Opening the Black Box of Team Processes and Emergent States: a Literature Review and Agenda for Research on Team Facilitation

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Abstract

The effects of facilitation on team outcomes have been in the focus of many studies. However, only a few quantitative studies investigate how teams evolve through team processes and emergent states. The goal of this review paper is to synthesize quantitative research studies to better understand the constructs of facilitation and to identify future avenues of facilitation research. We performed a structured literature review to identify relevant quantitative studies using the input-mediator-outcome model to group elicited constructs of facilitation. We found that most studies treat team processes and emergent states as a black box. We argue that we need to open this black box and include measures that allow for conceptualizing how human and automated facilitation affects team outcomes. Hence, we propose a research agenda, which enhances current models explaining team outcomes by a conceptualization and measurement of team processes and emergent states.

1. Introduction

Team members often experience challenges during collaboration [1]. Teams can benefit from professional facilitation because knowledge on effective meeting management, handling group dynamics and adequate technology use is provided [2]. Consequently, facilitation aims to counteract collaboration problems and fosters team effectiveness [3]. Even though the concept of facilitation has been around for quite a while now, it appears that there exists little synthesizing research in the form of structured literature reviews and meta-analyses [e.g., 3, 4, 5]. We provide a fine-grained review connecting facilitation constructs with team effectiveness using the input-mediator-outcome (IMO) model, a well-recognized model in team research [6]. The goal of this paper is to identify constructs of facilitation and discuss gaps in literature that future research could address to pave the way for facilitation research. The underlying research question is "*How does facilitation influence team effectiveness?*".

The remainder of the paper is structured as follows. Section 2 provides background on the concepts of facilitation and team effectiveness. Section 3 describes the research method we employed. Section 4 presents the results which are discussed together with limitations of this paper and synthesized in the form of a research agenda in Section 5. The paper closes with a conclusion given in Section 6.

2. Background

Facilitation is defined as "a set of functions or activities carried out before, during, and after a meeting to help the group achieve its own outcomes" [7 p. 147]. Past research came up with various labels for facilitation including intervention [2, 8], prompts and framing [9], decisional guidance [10, 11], structural tactics [12], or coordination mechanisms [13]. Facilitation strives to positively affect team process, i.e., process gains, and impede negative effects during collaboration, i.e., process loss [1, 14]. Process gains comprise e.g., building commitment for decisions, improving team mental models, managing time, achieving quick wins, or exchanging information unknown to all members, whereas process losses comprise e.g., production blocking, free riding, or member domination [15-17]. Consequently, facilitation is either carried out by human facilitators, also termed human facilitation, by human facilitators supported by technology, e.g., group decision support system (GDSS), or by the technology itself, also termed automated facilitation [18].

Human facilitation is usually differentiated into process, content, and technical facilitation. Process facilitation provides procedural support, which helps a team to coordinate and manage collaboration activities [19]. The structure of the overall process is improved by agreeing on, e.g., a meeting agenda or interaction routines leading to increased team effectiveness [1, 7]. Content facilitation, also termed task facilitation, offers insights, interpretations, or opinions about the task [4, 7]. Technical facilitation, also labeled chauffeur-driven

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facilitation [20], refers to helping team members use available technology that fits their task [3]. Effects of human facilitation are partially inconclusive. While positive effects were found for consensus [e.g, 20], process satisfaction [e.g., 21], or decision quality [e.g., 8], these findings could not be confirmed in other studies [e.g., 22, 23].

Automated facilitation usually relates to process restrictiveness, guidance, feedback, and feedforward. Process restrictiveness defines some sort of process structure that is provided by the configuration of a technology [24], which limits the users' decision-making alternatives by a set of pre-specified actions or sequences of actions [25]. Guidance supports users in selecting and using a technology when structuring and executing their decision-making process [26]. In addition, process guidance is differentiated into forward and backward guidance [25]. Forward guidance informs a team what to do next and is also termed feedforward [11]. Backward guidance, also termed feedback, summarizes a decision-process of a prior activity to allow a group to go back and resolve open issues [11]. Also for automated facilitation, past research findings are inhomogeneous. Automated facilitation was found to improve decision quality [e.g., 4, 11, 25, 27, 28] or reduce time to reach decision [e.g., 27, 29]. Other studies could not replicate those findings [e.g., 11, 24, 30, 31]. In any case, facilitation strives to neutrally contribute to a team's processes by enhancing communication and information processing [3]. Consequently, facilitation strives to positively impact team effectiveness [18, 32].

Team effectiveness is a complex phenomenon [33]. Figure 1 illustrates the IMO model which structures relations and antecedents of team effectiveness [33, 34] as a function of inputs, mediators, and outcomes. Inputs are composed of organizational context, team context, and team members. Mediators are differentiated into team processes and emergent states [34]. Outcomes represent criteria to assess the effectiveness of team actions. Team effectiveness is rather imprecisely defined and thus cannot easily be used as a construct assessing outcomes of team processes [6]. This paper puts particular focus on team processes and emergent states, which are equally vague constructs. Team processes transform inputs into outcomes with taskwork and teamwork processes. Teamwork processes describe "interdependent team activities that orchestrate taskwork in employees' pursuit of goals" [35, p. 358]. Teamwork processes describe how the team is doing something and relate to actions that deal with intragroup conflicts, establish roles or develop cohesion [36]. Taskwork processes describe what the team is doing and deal with team interactions to understand task requirements, discover the rules by which the tasks are to be performed, establish patterns of interaction with equipment, exchange task-related information or develop team solutions to problems [36]. Emergent states describe cognitive, motivational, and affective states of teams, which develop over time as the dynamics in teams change [35]. They emerge from team processes, tend to regularize over time, and, in turn, have impact on team processes [37]. Examples of emergent states comprise shared mental models, consensus, or cohesion [34].

Figure 1 links the concept of facilitation with the IMO model. Facilitation can be conceptualized as an input or as an independent variable since human or automated facilitation can be at a team's disposal or not [e.g.,18]. Therefore, facilitation and the other contextual inputs jointly impact team processes and emergent states. In addition, enacted facilitation can have moderating influence on the processes and emergent states [e.g., 38]. In particular, human facilitators moderate the impact of technology features and facilitation instruments on desired social structures, which, in turn, shape team processes and emergent states [38] (dashed grey line). Time is represented in two different ways. Firstly, it suggests that teams run through a development process (grey solid line) illustrating how teams qualitatively change as they mature over time in the sense of a continuous development (chronos in ancient Greek terms). Secondly, time is considered to occur in episodes (kairos). These episodic cycles can be understood as feedback loops that occur when a team transitions from one task or activity to another. Here, the solid black line implies influential feedback from team outcomes to mediators, whereas the dashed lines indicate less dominant effects [34].

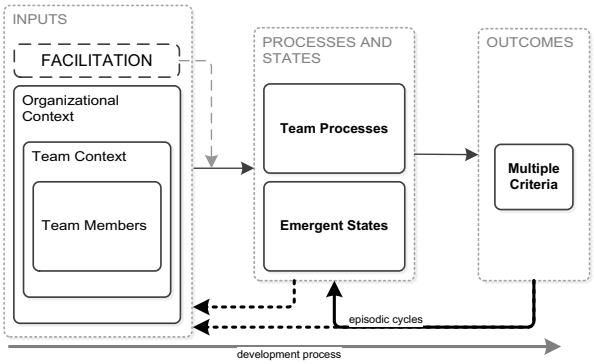

Figure 1: Conceptual Research Model, adapted from [34]

3. Methodology

We adopted a structured literature review methodology to synthesize relevant research and to uncover new areas where research is needed [39]. The review process consisted of three steps comprising the

inspection of leading journals, a forward, and a backward loop.

In **step 1**, the WebOfKnowledge (WoK) search engine was used to identify relevant journal articles. We focused on the Senior Scholars' Basket of Eight leading journals[1] of the IS domain. After an initial review of facilitation literature, the authors defined a set of keywords comprising facilitat*, intervent*, lever*, consultat*, mechanism*, framing*, guid*. We constrained the search by specifying the occurrences of keywords to be allowed in "topic" and set a time constraint between 1990 and 2013. A total of 87 articles were found and subsequently screened. We excluded in several iterations those articles that were not on a team-level and did not deal with facilitation. The sample size was 16 after step 1. In **step 2**, the backward loop focused on further facilitation literature cited in predominantly background sections of empirical papers and in facilitation-specific sections of non-empirical papers. The backward-loop result list included a total of 264 unique sources. We concentrated on the most important ones by selecting those sources whose number of occurrences was greater or equal to two. The sample size was 36 after step 2. In **step 3**, each of the 36 papers was included in the WoK search engine for the forward loop. The 50 most cited papers were considered, which resulted in 672 additional sources including redundant entries. As in step 2, the sample was reduced by assessing their importance. All papers were once more assessed resulting in a sample size of 66 after step 3.

We focused on a subset of 36 papers employing quantitative research, because these studies give a clear account of facilitation constructs investigated. Usually, they define dependent, mediating, moderating, and independent variables. This detailed account of facilitation constructs was deemed a prerequisite to answer the underlying research question "*How does facilitation influence team effectiveness?"* and to structure them into the IMO model.

4. Results

Table 1 lists study design parameters used in quantitative studies, comprising information on research methodology, sample size, subjects, task type, and team size.

In 27 articles, laboratory experiments were chosen as the primary research methodology. Other empirical research methodologies included one field study, two mixed methods designs, one multi-agent simulation, one questionnaire study, one quantitative literature analysis and three meta-analyses. Most studies had sample sizes between 101 and 300 participants. Only one study reported a sample size higher than 500. Predominantly, undergraduate students participated as subjects, followed by graduate students. One field study relied on US Air Force staff, which represents one of the two cases in which subjects originated from practice. Many studies associated the specific tasks to general task types as described in McGrath's group task circumplex [40]. The authors categorized those papers that did not explicitly state the type of the task. The table shows that most studies required teams to work on creativity, judgement, and intellective tasks. With respect to team size, none of the papers in the review investigated teams of 2. The majority of papers defined team sizes between 3 and 5 or above 5 team members.

Table 1: Study design parameters

Research Methodology	Field study	[41]
	Laboratory experiment	[8-11, 18-21, 23, 25, 27-31, 42-53]
	Mixed methods	[38, 54]
	Multi-agent simulation	[13]
	Questionnaire	[55]
	Meta-analysis and quant. review	[4, 24, 56, 57]
Sample Size	0 – 100	[8, 10, 18, 20, 38, 43, 46, 49]
	101 – 300	[9, 22, 27-31, 45, 48, 50-53]
	301 – 500	[25, 42]
	> 500	[21]
Subjects	Post-graduate	[10, 11, 20, 29]
	Professionals	[38, 41]
	Undergraduate	[8, 9, 11, 18, 21-23, 27, 30, 31, 42, 43, 45, 46, 48-53]
Task Type	Cognitive conflict	[49]
	Creativity task	[9, 22, 23, 25, 31, 41, 46, 48, 50]
	Intellective task	[10, 11, 20, 23, 27, 31, 52]
	Judgment task (decision-making)	[8, 9, 18, 21, 22, 25, 28, 30, 38, 41, 43, 45, 46, 50-52]
	Planning task	[29, 53]
Team Size	< 3 team members	n/a
	3-5 team members	[8-11, 22, 23, 25, 27, 28, 43, 46, 50, 52, 53]
	> 5 team members	[11, 18, 21, 29-31, 38, 42, 45, 48, 49, 53]

Figure 2 depicts the synthesis of reviewed facilitation research as part of the IMO model. The differentiation of outcomes into automated, external

[1] Link to Senior Scholar's Basket of Journals: http://ais.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=346

assessment, and team perception was induced from the synthesis of literature. The oval white boxes represent the fine-grained level and describe classes of synthesized constructs. The class labels of team outcomes, such as satisfaction or usability are based on a review analysis on GDSS experimental research [57]. Classes were associated to team process and emergent states when the respective paper performed a process-oriented analysis. A study was deemed process-oriented when it examined a construct's change over time. A detailed list of constructs and their association to classes can be taken from the Appendix.

Inputs

Facilitation. A*utomated facilitation* was dealt with on three levels of granularity. Coarse-grained studies focused on a general description of the technology used [29-31, 41-43, 46, 47, 49, 52, 57] with meta-analytic support [4, 56]. Medium level studies measured process guidance [10] and process restrictiveness [13, 45] with meta-analytic support [4, 24]. Fine-grained studies assessed feedforward [11, 18, 27] and feedback [8, 11, 18, 27]. Apart from that, studies described automated facilitation according to their support for anonymity, parallelism, meeting memory [28, 31, 38, 50, 51], and brainstorming [47, 48]. Papers dealing with *human facilitation* investigated content facilitation [42, 45-48], process facilitation [8, 18, 20, 22, 23, 25, 29, 31, 41, 42, 45, 55, 57] with meta—analytic support [4, 24, 56], and/or technology facilitation [8, 18, 20, 23, 29, 38, 41, 45, 57]. Thus, the structural dimensions of human facilitation differentiating between content, process, and technical facilitation are supported [3]. Some studies considered specific facilitation styles [21] comprising communication style [53] and prompting style [9]. The facilitation type *training* was understood as educating team members about structures of technology or norms and was considered as a further type of facilitation [13, 24, 25].

Contextual Input Factors. One study included national culture as an independent construct [52]. This construct was associated to the class *culture* and categorized into organizational context which also describes characteristics of the environment beyond organizational boundaries [34]. With respect to the team context, a few studies considered constructs related to the class *task characteristics.* Studies measured task sensitivity [48], task type [4, 49, 52], and agenda structure [21]. Many studies considered *team characteristics*, including group history [48, 56], task/technology fit [13, 44] with meta-analytic support [24], or leadership [20, 22, 23, 28, 43, 50, 51, 53] with meta-analytic support [56]. Only two studies specified constructs categorized as *technology characteristics*, which dealt amongst others with ease of use, reliability or enjoyment [53]. None of the studies specified team member specific attributes.

Mediators

Team processes. The review revealed that only one process-oriented study differentiated between team processes. That study distinguished team processes into leadership and decision-making processes [38]. In the other cases, team process were not further sub-divided. Process-orientation was included by linking measures across different time intervals [38], tasks [44], sessions [50], or agenda points [8]. The class *appropriation* was associated to *teamwork processes* and consists of the constructs communication support fit, information processing support fit, and appropriation changes [44]. The class *creativity* consists of a construct that measured the dimensions fluency, flexibility, and originality [50]. The class *performance* includes the constructs perceived meeting effectiveness [38, 44]. The class *quality* consists of accuracy of solution [8] and decision quality [44]. The class *satisfaction* assessed how happy the team member with the meeting [38] and the class *time* measured how long the team worked on the task [44]. The review highlights that none of the reviewed papers assessed taskwork processes.

Emergent States. Related research describes emergent stats as cognitive, motivational, and affective states of a team [35]. With one exception [38], our results indicate that emergent states were not yet explicitly considered in reviewed process-oriented studies. Reviewed studies performed a process-oriented analysis on the constructs group potency [50], equality of participation [38], and group cohesion [38] that were associated to the class *behavior pattern* [34].

Outcomes

The review shows that the effects of facilitation have been tested on many different outcome criteria, categorized into automated, external assessment, and team perception. Automated outcome criteria describe dependent constructs that can be collected with the help of technology, e.g., measuring time or counting messages deduced from communication logs. External assessment describes a rating of team outcomes by people outside the team, e.g., raters, experts, or coders. Team perception refers to collecting opinions of the study participants.

Automated. *Learning* was measured with model understanding [11] and *performance* assessed costs, revenues, or rewards of the final group outcome [8, 10, 42, 43]. The class *behavior pattern* includes the widely adopted and meta-analytic supported [56] construct group consensus. Many papers adopted a formula for

measuring group consensus by taking into account pre-meeting and post-meeting consensus [20, 27, 30] while others conceptualized full agreement [23, 31] or the rounds until consensus [52]. *Productivity* was measured by counting the number of ideas, contributions or messages [9, 10, 28-30, 45, 57] supported by meta-analysis [4, 24] and generated during the team process. *Quality* was operationalized with quality of decision [28] and *time* usually measured minutes to complete the task [44] with meta-analytic support [4, 24], a part of the overall collaboration process [10] or to reach a decision [11, 27, 29-31] with meta-analytic support [56]. *Performance* and *time* are frequently measured, whereas *quality* and *learning* were each measured only once.

External assessment. Two studies adopted adaptive structuration concepts, labeled in this paper as *appropriation*, and operationalized them with the construct (un)faithful use of technology or appropriation change [25, 44]. C*reativity* [9, 10, 51] was amongst others measured along the dimension fluency, flexibility, and originality [51]. Two studies applied cognitive mapping to assess knowledge acquisition [45, 46]. They were associated to the class *learning* together with the construct information learned [30]. *Behavior patterns* comprise constructs that measured participation [31, 46], extent of elaboration [9] and uninhibited behavior [31]. *Productivity* was typically operationalized with the number of unique ideas or solutions [9, 18, 23, 29-31, 47, 48] supported by meta-analysis [56]. *Quality* was measured in most studies on a fine-grained level of granularity comprising, quality of decision [23, 25, 30, 31, 44] supported by meta-analysis [4, 24, 56], feedback [46], ideas [29], and outputs [21]. Only one study assessed quality as a coarse-grained construct [41].

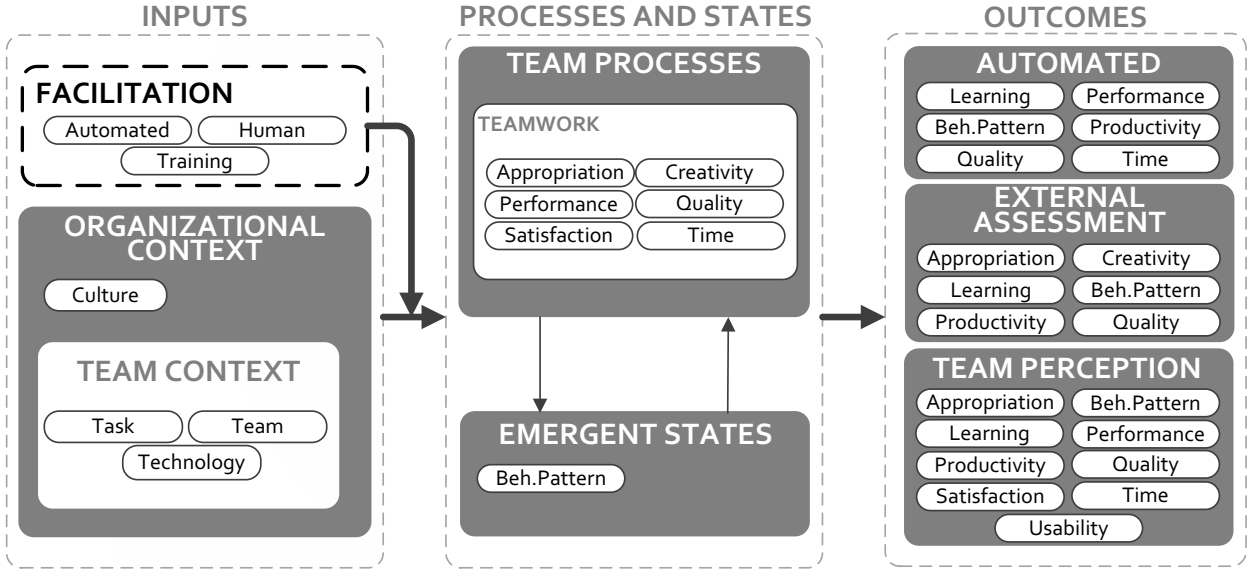

Figure 2: Synthesized Overview of Facilitation Research

Team Perception. The class *appropriation* was measured with perceived task-technology fit [44] and faithfulness of appropriation [27]. Concerning the class *behavior pattern*, studies measured amongst others group cohesion [18, 38, 42, 49], communication barrier [46], depth of evaluation [11], domination [46], evaluation apprehension [49], production blocking [49], or group potency [50]. Few studies investigated outcomes related to the class *learning* measured with reported learning [49] and post-meeting understanding [11, 28]. *Performance* was amongst others assessed with goal setting [51], perceived meeting effectiveness [18, 38], or perceived project impact [38]. *Productivity* included the measures information credibility and information use [30]. *Quality* was in the focus of many studies and comprised quality of decision [11, 22, 27, 28] and decision confidence [10, 11, 22, 27]. *Satisfaction* represents one of the most often adopted constructs. Studies either measured satisfaction on a coarse-grained level [23, 30, 31, 41, 53] or with various specified constructs including satisfaction with outcome [21, 43] supported by meta-analysis [4, 24, 56], process [18, 21, 22, 28, 43] supported by meta-analysis [4, 24, 56], contribution quality [45], decision quality [28, 29], decision scheme [11], time to decision [29], opportunity to contribute [29], agenda [21], meeting [38], task [21], and the facilitator [21]. Buying intentions [53], positive word-of-mouth [53], and affective reward [49] were also operationalized as constructs measuring satisfaction. One study assessed *time* by measuring the perception of time to completion [41]. Some studies investigated the class *usability*

measuring ease-of-use [18], challenge [11], comfort [11] and respect [11] of a specific technology.

5. Research Agenda and Limitations

The goal of this paper was to understand what constructs have been studied in connection with facilitation and what remains open for future research. It appears that facilitation research has not yet tested complex research models in which constructs describing organizational context, team context, and team member were included as independent variables. It was somewhat surprising that only four studies adopted a process-oriented approach and conceptualized team processes and/or emergent states as mediators that, in turn, influence team outcomes [8, 38, 50, 53]. One reason for this could be that there is little consensus about what constitutes taskwork processes and emergent states requiring more research on their structural dimensions. Consequently, results suggest that current quantitative studies pay little attention to team processes mediating inputs and outcomes. Yet, related work provides compelling arguments why future research should open the black box of team processes and emergent states [27]. In this regard, past research highlights the influence that facilitation has on team processes [7]. Facilitation is understood to have shapes and guides social structures during meetings [12] and that facilitators may exert intentional or unintentional power on the team [3]. What follows is a research agenda suggesting why process-oriented designs are deemed important and how future research could address this open issue. This section closes with an outline of limitations of our approach.

This paper argues that human and automated facilitation should be conceptualized as inputs and moderators depending on their state of enactment. When drawing on adaptive structuration theory (AST), facilitation can be understood as an input since technology, e.g., GDSS configuration, as well as facilitation instruments, e.g., meeting agenda, provide social structures, which can be described with structural features and spirit [58]. In this respect, structural features denote the specific components of the technology, whereas spirit describes the intended use of structural features [38]. AST provides additional grounds to conceptualize facilitation as a moderator due to the facilitator's influence on the appropriation process [4, 7, 53]. Thus, it is argued that social structures are enacted by the human or automated facilitator through the intentional application of actions or decisions during the team process [12]. The following example strives to picture this dual impact of facilitation.

Facilitation as input: An external facilitator is going to facilitate a team meeting and has prepared amongst others a meeting agenda and a set of tools to support different phases of collaboration. Both facilitation instruments (technology and meeting agenda) intend to enact social structures, which are templates for planning and accomplishing tasks.

Facilitation as moderator: Team members enact social structures during the meeting by running through the meeting agenda and using different tools at various points during their collaboration. Yet, the facilitator might intentionally intervene into the processes to boost, impede or change social structures.

Consequently, we propose to model facilitation as a set of interventions that moderate the relation between inputs and team processes.

In addition, the results show that time was conceptualized differently among all process-oriented studies. It is argued that the differentiation between episodic cycles adds comparability among process-oriented studies. Many facilitation studies differentiate between phases of collaboration, such as moving from brainstorming to convergence. A team process can be structured into six phases or patterns comprising generate, reduce, clarify, organize, evaluate, and build commitment [59]. Therefore, episodic cycles might be conceptualized as collaboration phases and process-oriented studies could assess team processes and emergent states at the end of each collaboration phase.

The conceptualization of team processes and emergent states as mediators is another central point. We argue that it is currently unclear how to appropriately assess mediators for facilitation research. Instead of reusing measures of team outcome as mediating constructs [e.g., 38, 44], it is suggested to develop corresponding process metrics. Researchers can select from a range of process metrics as developed in the field of process analysis and mining. Examples are the Heuristic Miner [60] or the Genetic Miner [61]. In addition to these process metrics, we would need to measure enacted social structures, i.e. behavior patterns. Some of the identified mediating constructs, such as group potency or group cohesion, could be regarded as candidates for behavior patterns that are assessed with one or multiple process metrics. However, more complex frameworks for team processes and emergent states are required to allow structuring process metrics and associated behavior patterns to better understand their potential interrelations.

Expanding facilitation research to include team processes and emergent states might also require other means for analysis. So far, only a few of the mentioned constructs can be collected in an automated fashion, such as task time [e.g., 44]. Process mining techniques

may be useful to support process-oriented analysis [62]. Teams perform many activities during collaboration such as communicating or writing documents. Consequently, their collaboration traces manifest in communication logs that can be analyzed with e.g., communication analysis [63] or document change logs that can be analyzed with e.g., history flow visualizations [64]. Automated classification such as sentiment analysis [65] are not yet sophisticated enough to allow the automated identification and description of complex behavior patterns as required for facilitation research, e.g., the negative evaluation of proposed solution alternatives. However, many constructs still need to be assessed by external people or even gathered from team members' perceptions. In the case of external assessment, communication analysis has a long tradition in small group research [e.g., 66, 67]. Recent research argues that specifically tailored coding frameworks show promising avenues for analyzing team processes with the help of behavior patterns, such as negative evaluation of solution alternatives, consensus-oriented behavior, breadth and depth of evaluation or effort spend on coordination [63]. Nonetheless, a comprehensive examination of process metrics describing behavior patterns has the potential to greatly enhance our understanding of how facilitation affects teamwork and taskwork processes as well as emergent states and, in turn, their effects on team outcomes.

Hence, we suggest three major streams for future research. *Firstly*, more research is required that tests the effects of facilitation on team outcomes in complex environments by considering various inputs, including organizational, team and individual contexts. *Secondly*, synthesizing research needs to puts forward constructs providing structural dimensions of teamwork and taskwork processes and emergent states in relation with facilitation. *Thirdly*, scholars need to develop process metrics for teamwork and taskwork processes drawing on e.g., process mining techniques, and elicit behavior patterns as well as emergent states.

Limitations. Our review is based on a traceably identified and analyzed yet still limited set of papers preventing to ground the drawn conclusions on the potential stock of knowledge available on facilitation. The review considered in its first round only journals of the IS domain, which might have limited the variety of facilitation studies in other domains such as social psychology or small group research. This limitation was mitigated to some extent by the backward and forward loop of the review process. Moreover, the review focuses on quantitative or mixed methods research studies. Much research on facilitation has used qualitative designs, which were not considered. These limitations were mitigated by drawing on conceptual work that was also identified as part of this review process.

6. Conclusion

This paper performed a structured literature review aimed at improving our understanding of how facilitation can influence team effectiveness. Results show that the state-of-the-art of facilitation research has generated a considerable stock of knowledge. The paper presents a comprehensive and structured set of input and outcome measures that allow assessing a team's effectiveness. Results indicate that more research is required on team processes and emergent states. The paper also identifies three avenues for future research which demand to open the black box of team processes in facilitation research and to intentionally analyze changes of team processes and emergent states during team facilitation with process metrics. This kind of process-oriented research has implication for research in practice. An improved understanding of facilitation from a process-oriented perspective promises to guide the design of technology to better support the various phases of collaboration. Current facilitation techniques might benefit from an improved understanding of how facilitation impacts team processes and emergent states so that predictions could be made what interventions trigger which behavior patterns resulting in recommendations for human facilitators or, on a more visionary string, automated facilitation that is sensitive to team processes and emergent states.

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7. References

[1] Nunamaker, J.F., Dennis, A.R., Valacich, J.S., Vogel, D., and George, J.F., "Electronic Meeting Systems", Communications of the ACM, 34(7), 1991, pp. 40-61.

[2] De Vreede, G.-J., Boonstra, J., and Niederman, F., "What Is Effective GSS Facilitation? A Qualitative Inquiry into Participants' Perceptions", Proceedings of the 35th Annual Hawaii International Conference on System Sciences, HICSS, 2002, pp. 616-627.

[3] Griffith, T.L., Fuller, M.A., and Northcraft, G.B., "Facilitator Influence in Group Support Systems: Intended and Unintended Effects", Information Systems Research, 9(1), 1998, pp. 20-36.

[4] Dennis, A.R., and Wixom, B.H., "Investigating the Moderators of the Group Support Systems Use with Meta-Analysis", Journal of Management Information Systems, 18(3), 2002, pp. 235-257.

[5] Macaulay, L.A., and Alabdulkarim, A., "Facilitation of E-Meetings: State-of-the-Art Review", Proceedings of the 2005

IEEE International Conference on e-Technology, e-Commerce and e-Service 2005, pp. 728-735.
[6] Kozlowski, S.W.J., and Bell, B.S., "Work Groups and Teams in Organizations": Handbook of Psychology, John Wiley & Sons, Inc., 2003
[7] Bostrom, R.P., Anson, R., and Clawson, V.K., "Group Facilitation and Group Support Systems", in (Jessup, L.M., and Valacich, J.S.): Group Support Systems: New Perspectives, Macmillan, New York, 1993, pp. 146-168.
[8] Reagan-Cirincione, P., "Improving the Accuracy of Group Judgment: A Process Intervention Combining Group Facilitation, Social Judgment Analysis, and Information Technology", Organizational Behavior and Human Decision Processes, 58(2), 1994, pp. 246-270.
[9] Santanen, E.L., Briggs, R.O., and Vreede, G.-J.D., "Causal Relationships in Creative Problem Solving: Comparing Facilitation Interventions for Ideation", Journal of Management Information Systems, 20(4), 2004, pp. 167-197.
[10] Barkhi, R., "The Effects of Decision Guidance and Problem Modeling on Group Decision-Making", Journal of Management Information Systems, 18(3), 2002, pp. 259-282.
[11] Limayem, M., and Desanctis, G., "Providing Decisional Guidance for Multicriteria Decision Making in Groups", Information Systems Research, 11(4), 2000, pp. 386-401.
[12] Niederman, F., Briggs, R.O., De Vreede, G.J., and Kolfschoten, G.L., "Extending the Contextual and Organizational Elements of Adaptive Structuration Theory in GSS Research", Journal of the Association for Information Systems, 9(10), 2008, pp. 633-652.
[13] Nan, N., and Johnston, E.W., "Using Multi-Agent Simulation to Explore the Contribution of Facilitation to GSS Transition", Journal of the Association for Information Systems, 10(3), 2009, pp. 252-277.
[14] Niederman, F., Beise, C.M., and Beranek, P.M., "Issues and Concerns About Computer-Supported Meetings: The Facilitator's Perspective", MIS Quarterly, 20(1), 1996, pp. 1-22.
[15] Hayne, S.C., "The Facilitators Perspective on Meetings and Implications for Group Support Systems Design", ACM SIGMIS Database, 30(3-4), 1999, pp. 72-91.
[16] De Vreede, G.-J., Niederman, F., and Paarlberg, I., "Towards an Instrument to Measure Participants' Perceptions on Facilitation in Group Support Systems Meetings", Group Decision and Negotiation, 11(2), 2002, pp. 127-144.
[17] Ackermann, F., Franco, L.A., Gallupe, B., and Parent, M., "GSS for Multi-Organizational Collaboration: Reflections on Process and Content", Group Decision and Negotiation, 14(4), 2005, pp. 307-331.
[18] Wong, Z., and Aiken, M., "Automated Facilitation of Electronic Meetings", Information & Management, 41(2), 2003, pp. 125-134.
[19] Tan, B., Wei, K.-K., and Lee-Partridge, J., "Effects of Facilitation and Leadership on Meeting Outcomes in a Group Support System Environment", European Journal of Information Systems, 8(4), 1999, pp. 233-246.
[20] Dickson, G.W., Partridge, J.-E.L., and Robinson, L.H., "Exploring Modes of Facilitative Support for GDSS Technology", MIS Quarterly, 17(2), 1993, pp. 173-194.
[21] Hostager, T.J., Lester, S.W., Bergmann, M., and Ready, K.J., "Matching Facilitator Style and Agenda Structure in Group Support Systems: Effects on Participant Satisfaction and Group Output Quality", Information Resources Management Journal, 16(2), 2003, pp. 56-72.
[22] Tan, B.C.Y., Wei, K.K., and Lee-Partridge, J.E., "Effects of Facilitation and Leadership on Meeting Outcomes in a Group Support System Environment", European Journal of Information Systems, 8(4), 1999, pp. 233-246.
[23] George, J.F., Dennis, A.R., and Nunamaker Jr, J., "An Experimental Investigation of Facilitation in an Ems Decision Room", Group Decision and Negotiation, 1(1), 1992, pp. 57-70.
[24] Dennis, A.R., Wixom, B.H., and Vandenberg, R.J., "Understanding Fit and Appropriation Effects in Group Support Systems Via Meta-Analysis", MIS Quarterly, 25(2), 2001, pp. 167-193.
[25] Wheeler, B.C., and Valacich, J.S., "Facilitation, GSS, and Training as Sources of Process Restrictiveness and Guidance for Structured Group Decision Making: An Empirical Assessment", Information Systems Research, 7(4), 1996, pp. 429-450.
[26] Silver, M.S., "Decisional Guidance for Computer-Based Decision Support", MIS Quarterly, 15(1), 1991, pp. 105-122.
[27] Limayem, M., Banerjee, P., and Ma, L., "Impact of GDSS: Opening the Black Box", Decision Support Systems, 42(2), 2006, pp. 945-957.
[28] Kim, Y., Hiltz, S.R., and Turoff, M., "Coordination Structures and System Restrictiveness in Distributed Group Support Systems", Group Decision and Negotiation, 11(5), 2002, pp. 379-404.
[29] Dowling, K.L., and St Louis, R.D., "Asynchronous Implementation of the Nominal Group Technique: Is It Effective?", Decision Support Systems, 29(3), 2000, pp. 229-248.
[30] Dennis, A.R., "Information Exchange and Use in Group Decision Making: You Can Lead a Group to Information, but You Can't Make It Think", MIS Quarterly, 20(4), 1996, pp. 433-457.
[31] George, J.F., Easton, G.K., Nunamaker, J., and Northcraft, G.B., "A Study of Collaborative Group Work with and without Computer-Based Support", Information Systems Research, 1(4), 1990, pp. 394-415.
[32] Nunamaker Jr, J.F., Briggs, R.O., Mittleman, D.D., Vogel, D.R., and Balthazard, P.A., "Lessons from a Dozen Years of Group Support Systems Research: A Discussion of Lab and Field Findings", Journal of Management Information Systems, 13(3), 1996, pp. 163-207.
[33] Cohen, S.G., and Bailey, D.E., "What Makes Teams Work: Group Effectiveness Research from the Shop Floor to the Executive Suite", Journal of Management, 23(3), 1997, pp. 239-290.
[34] Mathieu, J., Maynard, M.T., Rapp, T., and Gilson, L., "Team Effectiveness 1997-2007: A Review of Recent Advancements and a Glimpse into the Future", Journal of Management, 34(3), 2008, pp. 410-476.
[35] Marks, M.A., Mathieu, J.E., and Zaccaro, S.J., "A Temporally Based Framework and Taxonomy of Team Processes", The Academy of Management Review, 26(3), 2001, pp. 356-376.
[36] Morgan, B.B., Salas, E., and Glickman, A.S., "An Analysis of Team Evolution and Maturation", The Journal of General Psychology, 120(3), 1993, pp. 277-291.

[37] Kozlowski, S.W.J., and Ilgen, D.R., "Enhancing the Effectiveness of Work Groups and Teams", Psychological Science in the Public Interest, 7(3), 2006, pp. 77-124.
[38] Dennis, A.R., and Garfield, M.J., "The Adoption and Use of GSS in Project Teams: Toward More Participative Processes and Outcomes", MIS Quarterly, 27(2), 2003, pp. 289-323.
[39] Webster, J., and Watson, R.T., "Analyzing the Past to Prepare for the Future: Writing a Literature Review", MIS Quarterly, 26(2), 2002, pp. xiii-xxiii.
[40] Mcgrath, J.E., "Time, Interaction, and Performance (Tip): A Theory of Groups", Small Group Research, 22(2), 1991, pp. 147-174.
[41] Adkins, M., Burgoon, M., and Nunamaker Jr, J.F., "Using Group Support Systems for Strategic Planning with the United States Air Force", Decision Support Systems, 34(3), 2003, pp. 315-337.
[42] Anson, R., Bostrom, R., and Wynne, B., "An Experiment Assessing Group Support System and Facilitator Effects on Meeting Outcomes", Management Science, 41(2), 1995, pp. 189-208.
[43] Barkhi, R., Jacob, V.S., Pipino, L., and Pirkul, H., "A Study of the Effect of Communication Channel and Authority on Group Decision Processes and Outcomes", Decision Support Systems, 23(3), 1998, pp. 205-226.
[44] Fuller, R.M., and Dennis, A.R., "Does Fit Matter? The Impact of Task-Technology Fit and Appropriation on Team Performance in Repeated Tasks", Information Systems Research, 20(1), 2009, pp. 2-17.
[45] Khalifa, M., Kwok, R.-W., and Davison, R., "The Effects of Process and Content Facilitation Restrictiveness on GSS-Mediated Collaborative Learning", Group Decision and Negotiation, 11(5), 2002, pp. 345-361.
[46] Kwok, R.C.-W., Ma, J., and Vogel, D.R., "Effects of Group Support Systems and Content Facilitation on Knowledge Acquisition", Journal of Management Information Systems, 19(3), 2003, pp. 185-230.
[47] Lynch, A.L., Murthy, U.S., and Engle, T.J., "Fraud Brainstorming Using Computer-Mediated Communication: The Effects of Brainstorming Technique and Facilitation", The Accounting Review, 84(4), 2009, pp. 1209-1232.
[48] Pinsonneault, A., Barki, H., Gallupe, R.B., and Hoppen, N., "Electronic Brainstorming: The Illusion of Productivity", Information Systems Research, 10(2), 1999, pp. 110-133.
[49] Reinig, B.A., and Shin, B., "The Dynamic Effects of Group Support Systems on Group Meetings", Journal of Management Information Systems, 19(2), 2002, pp. 303-323.
[50] Sosik, J.J., Avolio, B.J., and Kahai, S.S., "Effects of Leadership Style and Anonymity on Group Potency and Effectiveness in a Group Decision Support System Environment", Journal of Applied Psychology, 82(1), 1997, pp. 89-103.
[51] Sosik, J.J., Avolio, B.J., and Kahai, S.S., "Inspiring Group Creativity Comparing Anonymous and Identified Electronic Brainstorming", Small Group Research, 29(1), 1998, pp. 3-31.
[52] Tan, B.C., Wei, K.-K., Watson, R.T., Clapper, D.L., and Mclean, E.R., "Computer-Mediated Communication and Majority Influence: Assessing the Impact in an Individualistic and a Collectivistic Culture", Management Science, 44(9), 1998, pp. 1263-1278.
[53] Van Dolen, W.M., Dabholkar, P.A., and De Ruyter, K., "Satisfaction with Online Commercial Group Chat: The Influence of Perceived Technology Attributes, Chat Group Characteristics, and Advisor Communication Style", Journal of Retailing, 83(3), 2007, pp. 339-358.
[54] Hengst, M.D., and Vreede, G.-J.D., "Collaborative Business Engineering: A Decade of Lessons from the Field", Journal of Management Information Systems, 20(4), 2004, pp. 85-114.
[55] Niederman, F., and Volkema, R.J., "The Effects of Facilitator Characteristics on Meeting Preparation, Set up, and Implementation", Small Group Research, 30(3), 1999, pp. 330-360.
[56] Benbasat, I., and Lim, L.-H., "The Effects of Group, Task, Context, and Technology Variables on the Usefulness of Group Support Systems a Meta-Analysis of Experimental Studies", Small Group Research, 24(4), 1993, pp. 430-462.
[57] Fjermestad, J., and Hiltz, S.R., "An Assessment of Group Support Systems Experimental Research: Methodology and Results", Journal of Management Information Systems, 15(3), 1998, pp. 7-149.
[58] Desanctis, G., and Poole, M.S., "Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory", Organization Science, 5(2), 1994, pp. 121-147.
[59] De Vreede, G.J., Briggs, R.O., and Massey, A.P., "Collaboration Engineering: Foundations and Opportunities: Editorial to the Special Issue on the Journal of the Association of Information Systems", Journal of the Association for Information Systems, 10(3), 2009, pp. 121-137.
[60] Weijters, A.J.M.M., and Ribeiro, J.T.S., "Flexible Heuristics Miner (Fhm)", IEEE Symposium on Computational Intelligence and Data Mining, 2011, pp. 310-317.
[61] De Medeiros, A.A., Weijters, A.J., and Van Der Aalst, W.M., "Genetic Process Mining: An Experimental Evaluation", Data Mining and Knowledge Discovery, 14(2), 2007, pp. 245-304.
[62] Van Der Aalst, W.M., "Exploring the CSCW Spectrum Using Process Mining", Advanced Engineering Informatics, 21(2), 2007, pp. 191-199.
[63] Seeber, I., Maier, R., and Weber, B., "Macrocognition in Collaboration: Analyzing Processes of Team Knowledge Building with CoPrA", Group Decision and Negotiation, 22(5), 2013, pp. 915-942.
[64] Viégas, F.B., Wattenberg, M., and Dave, K., "Studying Cooperation and Conflict between Authors with History Flow Visualizations", Proceedings of the SIGCHI conference on Human factors in computing systems, 2004, pp. 575-582.
[65] Prabowo, R., and Thelwall, M., "Sentiment Analysis: A Combined Approach", Journal of Informetrics, 3(2), 2009, pp. 143-157.
[66] Bales, R.F., Interaction Process Analysis: A Method for the Study of Small Groups, Addison-Wesley, Oxford, England, 1950.
[67] Poole, M.S., and Holmes, M.E., "Decision Development in Computer-Assisted Group Decision-Making", Human Communication Research, 22(1), 1995, pp. 90-127.

Appendix

INPUTS

FACILITATION – TRAINING

Appropriation training [24]
Heuristics training [13, 25]

FACILITATION – TECHNOLOGY

(Cognitive) feedforward [11, 18, 27]
Structural feature – Anonymity, parallelism, meeting memory [28, 31, 38, 50, 51]
(Cognitive) feedback [8, 11, 18, 27]
Electronic brainstorming (nominal, interactive, anonymity) [47, 48]
G(D)SS level [4, 29-31, 41-43, 46, 47, 49, 52, 56, 57]
Process Guidance [10]
Process restrictiveness [4, 13, 45]

FACILITATION - HUMAN

Content facilitator [42, 45-48]
Facilitation style (relationship vs. task) [21]
Communication Style [53]
Process facilitator [4, 8, 18, 20, 22-25, 29, 31, 41, 42, 45, 55-57]
Prompting Style [9]
Technical facilitator [8, 18, 20, 23, 29, 38, 41, 45, 57]

TASK

Agenda structure (relationship vs. task) [21]
Task Type [4, 49, 52]
Topic sensitivity [48]

TEAM CHARACTERISTICS

Group history (ad–hoc, established) [48, 56]
Group involvement [53]
Group receptivity [53]
Group similarity [53]
Task/Technology Fit [13, 24, 44]
Leadership (incl. communication style and leader) [20, 22, 23, 28, 43, 50, 51, 53, 56]

TECHNOLOGY CHARACTERISTICS

Perceived ease of use [53]
Perceived enjoyment [53]
Perceived reliability [53]
Perceived speed to delivery [53]
Perceived control [53]

ORGANIZATIONAL CONTEXT

National Culture [52]

MEDIATORS

TEAM PROCESSES

A – Appropriation changes [44]
A – perceived communication support fit [44]
A – perceived information processing support fit [44]
C – Idea-generation effectiveness [50]
Pe – Perceived meeting effectiveness [38, 44]
Q – Accuracy of solution [8]
Q – Decision quality [44]
S – Satisfaction with the meeting [38]
T – Task time [44]

EMERGENT STATES

BP –Participation [38]
BP – Group potency [50]
BP – Group Cohesion [38]

OUTCOMES

AUTOMATED

BP – Group consensus/Agreement/Majority Influence [4, 20, 22, 23, 27, 30, 31, 52]
L – Model understanding [11]
P – Number of contributions/messages/ideas [4, 9, 10, 24, 28-30, 45, 57]
Pe – Accuracy of solution [8]
Pe – Member reward [10]
Pe – Performance [42, 43]
Pe – Performance deviation [43]
Pe – Performance variability [43]
Q – Quality of decision [28]
T – Time for task [4, 24, 44]
T – Time to converge [10]
T – Time to decision [11, 27, 29-31, 56]

EXTERNAL ASSESSMENT

A – Appropriation changes [44]
A – Faithful use of GSS [25]
A – Unfaithful use of GS [25]
BP – Elaboration coefficient [9]
BP – Extent of uninhibited behavior [31]
BP – Participation [31, 46]
C – creativity (fluency, flexibility, originality) [51]
C – Creativity score [9]
C – Creativity solution concentration [9]
C – number of diverse solutions [10]
C – report effectiveness (imaginativeness, innovativeness, value addition) [50]
L – knowledge commonality [46]
L – information learned [30]
L – knowledge integration [45, 46]
L – knowledge complexity [45, 46]
P – % of available optimal decisions [30]
P – % of available preference neutral info [30]
P – % of available preference opposing info [30]
P – Number of common information [30]
P – Number of duplicate solutions [9]
P – number of nonsolutions [9]
P – Number of off–topic comments [9]
P – Number of unique/relevant ideas/solutions [9, 18, 23, 29-31, 47, 48, 56]
Q – Quality of decision [4, 23-25, 30, 31, 44, 56]
Q – Quality of feedback [46]
Q – Quality of ideas [29]
Q – Quality of output [21, 41, 50]
BP – Truthfulness of information exchange [10, 43]

TEAM PERCEPTION

A – Faithfulness of appropriation [27]
A – Perceived task–technology fit [44]
BP – (Group) Cohesion [18, 38, 42, 49]
BP – Communication Barrier [46]
BP – Cooperation in Learning [46]
BP – Depth of Evaluation [11]
BP – Domination [46]
BP – Evaluation apprehension[49]
BP – Free riding [49]
BP – Group potency [50]
BP – Group Process [42]
BP – Production blocking [49]
BP –Participation [38]
BP – Sucker effect [49]
L – Reported learning [49]
L – Post–Meeting Understanding [11, 28]
Pe – Goal setting [51]
Pe – Individualized consideration [51]
Pe – Inspirational leadership [51]
Pe – Intellectual stimulation [51]
Pe – Perceived meeting effectiveness [18, 38]
Pe – Perceived project impact [38]
P – Information credibility [30]
P – Information use [30]
Q – Decision confidence [10, 11, 22, 27]
Q – Quality of decision [11, 22, 27, 28]
S – Affective reward [49]
S – Buying intentions [53]
S – Positive word–of–mouth [53]
S – Satisfaction [23, 30, 31, 41, 53]
S – Satisfaction with contribution quality (own, other, overall) [45]
S – Satisfaction with decision quality [28, 29]
S – Satisfaction with decision scheme [11]
S – Satisfaction with opportunity to contribute [29]
S – Satisfaction with the software [21]
S – Satisfaction with the agenda [21]
S – Satisfaction with the facilitator [21]
S – Satisfaction with the group outcome / solution [4, 21, 24, 43, 56]
S – Satisfaction with the group process [4, 18, 21, 22, 24, 28, 43, 56]
S – Satisfaction with the meeting [38]
S – Satisfaction with the task [21]
S – Satisfaction with time to decision [29]
T – Time for task [41]
U – GDSS – challenge/sense of achievement [11]
U – GDSS – comfort/enjoyment [11]
U – GDSS – Respect/appreciation [11]
U – GDSS ease–of–use [18]
U – GDSS use [27]

A – Appropriation
BP – Behavior pattern
C – Innovation
L – Learning
P – Productivity
Pe – Performance
Q – Quality
S – Satisfaction
T – Time
U – Usability