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An empirical study of the effectiveness of telepresence as a business meeting mode

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Abstract Telepresence is a technology that has emerged as a promising mode for conducting business meetings with distributed participants, since it enables an immersive lifelike experience. However, telepresence meetings are substantially more expensive than audio- and video-conferencing meetings. This paper examines the justification of using telepresence for meetings. Based on an extensive literature review, two research questions about the effectiveness of telepresence for achieving meeting objectives are formulated. These are then addressed in an empirical study consisting of two phases, conducted in a large multinational corporation in which telepresence is widely used. In Phase 1, a list of meeting objectives is compiled. In Phase 2, the effectiveness of telepresence is analyzed relative to audio-conferencing, video-conferencing, and face-to-face for these objectives, based on input from 392 meeting organizers. The results of the analysis indicate that although the effectiveness of telepresence is higher than the effectiveness of audio- and video-conferencing for several meeting objectives, it is not significantly different from the effectiveness of face-to-face for any objective.

Keywords Technology-enabled distributed meetings · Telepresence · Video-conferencing · Meeting objectives · Communication media effectiveness

1 Introduction

A business meeting is an organizational activity which involves synchronous[1] interaction between two or more people to achieve shared objectives in business [74, 96]. Meetings are essential in business operations and are traditionally organized in a face-to-face setting [18, 29]. For organizations that require distributed meetings between people across multiple and possibly distant locations, technology-enabled communication media such as audio- and video-conferencing offer an alternative. While being less costly and more environmentally friendly, the use of such technologies is considered to be less effective than the setting of a face-to-face meeting, because of deficient functionalities [19, 22, 46, 77].

Recently however, telepresence has emerged as a potentially effective alternative for conducting distributed meetings [79, 80]. Telepresence has been defined as "the use of technology to establish a sense of shared presence or shared space among geographically separated members of a group" [9, p. 27]. The number of telepresence installations in organizations worldwide is currently about 15,000 and 21,000 new installations are projected for 2015 [16].

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[1] Research on Electronic Meeting Systems incorporates the notion of temporal dispersion in meetings and also considers asynchronous meeting support [24, 62, 87].

Telepresence installations are set up to closely resemble a face-to-face meeting: participants at different locations see each other in true life size, can make eye contact, and each person's voice comes from the direction of their screen image (spatial audio). In addition, lighting and furniture across locations are matched for a seamless look and feel of local presence [1, 15].

This paper examines the effectiveness of telepresence as a meeting mode, by comparing it with two technology-enabled meeting modes (audio- and video-conferencing), as well as with face-to-face, for achieving a broad set of business meeting objectives. In this study, meeting mode effectiveness is considered to follow from a match between characteristics of the meeting mode and the requirements of the meeting objectives [84]. It is important to note that the ultimate selection of a meeting mode may be influenced not only by meeting mode effectiveness considerations, but also by the cost of utilizing a meeting mode, which includes travel-related expenditures, participants' time, and the cost of hardware and software [67].

It is important to recognize that in any meeting mode, interpersonal communication can be combined with the use of software applications and tools such as desktop sharing and white-boarding. However, the focus of this work is not on the use of such e-collaboration tools, but rather on the primary mode of interpersonal communication between meeting participants. Furthermore, it is important to distinguish between meeting mode effectiveness and the broader notion of meeting effectiveness. In particular, meeting effectiveness is not only influenced by the meeting mode used, but also by cultural, organizational, temporal, and situational factors [50]. Hence, for two business meetings conducted in the same meeting mode and with the same objectives, meeting effectiveness may still differ because, for example, some participants arrive late for one of the meetings, or some participants are under time pressures, etc. [73]. Since such factors are difficult to control or even detect in the empirical approach used in this study, its scope is limited to an analysis of the extent to which different technology-enabled distributed meeting modes (and the face-to-face meeting mode) facilitate the achievement of different types of meeting objectives.

While the role and effectiveness of communication media has been studied before, this study makes three contributions to the field. First, although both practitioners and researchers have highlighted the importance of understanding how and why managers use new communication media [31, 52, 58], there is as yet a lack of research on the effectiveness of telepresence. By addressing this gap, this research can provide valuable insight for organizations that are considering the acquisition of telepresence systems.

Second, while the effectiveness of communication media for multiple objectives in different organizational settings has been examined in the literature, prior studies have not examined these objectives in the specific context of a business meeting. In this study, the intended meeting objectives are considered as a basis for assessing meeting mode effectiveness, using a list of 19 different meeting objectives, which were identified in the literature.

A final distinction of this work is the empirical approach, in that the analysis is based on data about actual business meetings in a large global corporation. As telepresence is widely used by the employees of the corporation in this study, it provides a unique opportunity to examine this new technology in relation to conventional meeting modes and discern the meeting objectives it is suited for [28, 53, 69]. Since the data concerns actual, real-life meetings and objectives, it is distinct from most prior studies on media choice and media effectiveness, in which either hypothetical choices for specific situations or outcomes of experiments have been examined [25, 58].

This paper is organized as follows: In the next section, the related literature on communication media effectiveness and communication objectives is reviewed. Section 3 discusses audio-conferencing, video-conferencing, telepresence, and face-to-face and formulates research questions on the effectiveness of telepresence as a business meeting mode. In Sect. 4, the empirical work, analysis and results are presented. Finally, Sect. 5 concludes by discussing the findings and addressing the implications, limitations and further research directions.

2 Related work

This study draws upon a wide array of literature, including theories on social presence, media richness, media naturalness, and media synchronicity, and research on group support systems and technology adoption. In this section, this literature is reviewed, and then a list of communication objectives that have been identified therein is assembled.

2.1 Effectiveness of communication media

Several theories on the effectiveness of communication media have been proposed in the literature. Two influential perspectives are *social presence* and *media richness theory*, both of which characterize communication media in terms of their functionalities and consider a medium to be effective to the extent that its characteristics match the requirements of the task.

The social presence of a medium involves the extent to which it conveys the actual presence of communication

partners and enables them to experience psychological presence, and is comprised of several factors such as the medium's capacity to transmit information about tone of voice, gestures, facial expression, direction of looking, posture, touch, and nonverbal cues [77]. The underlying principle of social presence theory is that, to communicate effectively, the level of personal involvement and attention that is required for the communication task should be matched with the social presence of the medium [77]. Social presence is closely related to the concept of media richness [13, 70]. A medium is considered to be richer if it has the capacity to convey multiple verbal and nonverbal cues, allows for immediate feedback, uses natural language, and has personal focus [19]. Media richness theory highlights that ambiguous (or equivocal) and non-routine messages are open to interpretation, and therefore richer media are needed to communicate them effectively [19].

However, the principles of social presence and media richness theory are contradicted by findings in several studies [22, 46, 66, 82]. For example, in Markus [58], managers found lean media to be effective for equivocal communication. In a similar vein, Dennis and Kinney [25] found that using richer media does not improve performance for equivocal tasks. Such findings have motivated further theoretical developments. Based on an extensive literature review, and as a remedy for the inconclusive findings in prior studies, Te'eni [84] presented a cognitive–affective organizational communication model, which breaks away from 'integrated perceptions', such as social presence and media richness, and instead examines what each characteristic of the medium affords separately.

Dennis and his colleagues have developed media synchronicity theory, introducing specific media attributes [22, 23, 26]. Synchronicity refers to a shared pattern of coordinated behavior among individuals as they work together, and is determined by five media attributes: symbol sets, parallelism, transmission velocity, rehearsability, and reprocessability. Two micro-level communication processes in tasks were found to have different synchronicity needs—low synchronicity for conveyance of information, and high synchronicity for convergence of meaning. Since completing a task involves both processes, they concluded that the use of a variety of media, either concurrently or consecutively, improves communication effectiveness [22].

A number of theory refinements have further enhanced views of effective communication. Kock [46] proposed media naturalness theory, based on Darwinian evolution. Media naturalness refers to the (dis)similarity of the medium to the face-to-face setting, and is characterized by the extent to which the medium supports co-location, synchronicity, and the transmission of facial expressions, body language, and speech [46, 48]. His "psychobiological" model predicts that lower naturalness leads to higher cognitive effort in a collaborative task, preventing effective communication. In a similar vein, Ferran and Watts [31] used dual-process cognitive theory to show that there is an increased cognitive workload in video-conferencing versus face-to-face communication, and as a result people are less influenced by argument quality and more by heuristic cues such as source likeability. Likewise, Robert and Dennis [71] presented a cognitive-based view of social presence based on the elaboration likelihood model and identify a paradoxical impact of social presence on performance, which is that high social presence increases the motivation to process a message, but decreases the ability to process it.

The context in which a medium is used has been found to influence the medium's perception and effectiveness [7, 66]. Carlson and Zmud's [12] channel expansion theory posits that the perceived richness of a medium is influenced by the experience the user has with the medium, with other users, and with the task and the organizational context at hand. Likewise, electronic propinquity theory [93] incorporates the influence of the perceived choice set of media available to an individual, on perceived social presence of a medium. The perception of social presence is negatively impacted when the alternative medium supports a wider variety of cues, and vice versa. In addition, Hollingshead et al. [41] suggested that work groups develop communication norms with regards to media which can compensate for limitations of the medium (e.g., caps and emoticons in e-mail). Also, the compensatory adaptation model by Kock [45, 47] suggests that users of lean media overcompensate for the obstacles encountered and as a result generate better outcomes than expected.

Prior research on group support systems and on the acceptance of information technology also provides useful insights. These systems are found to be especially useful for the generation, organization, and prioritization of ideas [62] and their use is associated with less social inhibition and status equalization [2, 62]. Group support systems involve a set of tools to enhance the achievement of group tasks through communication, process structuring, and information processing support, across time and space [24, 30, 62, 97]. The ability to interact and collaborate asynchronously enhances the utility of group support systems. For example, Ocker et al. [63, 64] found that groups using asynchronous group support systems produced more creative solutions than did face-to-face groups, due to group members having more time to develop and present diverse opinions. The theory of task-technology fit underscores the importance of achieving a fit between the task and the supporting technology for performance [36, 97]. The fit-appropriation model [27], states that beyond fit, the appropriation support received in the form of training, facilitation, and software restrictiveness, further enhances the

effective use of group support systems. Testing the fit-appropriation model, Fuller and Dennis [34] found that teams using poor-fitting technology improved performance over time by innovating and adapting structures.

The Technology Acceptance Model (TAM) hypothesizes perceived usefulness and perceived ease of use to be fundamental determinants of user acceptance of technology [20, 21]. Perceived usefulness, which includes items such as perceived effectiveness, productivity, quality of work, and job performance, is considered to be the most important driver of intentional as well as actual technology usage [43, 51]. This model has been extended to account for the impact of social influence processes, facilitating conditions, pre- and post-implementation interventions, collaboration-related constructs, gender, age and experience [6, 88–90].

The above literature provides valuable insights into the effectiveness of communication media. First, every medium provides distinct functionalities, and media can be arrayed along a continuum accordingly, with the face-to-face setting providing the most advanced functionalities [19, 22, 46, 77]. Second, communication effectiveness follows from a match between the functionalities of the medium and the requirements of the task at hand. With some exceptions [33, 78, 92], the face-to-face setting is considered the standard relative to which technology-enabled communication media are compared. As the functionality of the medium increases, it is found to be more effective [19, 22, 47, 69, 76, 77]. Finally, although prior research on asynchronous collaboration and interaction provides valuable insights, it should be noted that this study focuses solely on *synchronous* interaction in business meetings.

2.2 Communication objectives

A number of communication objectives have been identified in prior research on the effectiveness of communication media. In this section, these studies are reviewed and then a list of objectives is presented in Table 1, listed in the order in which they first appeared in the literature.[2]

In an empirical study on social presence, Short et al. [77] identified the following set of objectives, referring to them as recurring office activities: exchange information, ask questions, exchange opinions, make decisions, give or receive orders, solve a problem, generate ideas, persuade, generate buy-in or consensus, resolve conflicts and disagreements, maintain friendly relations/stay in touch, bargain, and get to know someone. In a later study, Fish et al. [32] studied many of the objectives identified by Short et al. [77], and added the following: exchange confidential information, explain a difficult concept, exchange time-sensitive information, make commitments, schedule meetings, and check project status. Likewise, Rice [70] and King and Xia [44] added exchange routine information, as well as exchange important information.

Straus and McGrath [83] examined three objectives, drawing from McGrath's task "circumplex" [59]: generate ideas, solve a problem, and resolve conflicts. Lengel and Daft [53] applied the richness matching hypothesis to routine and non-routine messages. Routine messages are straightforward, contain no surprises and a common frame of reference is established; non-routine communications involve novel events for which a common frame of reference has not been established. Also, Markus [58] studied a set of hypothetical communication tasks, drawing upon media richness theory and content analysis by Trevino et al. [85], which included the following objectives: communicate feelings or emotions, show personal concern or interest, show authority, status, position, and to exchange confidential, private or delicate information.

Te'eni [84] examined four communication goals, in keeping with Habermas [37]: instructing action, managing interdependent action, managing relationships, and influencing. Watson-Manheim and Bélanger [94] identified five purposes: simple and complex coordination, knowledge sharing, information gathering, relationship development, and conflict resolution. Finally, attention has been drawn recently to the preference and choice of media for deceptive communication in organizations [11, 35].

To summarize, these studies offer insight on the effectiveness of communication media for a variety of communication objectives. However, although prior research has often compared technology-enabled media with the face-to-face setting [32, 44, 58, 70, 77, 94], it has not examined the effectiveness of different communication media in the specific context of a business meeting (as noted earlier, this study focuses on business meetings, involving synchronous interaction to achieve specific objectives). In addition, as prior research did not consider telepresence, there is a lack of guidance on how to use this new technology-enabled communication medium effectively.

3 Business meeting mode effectiveness

This section discusses four synchronous business meeting modes in terms of their functionality: audio-conferencing, video-conferencing, telepresence, and face-to-face. The research questions that form the basis for analyzing the effectiveness of telepresence, audio-conferencing, video-conferencing and face-to-face meetings, for different business meeting objectives are then formulated.

[2] Prior research does not provide a theoretical basis to classify these objectives.

Table 1 List of communication objectives with references to the literature

Communication objective	References
Exchange information	[32, 44, 70, 77]
Ask questions	[32, 44, 70, 77]
Exchange/share opinions or views on a topic or issue	[77]
Make a decision	[32, 44, 70, 77]
Give or receive orders	[77]
Find a solution to a problem that has arisen	[77, 83]
Generate ideas on products, projects or initiatives	[32, 44, 70, 77, 83]
Generate buy-in or consensus on an idea	[77, 84]
Resolve conflicts and disagreements within a group	[32, 44, 70, 77, 83, 94]
Build trust and relationships with one or more individuals	[32, 44, 70, 77, 84, 94]
Maintain relationships with one or more other people and stay in touch	[32, 44, 70, 77]
Negotiate or bargain on a deal or contract	[32, 44, 70, 77]
Communicate positive or negative feelings or emotions on a topic or issue	[58, 85]
Show personal concern about or interest in a particular issue or situation	[58, 85]
Assert and/or reinforce your authority, status, position to your team or others	[58, 85]
Give or receive feedback	[85]
Assemble a team and/or motivate teamwork on a project	[85]
Routine exchange of information	[44, 53]
Non-routine exchange of information	[44, 53]
Clarify a concept, issue or idea	[32, 44]
Exchange confidential, private or sensitive information	[32, 44, 58, 70]
Exchange time-sensitive information	[32, 70]
Make commitments	[32]
Schedule meetings	[32]
Check project status	[32]
Exchange important information	[70]
To deceive someone	[11, 35]

3.1 Business meeting modes

In keeping with Te'eni [84], meeting modes are characterized in terms of their attributes. Also, in keeping with the literature, four meeting modes are ordered in terms of the progressive communication functionalities they provide: audio-conferencing, video-conferencing, telepresence, and face-to-face (see Table 2).[3]

Communication in audio-conferencing between meeting participants is based on voice transmissions (speech and vocal tone). In video-conferencing meetings, visual cues are added to the interaction, which enable the transmission of nonverbal cues, such as gestures and body language. The extent to which video-conferencing transmits these cues depends on the image size and quality [55]. Telepresence systems are designed to closely resemble the face-to-face setting and to create the "perceptual illusion of non-mediation" [55]. The immersive experience of telepresence is illustrated by the following comment from a user: "The detail you can see is that high, that when a cup of coffee is spilled in the one room, you can see every drop on the table from the other room, and you feel the urge to go and clean it up. It is that lively." Hence, the functionality of telepresence approaches that of the face-to-face setting [29]. Face-to-face interaction, however, also enables the transmission of other stimuli such as touch and smell.

3.2 Research questions

In the context of business meetings, effectiveness can be defined as the extent to which the meeting mode facilitates achieving the objectives set for the meeting [8, 39, 95]. Consistent with prior research, the meeting objective is considered to be a key factor in the evaluation of meeting

[3] Notably, each successive meeting mode provides the communication functionality of the previous mode, with equal or better quality. For example, the quality of auditory cues transmission in audio- and video-conferencing is the same, on the other hand, the transmission of visual cues in telepresence is typically through higher quality video than in video-conferencing.

Table 2 Communication functionalities of the business meeting modes (X refers to the functionality being supported by the meeting mode)

	Audio-conferencing	Video-conferencing	Telepresence	Face-to-face
Transmission of auditory cues (speech, vocal tone)	X	X	X	X
Transmission of visual cues (gestures, body language)		X	X	X
Life-size presence in a shared space (eye-contact, spatial audio)			X	X
Transmission of haptic and olfactory cues in an actual physical space				X

modes, and the effectiveness of meeting modes is expected to increase with their communication functionality [19, 69, 77]. However, with the increase in effectiveness typically comes an increase in the cost of using the meeting mode [14, 56, 69, 72, 75]. Therefore, the aim is to identify the meeting objectives for which the distinct features of telepresence are justified from an effectiveness standpoint. In particular, this study investigates how the effectiveness of telepresence compares to the effectiveness of less expensive technology-enabled meeting modes (audio- and video-conferencing) and to the effectiveness of face-to-face meetings, which potentially require extensive travel. Hence, the following research questions are used to frame the study:

Research Question 1: For which business meeting objectives is telepresence a significantly more effective meeting mode than audio- and video-conferencing?

Research Question 2: For which business meeting objectives is telepresence a significantly less effective meeting mode than face-to-face?

4 Research method

This section describes the research approach for the empirical study, which was conducted in a large publicly traded global company, headquartered in the United States of America. The company employs over 60,000 people worldwide and the nature of its business requires frequent interaction between employees across the globe. For scheduled meetings, the company uses the following modes, which are employed on a relatively broad basis: audio-conferencing, video-conferencing, telepresence, and face-to-face. In addition, every meeting organizer has access to all of these modes and has the freedom to choose between them for each meeting. Therefore, this research context provides a unique opportunity to study telepresence in relation to conventional meeting modes, in a field setting. The study was conducted in two phases, which are described next.

4.1 Phase 1

In a first phase, exploratory interviews were conducted with 39 upper and middle level managers in the company. Each interview was conducted in a separate session lasting about an hour. First, an open-ended question was asked about the objectives relevant to the interviewees' meetings. Then, the interviewees were asked to review the objectives listed in Table 1, and to offer feedback about the adequacy and completeness of this list in the context of their business meetings.

From the interviews, no additional meeting objectives emerged and hence the list of business meeting objectives included all objectives of the interviewees' meetings. Conversely, based on their feedback, the list was shortened, from 27 to 19 objectives, with 8 objectives being considered redundant and/or irrelevant for meetings in the company. The resulting list, presented in Table 3, consists of diverse objectives, which cannot be easily classified. Finally, some of the interviewees noted that a meeting usually serves more than one objective and furthermore, that different participants in a meeting may have different objectives.

4.2 Phase 2

Drawing from the insights gained in Phase 1, a brief online questionnaire was developed (see Appendix, ESM). This questionnaire asks each respondent to identify a specific business meeting that he or she had organized[4] recently (to minimize recall decay bias), and to indicate the meeting mode that he or she had selected for that specific meeting. In addition, each respondent was asked to identify the relevant objectives for that business meeting from the list of potential meeting objectives (see Table 3), and to evaluate the effectiveness of the business meeting mode, which was defined as the extent to which the business meeting mode that was selected facilitated the achievement

[4] In addition, as discussed below, responses were also sought from other attendees of a subset of the meetings, to analyze the effect of common method bias.

Table 3 List of business meeting objectives based on the literature review and the exploratory interviews

1	Exchange/share opinions or views on a topic or issue
2	Make a decision
3	Give or receive orders
4	Find a solution to a problem that has arisen
5	Generate ideas on products, projects or initiatives
6	Generate buy-in or consensus on an idea
7	Resolve conflicts and disagreements within a group
8	Build trust and relationships with one or more individuals
9	Maintain relationships with one or more other people and stay in touch
10	Negotiate or bargain on a deal or contract
11	Routine exchange of information
12	Non-routine exchange of information
13	Communicate positive or negative feelings or emotions on a topic or issue
14	Show personal concern about or interest in a particular issue or situation
15	Assert and/or reinforce your authority, status, position to your team or others
16	Give or receive feedback
17	Assemble a team and/or motivate teamwork on a project
18	Clarify a concept, issue or idea
19	Exchange confidential, private or sensitive information

of each of the business meeting objectives for that specific meeting. A five-point scale was used to measure the perceived effectiveness[5] of the business meeting mode, ranging from 1: "Not at all effective" to 5: "Very effective" [69, 95].

The data provide "a realistic context and point of reference" [86, p. 169], which is distinct from most prior studies on media choice and effectiveness, in which hypothetical choices or perceived appropriateness of different media for specific situations were examined [25, 58]. Given that this study is based on actual business meetings, it was not possible to control for meeting agendas and participants. It was also not possible to consult recordings or minutes of the meetings, or to solicit input from an organizer before each meeting. Likewise, it was not feasible to have an independent observer attend the meetings and rate meeting outcomes. In addition, the questionnaire was anonymous and the respondents were assured that the results would be reported in the aggregate only and without any attribution.

An overview of the key variables and the number of respondents is provided in Table 4, and described below.

1. For 392 business meetings, responses to the online questionnaire were obtained from meeting organizers, which were contacted by email. This data included 171 responses for audio-conferencing, 122 for video-conferencing, 56 for telepresence, and 43 for face-to-face (as shown in Table 5).

[5] Measuring the perceived effectiveness bears similarity with the construct of perceived usefulness, which is key in the TAM [20].

Table 4 Overview of the key variables and respondents in Phase 2

Key variables	Number of respondents
1. Meeting mode, objectives, and meeting mode effectiveness	392 Meeting organizers
2. Same as 1. above, as well as meeting duration, size, and prior use	155 Meeting organizers
3. Same as 1. above for meeting attendees that could be tied to the responses of a meeting organizer	139 Meeting attendees for 86 meeting organizers

2. For 155 of the total of 392 meetings, data was collected from the online calendaring and meeting scheduling systems on the number of meeting participants and the scheduled duration of the meeting. Also, the organizer was asked to indicate the number of prior times he or she had used the selected meeting mode.
3. Finally, data from 139 attendees of 86 out of the 155 meetings referred to in point (2) was obtained. These attendees were identified from the same online calendaring and meeting scheduling systems, and invited by email.

4.2.1 Data description

Table 6 shows the distribution of meeting modes for the 155 meetings for which additional data was obtained, the average number of meeting participants, and the average duration, across the four modes. In line with prior research [10], there was a slight decrease in the average number of meeting participants, going from low functionality to high

Table 5 Distribution of organizer respondents across the business meeting modes

	Respondents
Audio-conferencing (AC)	171
Video-conferencing (VC)	122
Telepresence (TP)	56
Face-to-face (FTF)	43
Total	392

Table 6 Average number of meeting participants and average meeting duration across the business meeting modes

Meeting mode	N	Average number of meeting participants (and SD)	Average duration in minutes (and SD)
AC	59	5.37 (4.46)	56.69 (23.32)
VC	34	5.21 (4.41)	61.82 (24.52)
TP	30	4.90 (2.83)	85.50 (49.38)
FTF	32	4.25 (3.99)	96.88 (67.75)

functionality meeting modes, however, these differences were not statistically significant [ANOVA: $F(3, 153) = 0.56$; $p > 0.05$]. In addition, face-to-face meetings were longer than mediated meetings on average and an ANOVA revealed that the average duration differed significantly across the modes [$F(3, 153) = 8.06$; $p < 0.001$]. This finding is in line with prior research [29, 49]. Post-hoc tests indicated that the duration of audio-conferencing meetings indeed differed significantly from the duration of telepresence and face-to-face meetings ($p < 0.05$). However, the observed average durations cannot be interpreted as being related to any inherent characteristics of the meeting modes themselves, since most telepresence meeting rooms had very high utilization levels, and therefore had to be reserved for specific durations for meetings. It is possible that these meetings could have been longer if the facilities were more freely available.

The number of times the meeting participant had used the selected meeting mode before, is shown in Table 7. The table shows that the large majority of meeting organizers had used the meeting mode more than 10 times in the past.

The extent to which each business meeting objective was considered to be relevant by the 392 business meeting organizers is shown in Table 8, in decreasing order of frequency. Overall, 15 out of the 19 objectives were indicated as relevant for more than 50 % of the meetings. The two most frequently cited business meeting objectives in the sample were "Clarify a concept, issue or idea", and "Exchange opinions" (81 and 79 % of meetings respectively). Next, "Building relationships and trust" and "Maintaining relationships" were considered relevant in

Table 7 Number of times the organizer has previously used the selected meeting mode

How often have you used the selected meeting mode before within the current organization?	Number of meeting organizers			
	AC	VC	TP	FTF
First time user	0	0	0	0
1–5 times used before	2	3	2	2
6–10 times used before	1	0	3	2
>10 times used before	56	31	25	28
Total (N)	59	34	30	32

about three quarters of the meetings. Conversely, four objectives were indicated as being relevant in less than 50 % of the meetings: "Give or receive orders" (44 %), "Resolve conflicts and disagreements" (44 %), "Assert and/or reinforce your authority, status, position to your team or others" (40 %), and "Negotiate or bargain on a deal or contract" (29 %). Given the low relevance of these four meeting objectives and thus the lack of sufficient data instances pertaining to them for a meaningful quantitative analysis, they are not considered further in the analysis.

Table 8 also displays the frequency of the relevance of the objectives for each of the four meeting modes. Although the ordering of frequencies was fairly consistent across the modes, there were some observations worth mentioning. First, for telepresence meetings, the objectives that involve building and maintaining relationships were more frequently considered relevant by the meeting organizers, whereas the objectives that involve making a decision and finding a solution to a problem, were relatively less frequently considered relevant. Secondly, face-to-face meetings had fewer stated objectives, as indicated by the consistently lower frequency numbers in that column (except for "Find a solution to a problem"). Finally, it is important to note that this table is specific to the current data set, and is not intended to represent the overall distribution of the objectives across all meetings at the company.

In order to compare the frequencies of objectives across the four meeting modes, an ANOVA of the data from 392 business meeting organizers was conducted. The results of 15 ANOVA tests are shown in Table 9. A conservative approach was adopted in order to statistically account for multiple comparisons. In particular, the family significance level was set at 10 % and divided by the number of tests (15) [61]. The table below shows that for 3 of the 15 objectives, the p value was below the critical level of 0.0067 (=0.10/15): building trust and relationships, finding a solution to a problem that has arisen, and a non-routine exchange of information. Post-hoc tests revealed that the frequency of "Building trust and relationships" is different

Table 8 Frequency of relevance of business meeting objectives (based on 392 meeting organizer responses)

Business meeting objectives	% Relevance	AC (%)	VC (%)	TP (%)	FTF (%)
Clarify a concept, issue or idea	81	82	84	79	77
Exchange/share opinions or views on a topic or issue	79	81	82	79	60
Build trust and relationships with one or more individuals	74	68	83	86	58
Maintain relationships with one or more other people and stay in touch	74	69	80	84	63
Generate buy-in or consensus on an idea	71	68	77	75	63
Give or receive feedback	71	71	73	73	65
Make a decision	70	73	75	61	56
Generate ideas on products, projects or initiatives	69	67	75	70	60
Routine exchange of information	68	72	74	57	53
Find a solution to a problem that has arisen	67	72	70	48	58
Non-routine exchange of information	64	62	70	70	42
Show personal concern about or interest in a particular issue or situation	62	54	71	68	56
Assemble a team and/or motivate teamwork on a project	59	58	62	68	42
Communicate positive or negative feelings or emotions on a topic or issue	58	57	66	63	37
Exchange confidential, private or sensitive information	52	50	59	48	44
Give or receive orders[a]	44	50	45	30	33
Resolve conflicts and disagreements within a group[a]	44	44	48	38	35
Assert and/or reinforce your authority, status, position to your team or others[a]	40	37	46	46	26
Negotiate or bargain on a deal or contract[a]	29	30	33	23	23

[a] Not analyzed further, due to insufficient data instances pertaining to this meeting objective

Table 9 ANOVA of frequencies of objectives across business meeting modes (based on 392 meeting organizer responses)

Business meeting objectives	df	F	*p* value
Clarify a concept, issue or idea	(3, 388)	0.44	0.725
Exchange/share opinions or views on a topic or issue	(3, 388)	3.27	0.021
Build trust and relationships with one or more individuals	(3, 388)	6.18	0.000*
Maintain relationships with one or more other people and stay in touch	(3, 388)	3.53	0.015
Generate buy-in or consensus on an idea	(3, 388)	1.53	0.207
Give or receive feedback	(3, 388)	0.35	0.787
Make a decision	(3, 388)	3.01	0.030
Generate ideas on products, projects or initiatives	(3, 388)	1.42	0.236
Routine exchange of information	(3, 388)	3.50	0.016
Find a solution to a problem that has arisen	(3, 388)	4.40	0.005*
Non-routine exchange of information	(3, 388)	4.21	0.006*
Show personal concern about or interest in a particular issue or situation	(3, 388)	3.45	0.017
Assemble a team and/or motivate teamwork on a project	(3, 388)	2.58	0.053
Communicate positive or negative feelings or emotions on a topic or issue	(3, 388)	3.77	0.011
Exchange confidential, private or sensitive information	(3, 388)	1.33	0.265

* $p < 0.0067$

between video-conferencing and both audio-conferencing and face-to-face, and between telepresence and both audio-conferencing and face-to-face. In addition, the frequency of the objective "Find a solution to a problem that has arisen" was found to be significantly different between telepresence and both audio- and video-conferencing. Finally, for "Non-routine exchange of information" the frequency is different between face-to-face and both video-conferencing and telepresence.

4.2.2 Analysis of business meeting mode effectiveness

The research questions stated earlier were addressed by examining the mean effectiveness scores for the 15

Table 10 Mean business meeting mode effectiveness scores (and standard deviations) (based on 392 meeting organizer responses)

Business meeting objectives	Mean business meeting mode effectiveness scores (and standard deviation)			
	AC	VC	TP	FTF
Clarify a concept, issue or idea	4.11	4.18	4.59	4.39
	(0.81)	(0.67)	(0.62)	(0.97)
Exchange/share opinions or views on a topic or issue	3.97	4.27	4.34	4.54
	(0.85)	(0.78)	(0.78)	(0.65)
Build trust and relationships with one or more individuals	3.58	4.03	4.63	4.52
	(1.06)	(0.81)	(0.61)	(0.82)
Maintain relationships with one or more other people and stay in touch	4.01	4.24	4.53	4.37
	(0.91)	(0.81)	(0.65)	(0.84)
Generate buy-in or consensus on an idea	3.85	4.05	4.31	4.44
	(0.96)	(0.79)	(0.78)	(0.64)
Give or receive feedback	4.00	4.12	4.59	4.29
	(0.88)	(0.74)	(0.63)	(0.81)
Make a decision	3.96	4.01	4.21	4.50
	(0.87)	(0.81)	(0.98)	(0.78)
Generate ideas on products, projects or initiatives	3.76	4.10	4.05	4.35
	(0.94)	(0.79)	(0.86)	(0.80)
Routine exchange of information	4.25	4.21	4.19	3.96
	(0.74)	(0.79)	(0.90)	(1.15)
Find a solution to a problem that has arisen	3.92	4.12	4.00	4.48
	(0.87)	(0.76)	(0.92)	(0.71)
Non-routine exchange of information	3.88	4.02	4.33	4.17
	(1.04)	(0.72)	(0.70)	(1.15)
Show personal concern about or interest in a particular issue or situation	3.74	4.02	4.34	4.25
	(0.95)	(0.85)	(0.88)	(0.74)
Assemble a team and/or motivate teamwork on a project	3.68	4.08	4.18	4.33
	(1.04)	(0.88)	(0.87)	(0.91)
Communicate positive or negative feelings or emotions on a topic or issue	3.58	3.90	4.43	4.63
	(0.96)	(0.81)	(0.70)	(0.62)
Exchange confidential, private or sensitive information	3.63	4.04	4.26	4.37
	(1.04)	(0.72)	(1.10)	(0.83)

meeting objectives. Table 10 shows the mean effectiveness scores and standard deviations for the organizer responses for 392 business meetings.[6] Note that the mean effectiveness scores are specific to the current data set, and are not intended to represent the general effectiveness of meeting modes across all meetings at the company.

One-sided *T* tests were used to identify significant differences between the effectiveness scores of telepresence and audio-conferencing, and telepresence and video-conferencing (Research Question 1), and between telepresence and face-to-face (Research Question 2), for each of the 15 meeting objectives. Again, the critical *p* value was divided by the number of tests, in order to statistically account for multiple testing [61]. Hence, the effectiveness scores were considered to be significantly different if the one-sided *p* values were below 0.0067 (=0.10/15). Table 11 lists the *T* test statistics of the pairwise effectiveness comparisons, and highlights (with a '*') the statistically significant differences.

As to Research Question 1, Table 11 shows that statistically significant differences were found between the effectiveness of telepresence and the effectiveness of both audio- and video-conferencing for four meeting objectives. However, as to Research Question 2, no statistically significant differences were observed between the effectiveness of telepresence and that of face-to-face. In Sect. 5, the findings of the study are further discussed.

[6] Mean effectiveness scores across all meeting modes were between 3.55 and 4.65 on a scale of 1–5, suggesting that meeting organizers were familiar enough with the meeting modes to avoid poor meeting mode choices.

Table 11 Pairwise comparisons of meeting mode effectiveness (t test statistics) (based on 392 meeting organizer responses)

Business meeting objectives	Effectiveness TP > Effectiveness AC	Effectiveness TP > Effectiveness VC	Effectiveness TP < Effectiveness FTF
Clarify a concept, issue or idea	3.63*	3.52*	1.02
Exchange/share opinions or views on a topic or issue	2.58*	0.50	−1.09
Build trust and relationships with one or more individuals	7.94*	4.54*	0.62
Maintain relationships with one or more other people and stay in touch	3.59*	2.11	0.92
Generate buy-in or consensus on an idea	2.76*	1.75	−0.75
Give or receive feedback	3.92*	3.47*	1.72
Make a decision	1.42	1.04	−1.22
Generate ideas on products, projects or initiatives	1.68	0.30	−1.40
Routine exchange of information	−0.42	−0.14	0.84
Find a solution to a problem that has arisen	0.43	0.66	−2.09
Non-routine exchange of information	3.02*	2.25	0.68
Show personal concern about or interest in a particular issue or situation	3.34*	1.91	0.43
Assemble a team and/or motivate teamwork on a project	2.68*	0.61	−0.59
Communicate positive or negative feelings or emotions on a topic or issue	5.57*	3.37*	−0.96
Exchange confidential, private or sensitive information	2.72*	0.96	−0.37

* One-sided p value for independent samples T test below 0.0067

To examine the relationship between the number of meeting participants and the effectiveness of the meeting mode, and between the duration of the meeting and the effectiveness of the meeting mode, an exploratory analysis was conducted on the subset of 155 meetings for which additional data was collected. The tables below show the correlation coefficients, along with their significance levels, of the effectiveness scores and the number of meeting participants (Table 12) and duration of the meeting (Table 13). Each table presents the overall correlation coefficient, as well as the correlation coefficient for each of the four meeting modes. After applying a correction for multiple testing, the critical p value becomes 0.0013 (=0.10/(15 × 5)) [61]. In addition to the critical p value, the 0.05 significance level is also reported in both tables.

As Table 12 shows, three significant correlations were found. Effectiveness of the telepresence mode was negatively correlated with the number of meeting participants for the objectives "Communicate positive or negative feelings or emotions on a topic or issue" (at the 0.0013 significance level), and "Give or receive feedback" (at the 0.05 significance level). Furthermore, the overall effectiveness across all modes was found to be positively correlated with the number of participants in meetings scheduled for "Routine exchange of information".

Table 13 presents the correlation coefficients between effectiveness scores and durations of meetings. It shows that overall there were no significant relationships between the duration of the meeting and effectiveness (at the 0.05 significance level). However, in audio-conferencing and telepresence meetings, longer meetings were negatively related to effectively exchanging non-routine information (at the 0.05 significance level). Likewise, longer video-conferencing meetings were negatively related to the effectiveness of giving or receiving feedback (at the 0.05 significance level).

In sum, the correlational analyses on a subset of the meetings suggested that the number of meeting participants and meeting duration had a limited impact on the effectiveness scores of the business meeting objectives. The managerial implications of these findings are examined in Sect. 5.

4.2.3 Common method bias

Since the data on the selected meeting mode, the objectives relevant to the meeting, and the perceived effectiveness of the meeting mode in achieving the objectives relevant to the meeting were obtained from a single questionnaire, common method bias could be a concern. To help rule out common method bias, several measures were taken. First, the meeting mode selected by the respondent was validated against, and found to be consistent with, the meeting mode set for each meeting in the online calendaring and meeting

Table 12 Correlation between meeting mode effectiveness and number of participants (based on subset of 155 meetings)

Business meeting objectives	Number of meeting participants				
	Overall	AC	VC	TP	FTF
Clarify a concept, issue or idea	−0.02	−0.01	−0.14	−0.24	0.20
Exchange/share opinions or views on a topic or issue	−0.04	0.18	−0.35	−0.36	0.17
Build trust and relationships with one or more individuals	−0.08	−0.02	−0.19	−0.12	0.13
Maintain relationships with one or more other people and stay in touch	−0.08	0.08	−0.43	−0.11	0.26
Generate buy-in or consensus on an idea	−0.03	0.00	−0.22	0.04	0.31
Give or receive feedback	−0.12	−0.03	−0.26	−0.48*	0.05
Make a decision	0.11	0.33	0.07	−0.45	0.01
Generate ideas on products, projects or initiatives	−0.06	0.08	−0.15	−0.40	0.06
Routine exchange of information	0.23*	0.31	0.25	−0.19	0.33
Find a solution to a problem that has arisen	0.11	0.28	−0.47	−0.29	0.36
Non-routine exchange of information	−0.05	−0.15	−0.20	−0.21	0.14
Show personal concern about or interest in a particular issue or situation	0.08	0.42	0.03	0.00	−0.06
Assemble a team and/or motivate teamwork on a project	−0.08	−0.03	−0.11	−0.47	0.39
Communicate positive or negative feelings or emotions on a topic or issue	−0.09	0.14	−0.20	−0.70**	0.07
Exchange confidential, private or sensitive information	0.03	0.15	−0.03	−0.29	0.14

* $p < 0.05$; ** $p < 0.0013$

Table 13 Correlation between meeting mode effectiveness and duration of the meeting (based on subset of 155 meetings)

Business meeting objectives	Duration of the meeting				
	Overall	AC	VC	TP	FTF
Clarify a concept, issue or idea	0.00	−0.20	−0.23	−0.26	0.07
Exchange/share opinions or views on a topic or issue	−0.02	−0.13	−0.34	−0.41	0.16
Build trust and relationships with one or more individuals	0.12	0.01	−0.09	−0.24	−0.08
Maintain relationships with one or more other people and stay in touch	−0.01	−0.18	−0.28	−0.17	0.17
Generate buy-in or consensus on an idea	0.11	0.01	−0.07	−0.17	0.05
Give or receive feedback	−0.10	0.02	−0.45*	−0.42	−0.11
Make a decision	0.12	0.21	0.20	−0.25	0.15
Generate ideas on products, projects or initiatives	0.10	−0.03	−0.20	−0.07	0.24
Routine exchange of information	−0.11	0.04	0.00	−0.48	0.02
Find a solution to a problem that has arisen	0.05	−0.16	−0.11	−0.33	0.30
Non-routine exchange of information	0.01	−0.37*	−0.38	−0.48*	0.22
Show personal concern about or interest in a particular issue or situation	0.05	−0.11	−0.40	−0.18	0.27
Assemble a team and/or motivate teamwork on a project	−0.11	−0.02	−0.31	−0.38	−0.21
Communicate positive or negative feelings or emotions on a topic or issue	0.11	−0.12	−0.41	−0.37	0.37
Exchange confidential, private or sensitive information	−0.17	−0.41	−0.04	−0.42	−0.28

* $p < 0.05$

scheduling system. Second, the list with objectives for the meeting was presented in a randomized order for each respondent, to remove a potential order effect. Third, as mentioned above, the responses of 139 meeting attendees (i.e., participants who were not organizers of the meeting) were obtained for 86 meetings for which organizer input was also obtained (see Table 5). For each of the objectives that were indicated by both organizer and attendee as relevant for the meeting, paired sample T tests revealed no significant differences (at both the 0.0067 and the 0.05

Table 14 Comparison of meeting organizer and attendee scores for meeting mode effectiveness: *T* test statistics

Business meeting objectives	Organizer	Attendee	N	*T* test statistic
Clarify a concept, issue or idea	4.31	4.37	81	−0.66
	(0.70)	(0.68)		
Exchange/share different opinions or views of a topic or issue	4.16	4.31	75	−1.29
	(0.77)	(0.77)		
Build trust and relationships with one or more individuals	4.27	4.23	66	0.36
	(0.89)	(0.86)		
Maintain relationships with one or more other people and stay in touch	4.34	4.25	65	0.85
	(0.64)	(0.75)		
Generate buy-in or consensus on an idea	4.09	4.23	56	−1.07
	(0.82)	(0.71)		
Give or receive feedback	4.22	4.37	54	−1.07
	(0.77)	(0.68)		
Make a decision	4.13	4.13	53	0.00
	(0.94)	(0.88)		
Generate ideas on products, projects or initiatives	3.93	4.16	61	−1.47
	(0.98)	(0.66)		
Routine exchange of information	4.19	4.11	47	0.41
	(0.80)	(1.15)		
Find a solution to a problem that has arisen	4.10	4.15	39	−0.26
	(1.10)	(0.67)		
Non-routine exchange of information	4.39	4.10	41	1.52
	(0.83)	(1.00)		
Show personal concern about or interest in a particular issue or situation	4.28	4.23	43	0.28
	(0.77)	(0.97)		
Assemble a team and/or motivate teamwork on a project	4.14	4.18	44	−0.30
	(0.85)	(0.84)		
Communicate positive or negative feelings or emotions on a topic or issue	4.11	4.29	35	−1.29
	(0.87)	(0.86)		
Exchange confidential, private or sensitive information	4.22	4.26	27	−0.15
	(0.97)	(0.86)		

* $p < 0.05$; ** $p < 0.0067$; no significant differences were found

significance level) in the perception of the effectiveness, as shown in Table 14.[7] Thus, common method bias was not a significant issue in this study.

5 Discussion

The goal of this paper is to analyze the effectiveness of telepresence as a meeting mode for achieving business meeting objectives. Drawing from the literature, two research questions were formulated and analyzed through an empirical study. The findings for each research question are discussed below.

[7] This analysis is based on the aggregate averages, across the four meeting modes, because of the limited number of observations for some of the objectives.

Research Question 1: For which business meeting objectives is telepresence a significantly more effective meeting mode than audio- and video-conferencing?

In line with prior research, the effectiveness of a technology-enabled communication medium was observed to increase with the functionalities it provides [19, 46, 77]. However, these studies did not examine telepresence and its effectiveness. This empirical study shows that the effectiveness of telepresence is higher than that of audio- and video-conferencing for four meeting objectives: build trust and relationships with one or more individuals; communicate positive or negative feelings or emotions on a topic or issue; give or receive feedback; and clarify a concept, issue or idea. At the same time, telepresence was not found to be more effective than video-conferencing for 11 meeting objectives and than audio-conferencing for 4

objectives. Moreover, telepresence was not found to be significantly less effective than audio- or video-conferencing for any objective. These findings highlight the importance of considering the meeting objective, as different objectives have different requirements for communication functionalities [44, 70, 84].

An interesting question for further research is why telepresence is significantly more effective for the four particular objectives above, but not for all the others that were considered in this study. One possible explanation is that the life-size presence, sense of shared space and eye contact may help participants transmit cues that have been identified to be important in virtual teams to "convey trust, warmth, attentiveness, and other interpersonal affections" [42, p. 793] and to transmit "emotion and strength of feeling" [53, p. 229] in business communication. Likewise, prior research has indicated that visual cues increase the effectiveness of giving feedback or clarifying an issue [22, 60, 83]. Thus, the better quality of visual cues transmission in telepresence may better enable meeting participants to achieve these objectives. However, the additional functionality of telepresence does not necessarily increase the effectiveness for all meeting objectives. In particular, the data in Table 11 suggests that the transmission of auditory cues only is required to effectively achieve four meeting objectives (make a decision, generate ideas, routine exchange of information, and find a solution to a problem) and that the transmission of auditory with visual cues is required to effectively achieve seven additional meeting objectives (exchange/share opinions or views, maintain relationships and stay in touch, generate buy-in, non-routine exchange of information, show personal concern, assemble a team, and exchange confidential, private or sensitive information).

Research Question 2: For which business meeting objectives is telepresence a significantly less effective meeting mode than face-to-face?

Another major observation is that no statistically significant differences were observed between the effectiveness of telepresence and face-to-face for any of the meeting objectives. Thus, despite the additional functionality of a face-to-face meeting relative to the immersive lifelike setting telepresence provides, telepresence is found to be comparable in effectiveness for achieving objectives in meetings. This finding adds to prior research [44, 70], by suggesting that face-to-face interaction is not necessarily superior to technology-enabled remote interaction. Hence, the current analysis suggests that in situations where face-to-face meetings would require significant travel, time and cost, telepresence provides an effective, possibly less costly and more environmentally friendly alternative [91].

Furthermore, the lack of significant differences between telepresence and face-to-face raises the question whether technology-enabled meetings could go "beyond being there". For example, technology-enabled interaction facilitates recordings of media and content during meetings [40]. Moreover, prior literature indicates that the additional functionality of face-to-face meetings may even impair effectiveness. For example, people interacting face-to-face have been reported to easily wander off topic [2, 7].

5.1 Implications

This research provides useful insights into the effectiveness of different communication media for technology-mediated distributed business meetings. The results of this study support the key principle of social presence and media richness theory, which is that for a medium to be used effectively, the requirements of the task have to be considered [19, 77]. Also, for most meeting objectives, the effectiveness was found to increase monotonically with the communication functionality of the medium, which is in line with previous qualifications/refinements of social presence and media richness theory [46, 69]. By introducing telepresence into the set of possible distributed meeting modes, this study broadens our understanding of the value and effectiveness of such technologies for meetings.

Also, while prior research on business meetings has focused on various elements such as meeting expenses, attitudes, satisfaction, duration, size, composition, and information systems support [5, 24, 30, 62, 74, 86], there is a paucity of research on the role of objectives in the choice of meeting modes. This study calls attention to the different communication functionality requirements of meeting objectives. The field study findings provide guidance in the effective utilization of meeting modes and serve as a starting point for the development of usage norms for different technology-enabled communication media in distributed meetings. However, further research is needed to identify the importance of specific communication functionalities, such as seeing body language or being present in a shared space, for each of the meeting objectives.

This study has key implications for the objective building relationships and trust, which is considered to be one of the major challenges in distributed work groups [54]. In particular, while no significant difference in effectiveness between telepresence and face-to-face was found, telepresence was found to be more effective than both audio- and video-conferencing for this objective. This finding contributes to the ongoing debate on the notion that "trust needs touch" [38], and whether trust engendered by the face-to-face encounter can be accomplished by

technology-enabled instead of face-to-face communication [4, 65]. In particular, the findings of this study suggest relationships can be effectively build through technology and therefore telepresence challenges face-to-face as the gold standard [4].

For managers, this study provides guidance for organizing meetings. First, the list of meeting objectives can help managers in planning meetings and preparing meeting agendas. In addition, the findings of the study provide guidance in selecting a meeting mode. Since telepresence is a more expensive and exclusive technology, the study results provide managers with useful insights on when its use is justified from an effectiveness standpoint. In particular, telepresence was found to be more effective than simpler/cheaper alternatives for four objectives. Moreover, telepresence is found to be an effective alternative for face-to-face meetings for any objective. This finding can have substantial implications for widely distributed organizations, and even widely distributed business eco-systems. In particular, investing in telepresence systems or gaining access to such facilities, may yield significant operational cost savings. The findings can also be valuable for sellers/providers of telepresence capabilities and systems, in best positioning their services to clients.

The findings on the correlations between the number of meeting participants, meeting duration and meeting mode effectiveness are also useful for managers. Overall, only a few significant correlations were found, suggesting that the decision of meeting size and duration has a limited impact on meeting mode effectiveness. Nevertheless, for a routine exchange of information, the number of participants is significantly and positively related to meeting mode effectiveness. On the other hand, when giving feedback or communicating feelings or emotions in a telepresence meeting, a meeting organizer should be careful not to invite too many people, as significant and negative relationships were found for these objectives. Likewise, a meeting organizer may want to be careful when determining the duration of the meeting, as significant and negative relationships were found between duration and meeting mode effectiveness for a non-routine exchange of information and for giving or receiving feedback.

5.2 Limitations and future research

This study focuses on the communication functionality of meeting modes. However, there are several other factors that may influence meeting mode effectiveness. While some of these, such as experience [12], group size [60], duration [74], and accessibility [17, 57], were considered in this analysis, there are still other factors such as free riding [62], multi-communicating [68], participants' preparation [3], the chair's leadership style [42], meeting structure [62, 76], and having ancillary interaction before or after a meeting. Informal interaction is considered to be important for building relationships and transmitting organizational culture and loyalty [32]. The extent to which these factors influence technology-enabled meetings, presents an interesting avenue for further research.

A second limitation is in terms of the generalizability of the results. Telepresence is not widespread within organizations yet, and thus the empirical study is limited to a relatively atypical organization. For example, anecdotal evidence suggests that access to telepresence is often limited to managers at the highest level of organizations, and that the use of telepresence differs across industries. Hence, the external validity of the findings still has to be established, and an important next step will be to study telepresence usage across a variety of organizational and industrial settings. Likewise, validating the adequacy of the list of meeting objectives that were compiled in this study, in other settings is also an important next step.

Third, in this study telepresence is considered in an intra-organizational setting. The advantage of this is consistency across respondents in access to the meeting modes. However, as adoption of telepresence further increases and interoperability between systems enhances, it will be important to investigate further how this new medium is deployed for effective inter-organizational collaboration [69].

Another interesting question involves hybrid meeting modes—how is the effectiveness of a telepresence meeting affected by one or more participants being limited to lower functionality modes? Interestingly, many telepresence meetings involve at least dual modes, where two or more participants are co-located and can thus interact face-to-face [81]. And finally, another set of questions relate to the fact that the use of telepresence for a meeting appears to signal situational characteristics that color users' reactions to it and to its effectiveness. All these offer interesting avenues for further research.

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