitive diversity on information processing and related team performance variables. For instance, Bunderson and Sutcliffe (2002) identified ten different studies revealing different relationships between TMT functional diversity and performance variables each [7]. Findings in diversity research imply that diversity offers great opportunities and at the same time an enormous challenge [32].

Several benefits have been attributed to cognitive diversity, e.g. increased breadth of perspectives, enlarged knowledge pool, cognitive resources and improved overall problem solving capacity of groups [22] or valuable dissimilar underlying assumptions [16]. According to Milliken and Martins (1996) diversity generates creativity and innovation by accessing diverse mental models of TMT members [32]. Bringing together representatives from all relevant areas might lead to gathering the full range of perspectives and issues that are crucial to a collective venture [44]. Further more, diversity may lead to a better acquisition and assimilation of new external knowledge [24] and thereby can contribute to the organisation’s adaptivity [1, 3], which affects the overall corporate performance in a beneficial way [20].

At the same time, as often confirmed in the past, a number of risks seem to be associated with highly diverse teams, e.g. conflict [11]. For instance Miller et al. (1998) conclude that TMT diversity inhibits extensive long-range planning and comprehensive examinations of current opportunities and threats [31].

Referring to social categorization theory and social identification theory [41, 43] conflicts among heterogeneous individuals emerge because of labelling processes, self-identification with certain groups while valorising the own group and devaluing the other group. These processes can seriously constrict cohesion, obstruct communication and hinder collaborative problem solving [41].

Pelled et al. (1999) showed that different types of diversity may lead to different categories of conflict: Race and tenure diversity predominantly cause emotional conflicts, which are potentially detrimental to team processes, because they
originate communication barriers [34]. Functional background diversity leads to task conflict, which is partially beneficial to team performance, as it enhances task related debate among team members and therefore facilitates knowledge sharing. Still even beneficial conflict can cause unwanted costs, e.g. due to difficulties in information sharing [5].

Therefore on the one hand a highly homogenous team might not realize innovative solutions, because its ability to scan the business landscape for creative ideas is limited in comparison to more heterogeneous teams. On the other hand a highly diverse team might suffer from poor communication and the obstruction of knowledge sharing which again lowers innovativeness [4].

The diversity-benefits and diversity-conflicts relationships described above demonstrate the enormity of interacting and intertwined variables in diversity research. Hence the relationship between TMT cognitive diversity and information processing is not clear up till now [5, 36].

Accordingly diversity can enhance or hinder a team’s ability to use the knowledge provided by heterogeneity itself [13]. Therefore it appears desirable to take influence on the makeup of the team to achieve a balance between risk and reward [16] and to maximize the information processing capability of the team. The positive effects of TMT diversity might only surface under certain conditions that enhance the benefits and diminishes the costs [5]. This requires knowing the relevant moderator and mediator variables of cognitive diversity and information processing in TMTs. Even though contemporary models of diversity seem able to explain the positive and the negative effects of diversity, they are not able to determine when each occurs [46] let alone how to manage a diverse team.

In sum, TMT diversity can constitute a valuable knowledge resource for an organization [4, 9]. But there is empirical support for TMT diversity to be both a facilitator and a barrier to knowledge sharing and team performance. Reasons for these inconsistent results are discussed in the following section.

3. Reasons for Inconsistent Results

3.1 Inconsistencies in Diversity Research

Aside from incorrect theories, falsely hypothesised relationships or illegitimate operationalisations [9, 20, 36] the inconsistent categorisation and nomenclature of diversity-types additionally to the use of varying proxies as described above impede comparability of research results [36].

Further more several authors [9, 20] query the adequacy of the proxies: As explained in Section 2.2, often demographic differences have been measured in order to approximate underlying variables like cognitions. Certainly demographic variables are easy to access and rather reliable. However, the validity of using demographic data for approximating underlying characteristics must be called into question [32, 36]. Instead deep level characteristics like individual differences regarding personal identities, personality, skills, and cognitions of team members should be assessed [25]. Yet obtaining rich cognitive data on variables like goals or beliefs requires extensive interviews or questionnaires [31]. Measuring the issue itself in a direct manner would require experimentation or at least observation, which is very difficult to realize in organisational research let alone upper echelon research [19].

3.2 Complexity and Dynamic Interactions

Unmeasured moderator, mediator, intervening, independent or dependent variables possibly contribute most predominantly to the observed inconsistency of empirical studies as described above [9, 20, 36]. In former cognitive diversity research mediating or moderating variables have not been considered in full range [25].

Further there is evidence for the necessity to treat diversity as a multifaceted construct (see section 2), whose facets interact with team processes and doing so take influence on team performance in the course of time [21, 36]. So aside from the complexity of the subject matter the underlying processes of information processing in diverse teams are highly dynamic. Longitudinal research, very complex research designs and large samples would be necessary to understand the effects of time on the relationship between diversity and knowledge use [13, 36].

However, the ambiguous results described in section 2 cast into doubt if empirical research designs can satisfy the criteria of representing all relevant variables and taking account of the dynamics evolving between the variables.

Therefore simulation methods are considered as an alternative research approach in the next section.

4. Resolving the Shortcomings of Diversity Research with Simulation

4.1 Simulation as an Appropriate Method

Colbert (2004) suggests accepting the dynamic and emergent properties as key features of complex systems like ecosystems, organisations or HR systems. Instead of testing discrete phenomena the interacting processes of the elements of a social system should be seen as a coherent whole with managerial leverage points [10].
Superior insight into complex relationships between ranges of variables can be provided by simulation methods [29]. Law and Kelton (1991) define simulation as a method for using computer software to model the operation of “real-world” processes, systems, or events. Simulation can reveal interactions between various underlying organizational and strategic processes, particularly as they evolve over time. Thus allowing computational experimentation, simulation approaches can contribute to theory development, specifying and extending extant theories [14].

Simulation is very valuable for explaining longitudinal, processual and dynamic phenomena being time and data demanding. Even nonlinear phenomena like feedback loops, tipping points or thresholds can be analyzed this way [14]. Furthermore there is no need for proxies in simulation. Depending on the respective simulation approach, observations about social actors can be immediately translated into a model [28].

According to Davis et al. (2007) using simulation for theory building in strategy and organizational research is particularly promising when the research question shows one of three specific characteristics: First, it addresses a fundamental phenomenon with limited theoretical backing or multiple theoretical roots. Second, longitudinal interactions that would be difficult to study empirically play a major role. Thirdly, the research question focuses on an essential tension or trade-off [14].

With respect to all of these three characteristics, the TMT diversity debate qualifies for a simulation study. First, in section 2.2 we have elaborated on the fragmented and contradictory results of empirical TMT diversity research, lacking an answer to the fundamental question of how to benefit from diversity as a knowledge resource. Furthermore, as shown in Section 3.2 there is some support in the literature for the dynamic nature of the problem, with information processes in diverse teams as well as diversity itself changing over time in the course of team interactions. Thirdly, the contrarian effects of TMT diversity that can be either beneficial or obstructive characterize the trade-off problem in diversity management.

With the TMT diversity debate being a promising subject, next steps towards a simulation study on this topic are described in the following.

4.2 Identifying Relevant Variables for a Comprehensive Framework

In order to design a realistic simulation model and to derive reliable insights the underlying theoretical concepts must be acknowledged [14]. Davis et al. (2007, p. 482) refer to this second step of their simulation roadmap as the identification of major variables and interacting processes, or “simple theory”, with a focus on intertwined processes, non-linearities and longitudinal effects associated with the research question.

Recognizing the neglection of relevant variables as the central methodological shortcoming of empirical research, the full range of moderator and mediator variables of TMT cognitive diversity effects has to be identified. Therefore an extensive literature review on the relationship between cognitive diversity and information processing was conducted. Primarily papers concerning TMTs were incorporated. Supplementation from non-TMT cognitive diversity research were made only if they add crucial insights to the diversity - information processing relationship. Information processing itself was defined in a broader sense due to its entangled relationship to several performance variables, e.g. team performance or strategic decision making (see section 2.3). Additionally the social network perspective provides crucial insights into diversity effects [e.g. 8, 17, 35]. Thus variables identified in social network research were incorporated into the framework described below.

The results of the literature review are shown in Table 1. The variables in the third and fourth column refer to the framework shown in Figure 1, comprising all relevant identified moderator and mediator variables of the relationship between TMT cognitive diversity and information processing. In order to avoid misunderstandings due to inconsistent nomenclature, single variables were summarized if their content allowed for it. For example the moderator variable “environmental turbulences” in line two of Table 1 is relabelled “task complexity”. The variables in Fig. 1 are grouped according to their specific context (social categorization, team climate, ability and team processes as well as environmental characteristics) and are arranged in columns from left to right.

In the upper part of the framework (Fig. 1) relevant mediator variables are displayed. One of the moderator variables “Affective and Evaluative Reaction” is additionally affected by Stereotypes and Bias [46] which again is influenced by Cognitive Diversity itself. At the bottom of the framework three variables mediate the relationship between cognitive diversity and information processing. Again one of them, “tie strength”, is affected by the number of exchange partners. The framework combines the whole range of variables identified by the referenced empirical studies. Still more interactions between the incorporated variables are thinkable, although not being detected yet. Due to space limitations, just one moderator variable (task complexity) and one mediator variable (tie strength) will be specified exemplarily.

The relationship between TMT cognitive diversity and firm performance is moderated by task complexity [9].
<table>
<thead>
<tr>
<th>Author</th>
<th>Proxies for cognitive diversity</th>
<th>identified moderator variables</th>
<th>identified mediator variables</th>
<th>output variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auh, and Menguc (2005a)</td>
<td>functional background gained through career experience and education</td>
<td>interfunctional coordination</td>
<td>-</td>
<td>innovativeness</td>
</tr>
<tr>
<td>Auh, and Menguc (2005b)</td>
<td>functional background gained through career experience and education</td>
<td>interfunctional coordination, environmental turbulence (Fig. 1: task complexity)</td>
<td>-</td>
<td>strategic orientation</td>
</tr>
<tr>
<td>Burt (2004)</td>
<td>group-affiliation</td>
<td>-</td>
<td>structural holes (Fig. 1: tie strength)</td>
<td>good ideas, creativity</td>
</tr>
<tr>
<td>Carpenter (2002)</td>
<td>educational background, work experience, tenure</td>
<td>task complexity</td>
<td>-</td>
<td>firm performance (Return on Assets)</td>
</tr>
<tr>
<td>Cronin, and Weingart (2007)</td>
<td>educational background</td>
<td>-</td>
<td>representational gaps</td>
<td>information processing, conflict</td>
</tr>
<tr>
<td>Cross, Liedtka, and Weiss (2005)</td>
<td>functional background, educational background, business experience</td>
<td>task environments (Fig. 1: task complexity), network structures (Fig. 1: intragroup interdependence)</td>
<td>-</td>
<td>innovativeness</td>
</tr>
<tr>
<td>Dahlin, Weingart, and Hinds (2005)</td>
<td>educational background</td>
<td>task characteristics (Fig. 1: task complexity), social categorization (Fig. 1: Stereotypes and bias)</td>
<td>-</td>
<td>information use</td>
</tr>
<tr>
<td>Granovetter (1973)</td>
<td>affiliation to a network</td>
<td>-</td>
<td>tie strength</td>
<td>diffusion of influence and information</td>
</tr>
<tr>
<td>Kauer, zu Waldec, and Schäffer (2007)</td>
<td>experience, personality</td>
<td>network abilities (Fig. 1: integration abilities), achievement motivation (here: task motivation) leadership, action orientation</td>
<td>-</td>
<td>strategic decision making</td>
</tr>
<tr>
<td>Van Knippenberg, De Dreu, and Homan (2004)</td>
<td>functional and educational background</td>
<td>task motivation, task ability, affective and evaluative reactions influenced by stereotypes and bias</td>
<td>-</td>
<td>creativity and innovation, decision quality</td>
</tr>
<tr>
<td>Miller, Burke, and Glick (1998)</td>
<td>4 questionnaire items: 2 on preferred goals for the firm, 2 on beliefs</td>
<td>-</td>
<td>decision comprehensiveness</td>
<td>strategic decision process</td>
</tr>
<tr>
<td>Olson, Bao, and Parayitam (1998)</td>
<td>(dis)agreement of executives on key firm ideals</td>
<td>trust</td>
<td>-</td>
<td>commitment and decision quality</td>
</tr>
<tr>
<td>Pelled, Eisenhardt, and Xin (1999)</td>
<td>functional background, tenure, age, race</td>
<td>task routineness (Fig. 1: task complexity)</td>
<td>-</td>
<td>task performance, conflict</td>
</tr>
<tr>
<td>Perry-Smith, and Shalley (2003)</td>
<td>affiliation to a network</td>
<td>-</td>
<td>tie strength influenced by the number of ties</td>
<td>creativity</td>
</tr>
<tr>
<td>Simons, Pelled, and Smith (1999)</td>
<td>company tenure, functional background, educational level</td>
<td>debate</td>
<td>decision comprehensiveness</td>
<td>financial performance (profitability and sales growth)</td>
</tr>
<tr>
<td>Van der Vegt, and Bunderson (2005)</td>
<td>expertise</td>
<td>collective team identification</td>
<td>-</td>
<td>team learning, team performance</td>
</tr>
<tr>
<td>Van der Vegt, and Janssen (2001)</td>
<td>questionnaire: to what extent members differ in their way of thinking, knowledge and skills</td>
<td>intragroup interdependence</td>
<td>-</td>
<td>individual in-role job performance and innovative behaviour in the workplace</td>
</tr>
<tr>
<td>West (2002)</td>
<td>e.g. professional background, knowledge, skills, abilities</td>
<td>integration abilities, intragroup safety</td>
<td>-</td>
<td>creativity and innovation implementation</td>
</tr>
</tbody>
</table>
Figure 1. Identified Moderator and Mediator Variables of TMT Cognitive Diversity Effects

Hence in highly complex settings, here defined as high level of internationalisation, cognitive diversity had a negative effect on performance while at low levels of complexity the benefits of cognitive diversity became evident. The author reasons that the benefits of diversity are threatened by time pressures and uncertainty potentially due to a loss of team coherence and behavioural integration in the face of highly complex environments. Auh and Menguc (2005b) ascertain the effect of environmental turbulence on strategic orientation and attain results supporting Carpenter (2002). Contradictory Pitcher and Smith (2001) derive from their findings that heterogeneity is advantageous especially in turbulent competitive environments. Further more there is evidence that the nature of the task itself [13] respectively task requirements [46] takes influence on the utility of diversity.

Tie strength mediates the cognitive diversity – information processing relationship. Strong ties typically link similar people in dense social circles with frequent interactions, high emotional closeness and reciprocity [17, 18]. Individuals from different social circles are often connected by what is known as “weak ties”. Weak ties involve low communication frequency, low emotionally closeness and one way exchanges [35]. Weak ties often emerge between people with dissimilar perspectives, diverse outlooks, varying interests and different approaches to problems [18].

In this regard Burt (2004) describes structural holes emerging amongst heterogenic individuals and contributing to innovative outcomes. If weak ties connect different social circles without any other direct relationships between the members of the groups, access to a wide array of information is provided [17, 18] and a variety of processes being helpful for creativity are facilitated [35].

Additionally two repercussive variables, composing feedback loops as shown in Fig 1, where identified by literature research. First Akaishi and Arita (2002) found out that accurate communication (in the current paper understood as effective information processing) itself reversely takes influence on cognitive diversity. Among the considered literature, this is the first and only study, applying a simulation approach (see section 4.3) [1]. Second Kilduff et al. (2000) ascertained an interaction between team performance and cognitive diversity itself[27].

4.3 Choosing a Simulation Approach

After having identified the major variables and interacting processes in the context of our research question, the next step of the simulation roadmap is to choose an appropriate simulation approach [14]. This simulation method should be able to model the interactions of diverse team members and their information processing performance over time within the identified framework in Figure 1. Furthermore, it should be able to capture the nonlinear, recursive or feedback nature of the system, with team members adapting to team interactions and thus team diversity and influencing factors changing under ongoing information processing activities.

There are three main simulation schools that are used to model information processing problems in
organizations, discrete event simulation, System Dynamics, and Agent-Based Simulation [15].

In discrete event simulations all system changes are triggered by outside events with the system itself remaining unchanged. Given these limitations, it is obvious that this simulation approach has two major shortfalls with regard to our research problem. First, individual or team information processing covers a broader range of activities than just reacting to inputs from the outside, e.g. actively producing or searching for information, as stated in Section 2.2. Secondly, discrete event simulation cannot deal appropriately with the feedback nature of the system, where not only system behaviour, but also system structure characteristics can change adaptively, e.g. tie strength or diversity. Therefore we consider discrete event simulation inappropriate for our specific modelling needs.

System Dynamics takes an aggregate view on a system, not focusing on external events nor on the behaviour of a single system element, but rather on the overall system’s structure, which accounts for the system behaviour over time. A System Dynamics model typically consists of different interacting feedback loops. On a more detailed level, these loops include a number of system state variables, called stocks, along with flow variables that can change the state of the stocks [40].

However, feedback loops are the system structure’s basic building blocks driving the system behaviour in System Dynamics simulations. The identification and simulation of feedback loops in the system under investigation can even be called a core paradigm of that modelling approach [37]. This underlying feedback loop structure accounts for the overall system’s behaviour. Qualitative changes in system behaviour known as tipping point result from changing feedback dominance in the existing system structure, which remains unchanged during simulation in this modelling approach [37].

With regard to our research problem, a System Dynamics model obviously would be able to capture the aggregate feedback structure underlying the information processing behaviour of a diverse TMT on a macro level. On a micro level, System Dynamics has also proven helpful gaining insights in the dynamics of an individual person’s behaviour, e.g. by Homer (1985) modelling the interplay between an individual’s goals, perceptions and actions in the occurrence of burn-out [23]. However, while System Dynamics could be used to model the fixed underlying structures of the macro as well as the micro level of our framework, this modelling approach is not suited for capturing a structural change on either level, let alone those structural adaptations resulting from an interplay of the two levels.

Hence, if we assume that in the problem under investigation the system structure itself can change, and moreover, if our research problem is of a multilevel type, it is Agent Based Simulation that seems most appropriate to model such a system. Agent Based Simulation is a bottom-up simulation approach [28]. It aims at modelling the individual behaviour and interactions of a system’s micro-level entities, called agents, with the overall multiagent system’s properties resulting emergently from these interactions and in turn setting conditions for the individuals’ behaviour. Depending on the specific simulation method used, e.g. cellular automata, Boolean networks, artificial neural nets or genetic algorithms, these emergent properties can either relate to order formation or even include innovation [42].

As Wooldridge (2004) states multiagent systems are unique in being computational information processing entities [48]. Agents are designed to act upon individual goals being assigned to them. In this means their behaviour is self-induced [10, 18, 43]. After a task has been delegated to an agent it figures out for itself what has to be done without being told explicitly every single step. Agents optimize their behaviour and evaluate goals accordant to programmed incentives [48]. Most important concerning the current issue agents possess schemes determining the behaviour towards and the information exchange with other agents [15, 28]. Therefore multiagent systems enable to simulate the emergence of cooperation in social groups, the communication of beliefs and aspirations, the negotiation with or without resorting to conflict, and the coordination of activities [37, 48]. Furthermore agents are able to interact not only among themselves, but also with their environment. In other words they sense their environment and react adaptively to it [48].

Altogether agents’ behaviour is situation dependent and cannot be pre-estimated. In this means agents are capable of self-contained planning and organising their behaviour in order to achieve their implanted objectives. Hence it is possible to simulate planning, knowledge, opinions, motivations and emotions [48].

Recapitulatory, with regard to our research problem Agent-Based Simulation seems to be particularly well-suited to model TMT diversity and information processing. The respective TMT characteristics and other relevant variables shown in Fig. 1 could be modelled in a multiagent system, allowing for experimentation and clarification of the contradictory empirical findings. However, up to now there are few papers that make use of Agent-Based Simulation with regard to cognitive diversity.
One example is given by Boisot and Child (1999), who apply Boolean networks (NK-models) to strategy processes. These can be considered team information processing activities that depend on differences in the team members’ or agents’ individual information processing as well as on the speed of information diffusion through the network of agents [6]. The authors relate the cognitive complexity of strategies to the relational complexity of the strategy processes. Relational complexity increases with the number of agents that are linked in the system. Cognitive complexity is high when the codification of information is low and the degree of information abstractness is low, too. Under these conditions, information needs to be interpreted by every single agent to which it is passed. This bears the risk of misinterpretation and may lead to great diversity in information processing. In analogy to Kauffman’s (1993) general insights on Boolean Networks [26], the authors find that there are only a few combinations of cognitive complexity and relational complexity that lead to effective strategy processes [6]. Although based on very simple computational representations of information processing and focusing on strategy rather than on strategy maker characteristics, this model provides first hints towards computational representation of diversity.

Another example is given by Akaishi and Arita (2002), based on an ant food foraging model [1]. The authors design agents being diverse in means of the divergence of their so called resource maps. Those maps function as belief systems and comprise information on food resources which the agents have to obtain. The diversity of those belief systems positively affects the diversity of the agents’ behaviour.

To summarize, while agent-based modelling has been shown to be the most appropriate modelling approach for our research problem, and there is an extensive literature on agent-based simulation models in general, the diversity debate has not been addressed intensively by this literature yet.

Hence, there is little to draw on and the next challenge will be to stepwise design a computational representation that fits the system outlined in Fig. 1.

5. Discussion and Conclusion

Depending on numerous moderator and mediator variables, diversity can constitute a resource, providing an enlarged knowledge pool to a team. Empirical research did neither clarify the relationship between cognitive diversity and information processing nor deliver definite implications for how to benefit from this knowledge resource, respectively how to manage a diverse team successfully.

The current paper suggests resolving the diversity debate by applying a simulation model. Following the first steps of a roadmap for using simulation given by Davis et al. (2007) a framework comprising relevant moderator and mediator variables is identified and different simulation approaches are discussed. Integrating relevant moderator and mediator variables of the relationship between cognitive diversity and information processing in TMTs, the framework in Fig. 1 reveals a very complex and highly dynamic matter of interest. The highly complex and dynamic interactions of diversity and its effects additional to the need for modelling individual behaviour and interactions of the system’s micro-level entities provide evidence for agent based simulation as a promising methodological approach.

Agent based simulation allows for integration of the identified relevant variables by programming the schemes of agents. Hence multiple autonomous entities interact with each other and strive to carry out a task being assigned to them. Due to the agents’ ability to interact with each other and to react to environmental factors in a self-induced manner, the resulting behaviour cannot be pre-estimated. This enables to observe developments on a micro level, e.g. knowledge sharing, the emergence of cooperation and conflict or the coordination of activities, along with the emergent macro-level properties resulting in team performance.

Even in a multiagent system it obviously is not possible to consider every single variable, possibly taking influence on diversity effects. For instance our framework does not include organisational structures. In this sense simulation simplifies the reality, yet allows for more complex considerations than any empirical research method. As described above classical empirical research tools are unlikely to capture the complexity and the dynamic of the relationships shown above (see Fig. 1).

Next steps according to the simulation roadmap given by Davis et al. (2007) will be to operationalise the identified theoretical constructs for the computational representation and apply the appropriate software. The computational representation shall integrate the propositions of former research, mirror the underlying theoretical logic and allow for theoretically valuable experimentation [14]. If thus the propositions of former research can be replicated, the computational representation is verified and the accuracy and robustness of the computational representation additional to the internal validity of the “simple theory” is confirmed. If the verification fails, modification of the underlying construct has to be undertaken until integration is achieved [14]. At that
time experimentation in terms of exploration, elaboration, and extension (e.g. varying constructs, altering assumptions or adding new features) must be conducted in order to build novel theory. Most probably this process will contribute to clarify the considered relationships and shed light on momentary inconsistent findings in TMT cognitive diversity research. Finally the results of the simulation should be compared with empirical data in order to ensure external validation [14].

The present paper focuses on the first step of a research project being supported by the Peter Curtius-Foundation. In the long we are aiming to derive implications for managing cognitive diverse TMTs using the approach described in this paper. Especially the relationship between cognitive diversity and strategy innovation is of utmost significance to our project.

Additionally this research project might contribute to establish agent based simulation as option in management and organizational research, especially in case of highly complex and dynamic issues like the diversity debate.

6. References


[22] L.R. Hoffman, and N.R.F. Maier, “Quality and acceptance of problem solutions by members of


