Exploring the Relationship Between Communication Risk Perception and Communication Portfolio

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Abstract—With the rapid development of information communication technologies (ICT) over the past decade, the nature of how organization members communicate has changed, becoming far more complex and challenging. Communication risks brought about by technology-mediated communication can sometimes be detrimental to the overall organizational function and success. We classify these communication risks into three types: reception, understanding, and action risks.

We propose the notion of COMMUNICATION PORTFOLIO which refers to a single ICT or a specific combination of ICTs that can be used to manage any perceived risk of communication. Specifically, this study aims to examine the relationship between perceived risks (i.e., risk of reception, risk of understanding, and risk of action) in the communication process and the dimensions (i.e., size, content, and structuring mechanism) of the communication portfolio used for communication. We also identify communication risk factors that may accentuate the different types of risks. We develop a communication risk perception framework to illustrate the relationship between the communication risk factors, the different types of communication risks, and the communication portfolio. Finally, we illustrate how the communication risk perception framework can be applied in a real-life natural setting by using the shuttle Challenger incident as an example.

Index Terms—Communication, information and communication technology, risk perception.

Communication is a dominant and important activity for many organization members. In the past, studies on communication and usage of information communication technologies (ICT) have focused mainly on managers because communication was an important part of a manager’s job (e.g., [1]–[4]). Specifically, communication activities have been found to account for a significant portion of the working time of managers [5], [6]. Today, however, with greater emphasis on collaboration and teamwork among organization members in different functional groups, more organization members find that an important part of their work is communication. Furthermore, with the proliferation of geographically distributed workplaces, technology-mediated communication is becoming the way of life in many organizations as it allows organization members to communicate across time and distance to perform work activities. For these reasons, the study of organization communication practices and usage of ICT by different organization members is an important and significant topic in organizational research.

Many people expect that advancements in ICT will help facilitate communication among organization members and help organization members to accomplish difficult tasks even though they are remotely located or rarely working synchronously on tasks. However, past studies have reported that the use of ICT may sometimes threaten the effectiveness of communication, leading to somewhat undesirable consequences. For example, Rice and Shook pointed out a problem of reception when using the telephone: business phone calls failed 60% of the time to reach their intended recipient [6]. El-Shinnawy and Markus further elaborated the problems in understanding messages via voice mail, as it was difficult to process a lengthy or complex sequence of messages [3]. In addition, Olson and Olson showed that the use of audio conferencing systems resulted in difficulties with keeping track of who was talking during a conversation, consequently reducing the effectiveness of the meeting [7]. Finally, Heath and Luff found that videoconferencing created misleading assumptions about the shared space that could be highly disruptive for communication [8]. These studies show that the use of ICT can create problems during communication, which can potentially affect the reception of the message, comprehension of the message, or intended action of the recipient.
In recent years, some researchers have indicated that organization members have a tendency to rely on a mix of technologies in the workplace [9]–[11]. This is not surprising since different technologies vary depending upon different dimensions of communication, and certain technologies may impose constraints while affording certain resources [12]. Thus, organization members are often provided with a wide array of communication tools to provide them with the flexibility to manage any potential risks or problems associated with a particular ICT. Specifically, Nardi et al. found that the combined usage of instant messaging and telephone helped to prevent miscommunication [13]. Indeed, the combination of multiple ICT usage is occurring more frequently now than in the past because of a greater variety of new communication tools [14]. Furthermore, past research has also advocated that switching from one technology to another may derive more optimal performance than using one ICT alone [15], [16]. Thus, we propose that the use of a combination of multiple ICT usage may provide redundancy and reinforce the use of message clarity to reduce any threats of poor communication. Hence, we introduce the notion of a COMMUNICATION PORTFOLIO, which is defined here as a single ICT or a specific combination of multiple ICTs used to manage and control any perceived risk of poor communication.

The study of multiple ICT usage has not been well-documented in the literature. In their recent article, Boczkowski and Orlikowski noted that past studies tend to focus on examining a single ICT in isolation from other ICTs in the organization [17]. In fact, much of the debate on ICT choice and usage within the IS and communication literature has centered around the question of whether the choice of a single communication media is contingent upon factors such as the richness of the ICT, fit between tasks and ICT, messages, or social influence (e.g., see [18]–[21]). We attempt to address this gap by focusing on how the use of a communication portfolio can manage perceived risks in the communication process. We study perceived risk in the communication process by examining three communication components—the message (i.e., reception of the message), the information (i.e., understanding the information in the message), and the action (i.e., action intended for the recipient of the message). We propose that perceived communication risks should influence the type of communication chosen for use. Specifically, we aim to explore the following research question: **What is the relationship between perceived communication risk and the usage of the communication portfolio?**

As mentioned in the abstract, communication portfolio refers to a set of ICTs that organization members use for communication. Specifically, the communication portfolio may contain a single ICT or multiple ICTs that should help organization members to manage the perceived communication risks and reduce threats to communication failure. However, we contend that such threats are not eliminated when the communication portfolio is not adequate to manage all the communication risks during the communication process.

The paper is organized as follows. In the following section, past studies on ICT research, communication, and perceived risks are reviewed. Communication risk factors are discussed next. The concept of communication portfolio and the communication risk perception framework are then presented. Next, using the shuttle Challenger disaster as an example, we illustrate how the communication risk perception framework may be applied. This is followed by a discussion of implications for research and practice. Lastly, the paper concludes with the contributions of the research.

**LITERATURE REVIEW**

**Perceived Risk in Communication**  Perceived risk measures beliefs of uncertainty regarding possible negative consequences of using a product or service. It has been defined as a combination of uncertainty plus the seriousness of the outcome involved [22]. Uncertainty refers to threats that are capable of producing adverse consequences. Therefore, a risky choice is one that contains a threat of a poor performance or an adverse outcome, and success is defined through the avoidance of such alternatives [23], [24]. Past studies have indicated that when risk involves great losses, individuals may seek to avoid risks or manage the risks rather than just accept them [25].

The basic function of communication is to affect receiver knowledge or behavior by informing, directing, and regulating [26]. Thus, in the communication context, perceived risk arises when a potential communication participant perceives possible threats to successful communication. The major focus in many past communication studies is whether the message communicated has been received (message reception) and information within the message has been understood (information
To Huber, MESSAGE refers to vehicles in which information is communicated (e.g., letters, reports, or phone calls) and INFORMATION refers to what is received by the senses such as numbers and words [27]. Poor or unsuccessful communication refers to (1) mechanical failure during the exchange of message between the sender or receiver or (2) any exchange of information that leaves the receiver unable or unsure of how to proceed with the sender’s intended impact.

When examining the impact of a communication, it is critical that we should not only be concerned with whether the message is received and understood but also with how the communication relates to a receiver’s action (i.e., receiver’s intent to act or react) [30]. According to Miller, communication is of central interest in those behavioral situations in which a source transmits a message to a receiver(s) with a conscious intent to affect the latter’s behavior ([31], cited by [26]). Thus, based on this definition, poor or unsuccessful communication can be defined as an impediment to action [30]. As noted by Weick, an equally important element of organization communication is action and most often organizational communication may even be viewed as the foundation for most organizational action [32]. Hence, as highlighted in past communication literature, the three important components in any communications are message, information, and action.

To explain the relationship between these three components of communication (i.e., message, information, action), we draw upon Berlow’s model of the communication process [33]. Specifically, he described communication as a process involving several distinct stages: message generation and transmission (i.e., message encoding and transmission via a channel on the part of the sender), information reception (i.e., message decoding and understanding on the part of the receiver), and possible action taken by the receiver (i.e., receiver is expected to take action after receiving the information such as replying to the sender).

Communication failure occurs when there is a mismatch between the expectation of the sender and the actions of the receiver. As noted by Weaver, communication failure can happen during different stages in the communication process [34]. Specifically, he highlighted three levels of communication problems. The first level, the technical level, concerns the accuracy of the transmission of information. The second level, the semantic level, deals with the meanings of the information source and receiver. Finally, the effectiveness level deals with the influence of information on the receiver.

By applying Weaver’s three levels of communication problems [34] to the communication process described by Berlow [33], we are able to outline the possible communication problems in the different components of the communication process and identify levels of perceived risk in communication. In the message component, a mismatch could occur when there is an error in the message generation, transmission, or reception, indicating that the receiver either did not receive the message or the message received was incorrect. We define PERCEIVED RISK OF RECEPTION for communication problems to be related to incorrect reception or absence of reception of the message component. In the information component, a mismatch would indicate that the receiver was not able to extract the intended information from the message. The risk associated with the understanding of the information in the message is known as the PERCEIVED RISK OF UNDERSTANDING. Finally, in the action component, a mismatch can occur when the action taken by the receiver did not match the intended action of the sender. For this component, we define PERCEIVED RISK OF ACTION as the risk associated with the implementation or intended action of the communication. Fig. 1 summarizes the perceived risks in different components of the communication process.

**Perceived Risk and the Use of Multiple ICTs** As noted in past studies, communication is inherently a difficult task since people tend to adopt only one perspective of reality, refuse opposite views, and converge on a solution prematurely [35]. This difficulty is further amplified when communicating partners are not co-located. Past empirical work has confirmed that people experience higher levels of conflict and misunderstanding when they have to work with distributed co-workers [36]. Relying on technology-mediated communication in such situations is likely to exacerbate these problems. This is due to the limitations of ICTs, such as a lack of verbal or nonverbal feedback, lack of visual feedback, and limitations of the written language [15]. Thus, any communications involving the use of ICT are very prone to a certain degree of risk and threats to poor communication.

The emphasis of past research on ICT use and choice has been on investigating and providing
explanations about why and when individuals use a particular ICT, such as email, rather than engage in a face-to-face conversation [4], [17], [37], [38]. Research on usage of multiple ICTs has not been well documented in the literature. However, the need for multichannel interaction and switching in the workplace has been acknowledged due to the complementary nature of different communication channels [39]. Specifically, as elaborated by [40], usage of multiple ICTs or media allows users to capitalize on the advantages and avoid the disadvantages of ICT. For instance, several studies have indicated that organization members tend to combine textual and audio media, such as sending a voice memo about a written report or making a phone call for a written memo [41], [42]. In addition, some studies have shown that high error costs will result in a preference for multiple channel usage [42], [43].

In recent years, the literature has provided more evidence that organizational communication is carried out with the help of a range of ICTs [44]. These commonly available ICTs include instant messaging, email, telephone, audio conferencing, and shared workspaces. In particular, Watson-Manheim and Belanger found that organization members who had access to a wide variety of ICTs and made communication choices (either single ICT or multiple ICT usage) based on established local practices, modified subsequent usage depending on the situation [11]. In addition, Woerner, Orlikowski, and Yates concluded from their field study that organizational members used single and multiple ICT work with colleagues who were both colocated and distributed across distant sites to accomplish different objectives during the interaction process [45].

Hence, it is likely that using different combinations of ICTs will be helpful to manage different communication situations. For example, some recent studies suggest that the combination of instant messaging with a phone call is useful to handle interruptions [13], [46]. In addition, Grandhi reported that subjects switched from instant messaging to a phone call to enhance the conversation [14]. If perceived risk in communication involves great losses, it is reasonable that individuals may try to develop and utilize a strategy to manage the risk and avoid the losses. Thus, the ability to adopt, combine, or switch to different kinds of ICTs to manage different situations is important for organization members to ensure effective communication [13], [44].

**COMMUNICATION RISK FACTORS**

From our review of past literature on ICT usage, we next identify the underlying risk factors that
may accentuate the different types of risks in communication. Identification of such factors will help organization members pinpoint precisely where communication problems lie.

**Risk of Reception** We contend that problems with the generation, transmission, and reception of the message with ICT will affect organization members’ perceived risk of reception. Message generation focuses on the creation of the message. It has been reported that when users are not familiar with the ICT or find ICT usage cumbersome, then they may experience message generation problems [7]. In addition, message generation via some ICTs (e.g., E-mail, NetMeeting) that require typing introduces a delay that affects the transmission and reception of the message [1], [42].

Transmission challenges are often exacerbated during technology-supported communication since unfamiliarity with ICT usage as well as ICT hardware and software failures may lead to connection and transmission delay (e.g., see [6], [7], and [50]). For instance, Olson and Olson elaborated that people using audio conferencing have trouble figuring out who is talking or what is being referred to [7]. Even the use of video camera does not solve the transmission problem entirely because several studies have found that transmission and reception problems worsen when people who are speaking are not on the camera [50].

The risk of reception is further amplified in some computer-mediated communications due to the lack of efficient feedback or acknowledgment [42], [47]. Without feedback or acknowledgement, the status of message reception can be ambiguous and can affect the accuracy of communication [48]. Subsequently, miscommunication and misinterpretation will happen as it is not clear whether the ICT failed to function properly or the receiver chose not to respond [49]. In sum, perceived risk of reception is affected by the following risk factors: generation, transmission, and reception of the message.

**Risk of Understanding** Risk of understanding is concerned with whether the receiver understands the information exactly as intended by the sender. Problems with message understanding occur when the receiver’s interpretation of the information in the message differs from the sender’s intended interpretation. We focus on three factors that pose potential threats to message understanding: cognition, affect, and shared understanding.

Past studies have shown that cognitive limitations will inhibit a receiver’s understanding of a lengthy or complex message sequence and thus affect a receiver’s ability to understand the message [3], [51]. The use of ICT can compel senders to fit cognitively complex messages to the capabilities of the ICT (e.g., one may be compelled to communicate a complex idea only verbally via telephone without the aid of a diagram, or only through sequential interactions among the participants via email). On the other hand, ICT can facilitate cognition and help a receiver to understand the message by providing tools such as a whiteboard or a shared database that supplies additional information or background knowledge to the complex idea. Taken together, the use of ICT can lead to changes in the cognition of the receiver(s) during communication—in both desired and undesired ways. These changes can enhance or diminish the risk of understanding.

Affective components enable senders to include information beyond the words themselves when the message is transmitted [52]. When verbal and nonverbal cues are removed, it takes longer and is more difficult to fully understand a message [16]. Exclusion of affective components, such as observation of facial expression, tones of voice, and gestures, tend to make it difficult for the receiver to interpret the emotions or moods from the message [53], [54]. Thus, this will increase the risk for the message to be misunderstood or interpreted incorrectly. Past studies have found that usage of some ICTs, such as telephone, email, fax, and audio conferencing, may inhibit the transmission of the affective components primarily because either the sender or receiver cannot hear the verbal cues or see the nonverbal cues of the other party [7], [16], [53]. Hence, limitations on communicating affect can influence the risk of understanding and need to be explored in relation to communication problems.

Finally, ICT can affect the risk of understanding (1) by affecting the sharing of understanding among participants, and (2) by facilitating the collaboration of a group of people that may a priori have limited shared understanding. Hence, lack of shared understanding between a sender and receiver implies that the sender and receiver have dissimilar backgrounds or they do not share the same context [55], [56]. The dissimilarities accentuate communication difficulties as it is more difficult to establish common understanding or knowledge between the sender and receiver which may ultimately affect communication outcome [29]. Furthermore, as noted in several past studies, unshared contextual and situational
information can lead to misunderstandings during communications among non-colocated members that rely mainly on ICT [7], [57]. In their study, Olson and Olson observed that misunderstandings arose during a video conferencing meeting between participants in the United States and Europe due to unshared contextual information about the cultural differences between the United States and Europe on saying farewell in a video conference meeting [7]. In sum, these three factors—cognition (i.e., cognitive limitation), affect (i.e., affective limitation), and shared understanding (i.e., lack of shared understanding)—pose potential threats to risk of understanding.

Risk of Action In this study, risk of action is concerned with whether the receiver implements the intended action required of him by the sender during communication. The impact and effect of communication on an individual’s course of action has been well-elaborated by Ackoff, who proposed that a message can inform, instruct, or motivate the receiver ([58], as cited in [26]). We found that there is a limited amount of literature examining the action component in the communication process and we are unable to uncover many well-documented risk factors affecting risk of action. Hence, we propose three potential risk factors based on Ackoff’s explanation above: inaction, incorrect action, and in-adaptive action.

For messages that aim to instruct or motivate the receiver, perceived risk of inaction exists because the message may be ignored, resulting in no action taken by the receiver. Specifically, past studies have shown that a receiver can easily ignore messages sent by an ICT that is low in social presence such as email [59]. Incorrect action is especially critical for instruction-based messages where wrong actions could potentially lead to undesirable outcomes. Past studies have indicated that the message has to compete with other activities to get the attention of the receiver especially during communication where it is not required for receiver to be at a specific time or place [40]. Without getting the required and relevant attention from the sender, it is possible that the receiver will take the wrong action.

In-adaptive action refers to the situation where the right action is taken without a good understanding of the message. Specifically, for messages that instruct, there is the risk that the receiver may just follow the instructions “blindly” without fully comprehending the action or the reasons behind the action. Consequently, the receiver may not be able to adapt the action if the situation or the condition changes, which is a common occurrence in the workplace.

Hence, for messages that serve to instruct or motivate the receiver, the action component becomes more critical and important in the communication process than for messages that serve only to inform. Specifically, if the intention is just to inform the receiver, the receiver may not be expected to take any action and therefore perceived risk of action may be nonexistent in such situations.

It is important to note that the three types of perceived risks have cumulative effects because it is possible that the perceived risk of reception and understanding may influence the perceived risk of action. Specifically, the problems with message reception and understanding may ultimately affect the course of action taken by the receiver. For example, it is likely that the receiver may take a wrong course of action if the message is not received or interpreted correctly.

The Concept of Communication Portfolio

We introduce the concept of communication portfolio to refer to a set of ICTs that organization members can use for communication. Specifically, the communication portfolio can contain a single ICT or multiple ICTs; hence, it can be characterized by size (i.e., number of ICTs used) and content (i.e., specific ICTs used). Also, there may be certain identifiable patterns of use of ICTs (i.e., structuring mechanisms) that characterize the portfolio [60]. We expect that different types of communication portfolios that vary in size, content, and structuring mechanism will be utilized in different situations. For instance, the size of the communication portfolio refers to the total number of ICTs used by the sender and receiver during the communication. The content of the communication portfolio refers to the mix of ICTs (i.e., single or multiple ICTs) used during the communication. The structuring mechanism of the communication portfolio refers to the usage pattern of single ICT or combinations of ICTs to manage risk perceptions during communication. We are concerned with three types of structuring mechanisms: sequential (i.e., switching from one ICT to another), concurrent (i.e., using two or more ICTs in parallel), and repetitive (i.e., using the same ICTs more than once) [60]. For example, using email and telephone at the same
time during a communication would constitute a communication portfolio of size two. The content of the communication portfolio would consist of email and phone calls, and the structuring mechanism would be concurrent. On the other hand, if email is being used repeatedly to send messages to and from, then the communication portfolio would be of size one, the content of the communication portfolio would consist of only email, and the structuring mechanism would be repetitive.

There are several reasons why we focus on the size, content, and structuring mechanism of the communication portfolio. First, the size of the communication portfolio is useful in determining the number of ICTs that organization members are handling under different situations. Second, examining the content of the communication portfolio can provide better insight into the complementary usage of the variety of ICTs available in the workplace. Third, the structuring mechanisms of the communication portfolio...
provide insights on how users manipulate the communication technologies to accomplish work [60]. Fig. 2 depicts the communication risk perception framework and illustrates the relationship between communication risk factors and the communication portfolio.

**AN ILLUSTRATION OF THE COMMUNICATION RISK PERCEPTION FRAMEWORK USING THE SHUTTLE CHALLENGER DISASTER**

There are many comprehensive and scholarly works that have conducted thorough reviews of the space shuttle Challenger disaster [61]–[64]. Because it has been investigated so exhaustively, the disaster affords a rich example that illustrates important issues related to communication. In particular, the accounts of the teleconference meeting the night before the Challenger launch have been widely reported. In fact, many publicly available reports have documented that the breakdown in communication between engineers and NASA officials during the teleconference meeting was a contributing factor to the disaster [61], [62], [65], [66]. Instead of providing an exhaustive historical treatment of the Challenger disaster, this article seeks to extract useful lessons from the Challenger disaster by focusing on the final communication incident leading to the launching of the space shuttle. Specifically, we draw from this communication incident to illustrate how different risk factors accentuate the different types of communication risks and the importance of taking proactive action to manage these risks. More specifically, we want to illustrate the potential disastrous communication outcome when such risks are ignored or are ineffectively managed and to show how the use of appropriate communication portfolio can help in the management of these risks.

**Space Shuttle Challenger Case Description**

The Challenger was scheduled to launch its 25th mission on January 28, 1986. The night before launching the Challenger, an audio conference was held between officials from Morton Thiokol (the firm contracted to build the rocket booster) and officials from NASA to discuss the decision to postpone the launch. Due to the uncommonly low temperatures forecasted in Florida at the launch site, the engineers from Morton Thiokol were very concerned with the possibility of O-ring seal erosion that would pose potential danger to shuttle flights. Despite repeated warnings of catastrophic consequences given by the engineers, data presented during the teleconference were deemed inconclusive and did not convince the management of Morton Thiokol and officials at NASA that the launch would be unsafe. Hence, the decision from the management of Morton Thiokol was to proceed with the launch. NASA officials readily accepted the recommendation by the management of Morton Thiokol and further requested a written copy of the recommendation. The next day, about a minute into the flight, the flames from the failed solid rocket booster burned through the fuel tank and the Challenger and its crew members perished in an explosion [62].

The main communication incident we examine in the Challenger disaster is how the engineers communicated the concerns about the serious technical problem regarding the safety of shuttle launch during the teleconferencing meeting. There were 32 individuals involved in the communication incident and they were from three locations—16 NASA officials from Marshall Space Flight Center (MSFC) in Huntsville, Alabama, 14 from Morton Thiokol Wasatch Division in Brigham City, Utah, and 2 from Kennedy Space Center (KSC) in Florida. The two individuals located at KSC were the manager and director from Morton Thiokol in charge of the operation. Since the engineers and NASA officials were located in different locations, they often had to rely on communication technologies such as email, fax, memo, and teleconferencing for communication purposes. The teleconferencing meeting was the final communication incident preceding the Challenger disaster among all the meeting participants. Thus, the questions we explore are: Are there any risk factors in this particular communication incident that could have accentuated the risk of reception, risk of understanding, or risk of action? How did the different types of communication risk affect the communication failure during the meeting?

**Data**

In this study, we use secondary data to investigate the relationship between the different risk factors and the type of perceived risks and their effects on the final communication outcome. The secondary data for this research were gathered from multiple publicly available sources, namely testimony before the Presidential Commission, congressional hearing records, NASA’s archival reports, reports in magazines and newspapers, journals articles, and books. The data can be classified under three main sources—print media, official government reports/documents, and other sources. We adopted the triangulation procedure by collecting the data from a variety of data sources to clarify the meaning and to provide us with different perspectives on the same event [67].
This procedure minimizes the possibility of misinterpreting the data and allows a better generality of the explanations. The data sources used are detailed in Table I.

A member of the research team went through all the data sources to look for reported communication problems during the teleconferencing meeting. For each reported communication problem, the potential risk factors (as illustrated in the communication risk perception framework) that might accentuate the different types of communication risks were identified. The reported communication problems were further verified with other data sources. We concentrated on communication problems that were commonly cited in the various data sources. Each communication problem was then categorized under different types of perceived communication risks based on the identified risk factors. Due to the cumulative effects of the communication risk perceptions, a communication problem categorized as risk of reception might also subsequently influence the risk of understanding and action. Hence, it is likely that a communication problem categorized under perceived risk of reception might also be categorized under perceived risk of understanding. Our main aim in this process is to uncover the potential communication risk factors and whether they influenced the communication portfolio used. The initial findings were discussed with another member of the research team until both of them agreed on the groupings of the communication problems. A sample of the identified communication problems is shown in Table II. Our data analysis provided evidence that the communication problems reported during the teleconference meeting can be classified under three types of risks (i.e., perceived risk of reception, perceived risk of understanding, and perceived risk of action). We found that the communication portfolio chosen for use during the communication incident was adequate to manage some communication risks, but there were also some risks that were not effectively managed by the chosen communication portfolio. Based on these findings, we proceed to discuss the case in the following section.

### Case Discussion

The NASA officials and management at Morton Thiokol were the key decision makers who needed to take critical actions to decide if the schedule of the launch should be delayed. The engineers had communicated to management their concerns with the O-rings many months before the scheduled shuttle launch via fax and memo [65]. Even though we did not find much documented evidence of reception problems with those messages, we contend that the teleconferencing meeting itself may have created significant communication risk of reception. Specifically, given the fact that most of the materials required for the teleconference meeting were prepared hurriedly and faxed just prior to the meeting, it would be highly likely that some of the materials might not have been received in the intended order or the image or diagrams might not have been clearly illustrated. Furthermore, since there were 32 attendees in the meeting from 3 different locations, it is highly possible that some of the side or local conversations were not transmitted or received by others in different locations. Specifically, it has been shown in past studies that people using audio conferencing have trouble figuring who is talking or what is being referred [7]. Hence, the problem with message generation, transmission, and reception during the use of the teleconferencing system might have heightened the risk of reception during the meeting.

### Risk of understanding

Appeared to be a major factor in this particular communication incident. First, the engineers from Morton Thiokol, the management of Morton Thiokol, and officials...
TABLE II(a)
SAMPLE OF THE IDENTIFIED COMMUNICATION PROBLEMS

<table>
<thead>
<tr>
<th>Communication Problem</th>
<th>Supporting Quotes</th>
<th>Possible Risk Factors</th>
<th>Types of Risk: RR, RU, RA</th>
<th>Manage risk with communication portfolio?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Numerous charts were made hurriedly and faxed to meeting participants just before and during the teleconference meeting by the engineers at Morton Thiokol. Due to the volume of fax materials and the insufficient time to prepare and organize the materials ahead of time, the faxed materials may not be transmitted and received clearly in the intended manner which might ultimately affect the reception of the message.</td>
<td>1. Robert Lund (Vice President, Morton Thiokol): We tried to have the telecon, as I remember it was about 6:00 o’clock [MST], but we didn’t quite get things in order, and we started transmitting charts down to Marshall around 6:00 or 6:30 [MST], something like that, and we were making charts in real time and seeing the data, and we were discussing them with the Marshall folks who went along.</td>
<td>Potential problems in the message transmission and reception since messages (i.e., fax materials) may not be transmitted and received in the intended manner</td>
<td>RR</td>
<td>No</td>
</tr>
<tr>
<td>2. George Hardy (Deputy Director, NASA): At the teleconference on the evening of January 27, 1986, Thiokol engineering personnel in Utah reviewed charts that had been data-faxed to Huntsville and KSC participants just prior to the beginning of the conference. ... There was a discussion of various data and points raised by individuals at Thiokol or at Marshall or at Kennedy. I think it was a rather full discussion. There were some 14 charts presented, and as has been mentioned earlier, we spent about two, two and a half hours reviewing this.</td>
<td>Allan McDonald (Director, Morton Thiokol): The teleconference started I guess close to 9:00 o’clock and, even though all the charts weren’t there, we were told...</td>
<td></td>
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</table>

from NASA did not share the same engineering background. Due to the difference in backgrounds, it was not surprising that engineers and managers (from both Morton Thiokol and NASA) did not agree about the O-ring problem because they had different interpretations of the risk involved with the shuttle [66], [69]. In fact, it has been found that managers did underestimate the risk involved with the shuttle due to their lack of technical expertise in engineering [70]. Hence, we contend that the lack of shared background between the receivers and senders contributed to the risk of understanding in communication.

Second, it is possible that the risk of understanding during the teleconferencing meeting was further elevated due to the lack of affective components in the message. Specifically, the engineers at Morton Thiokol were very worried and concerned about the problems of O-ring seal erosion and the potential danger it posed to the launch. However, the recipients of the message were not able to effectively decipher the affective components of the messages, such as the worries and concerns of the engineers via teleconferencing system or fax. As elaborated by Te’eni, affective components in a message can be used to sustain favorable attitudes and dispositions during communication [30]. Hence, exclusion of these affective components can be detrimental to the effectiveness of the communication.

Third, the cognitive limitation in that situation could have further affected the risk of understanding. Since a complex message requires a high cognitive ability to process the information during communication, it is likely that the meeting attendees require a high level of cognitive ability to understand a highly technical, complex, and urgent problem [40]. The fact that the meeting participants were in different locations could have compounded the communication complexity and increased demand for high cognition to process all the information during the communication. Specifically, Cramton has concluded that communication partners who are not colocated typically demand high cognition during communication [29]. Apparently, the choice of the teleconferencing system did little to alleviate the high cognition demand since it did not permit transmission of a complex diagram and pictures. As a result, the engineers had to delay the teleconferencing meeting to prepare additional visual materials for faxing to KSC and MSFC to complement the teleconferencing meeting. However, it appears...
that the faxed materials did not provide as much detail as the engineers wanted since officials from NASA found the data presented was inconclusive. Hence, cognitive limitation in terms of not providing enough visual materials, affective limitation of not transmitting the emotions associated with the message, and the lack of shared understanding in terms of the different backgrounds between the receiver(s) and sender(s) might all have contributed to the risk of understanding.

In this particular communication incident, the high potential risk of action resulted in a catastrophic consequence. The main risk in this incident was the incorrect action taken by the officials from NASA and the management of Morton Thiokol to allow the shuttle to launch. In addition, one could also argue that the risk of reception and risk of understanding might have also affected the actions taken because the message was not received properly and the meaning of the information was not adequately understood. Hence, in many actual circumstances the risks of reception and understanding might have some cascading effects on the risk of action.

Were the participants of the meeting aware of risk factors that may have accentuated the different type of risks in communication? Could the communication risks be managed effectively by communication portfolios such that the disaster could have been prevented? The existence of the different types of communication risks in the incident is evident; however, it appears that different meeting participants attempted to manage different risks. The NASA officials appeared to be concerned with the perceived risk of action while the engineers were concerned mostly with the perceived risk of understanding.

To manage the risk of action, NASA officials requested a written copy of the recommendation from Morton Thiokol since the written document would serve as a form of accountability. Keeping permanent records has been shown to help avoid potential dispute and blame between parties [71]. To manage the risk of understanding during the teleconference meeting, the engineers combined the use of faxing with the audio conferencing system. The faxed materials were able to provide explicit context in the form of external representation.

### TABLE II(b)

<table>
<thead>
<tr>
<th>Event</th>
<th>Participant/Source</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Roger Boisjoly (Morton Thiokol): Then MTI management then asked for a five-minute caucus. I'm not sure exactly who asked for that, but it was asked in such a manner that I remember it was asked for, a five-minute caucus, which we put on the line on mute and went off-line with the rest of the net.</td>
<td>RR</td>
<td>No</td>
</tr>
<tr>
<td>2. George Hardy (Deputy Director, NASA): The status of the caucus by Thiokol lasted some 30, 35 minutes. At Huntsville during this Thiokol caucus, we continued to discuss the data presented. We were off the loop, we were on mute.</td>
<td>RR</td>
<td>No</td>
</tr>
<tr>
<td>3. Some meeting participants did not generate message and participate in the discussion because they were not comfortable to</td>
<td>RR</td>
<td>No</td>
</tr>
</tbody>
</table>

Source: Testimony of the teleconference meeting, Official Government Report/Document [82]
ICT communication portfolio consisting of fax and audio conferencing system using concurrent structuring mechanism was used to manage the risk of understanding. Hence, the perceived communication risks during the communication process did influence the type of communication portfolio the meeting participants chose to use.

With regard to the other risks discussed earlier, it was apparent that the meeting participants were either not aware of or had completely ignored them. Specifically, the perceived risk of understanding could be highly alleviated by the lack of affective components in the message and the risk of reception of the message. At the meeting, the participants were connected by audio (not video) conferencing. It is not clear whether the video quality in 1986 could have provided more insightful details on the affective mood of the meeting. However, if the worried facial expression of the engineers had been visible via video conference, it is likely that more time might have been devoted to understanding the seriousness of the O-ring problem since video can help to disambiguate difficult to understand audio [72]. In addition, a concurrent structuring mechanism using a multiple-ICT communication portfolio might help to manage the risk of understanding. Specifically, the presentation of the visual materials via a more interactive system such as NetMeeting might have helped engineers in explaining the problem much better than just the paper materials sent via fax during the conference call. Therefore, it is likely that with better understanding of the seriousness of the O-ring problem, a possible different action might have been taken if sufficient steps had been taken to manage the risk of reception and risk of understanding. (Note: We acknowledge that there are other institutional, historical, political, and cultural factors which also affected the shuttle launching decision but are beyond the scope of our discussion in this paper.)

We believe that our analysis illustrates the usefulness of our communication risk perception framework. Overall, the size, content, and structuring mechanism of the communication portfolio used during the Challenger communication incident appeared to have potential influences on managing the different communication risks. More importantly, we found that some of the perceived communication risks were not managed effectively
by the communication portfolio used during this communication incident, which consequently may have had an influence on the disastrous communication outcome.

**IMPLICATIONS FOR RESEARCH AND PRACTICE**

The major implication for research is the identification of a much understudied area, the relationship between multiple ICT usage (i.e., communication portfolio) and an individual's communication risk perception. Although there is an abundance of research on ICT selection and usage in organizations, very little has been done to understand how and when organization members cope with multiple ICTs in the workplace. Furthermore, our literature review suggests that there is a lack of a clear underlying model of the relationship among core communicative phenomena such as processes, problems, technologies, and communicators' risk perceptions in the media choice literature. Specifically, as Te'eni pointed out, there is little research on the negative impact of communication when ICT is used (particularly focusing on communication failures and problems) [30].

Another major implication for research is the proposed communication risk perception
framework that provides a conceptual foundation from which to further explore the effect of individual risk perception of the communication on the usage of the communication portfolio. Our framework focuses on the risk perception of different components in the entire communication process (i.e., message, information, and action) from the perspective of the sender. Perceptions of the communication are a fruitful area for potential theoretical development since many past studies on ICT selection and usage primarily focused on users’ perceptions of the ICT [16]. Specifically, more research on the communication risk perception from the perspective of the receiver and how these perceptions differ between the sender and receiver can be further explored. Moreover, we have identified the action component of the communication process as an important but surprisingly understudied area, which should be examined further from both the sender and receiver perspective. Another important area for further research is to extend the communication risk perception framework to examine how individuals can use a communication portfolio to perform multiple communication tasks concurrently. Specifically, the use of ICTs such as instant messaging and email allows individuals to chat with one person and talk on the phone with another person. This is definitely an interesting phenomenon that warrants further research.

We believe that the proposed communication risk perception framework has important implications for practice. First, understanding communication risk factors allows organization members to be able to be aware of the types of risks that are eminent during communication. This is especially important during critical decision-making situations. Specifically, such understanding allows organization members to choose an appropriate communication portfolio so that they will be able to manage the communication risk effectively. For instance, if individuals involved in the launching decision of the shuttle Challenger had been aware of the communication risk factors that would have accentuated the high perceived risk in reception and understanding during the teleconference meeting, they might have proposed a face-to-face meeting instead. Second, due to the cumulative effects of the perceived communication risks, organization members should be very cautious during communication situations involving high perceived risks in action. During such situations, the communication portfolios used by organization members must first ensure that the perceived risks of reception and understanding are managed (i.e., the message to be received and received messages to be understood) before they can manage the perceived risk of action (i.e., the appropriate actions can be taken by the receiver(s) of the message).

CONCLUSION

A major contribution of this study is organizing diverse literature on communication, ICT usage, and risk perception into a coherent communication risk perception framework. Specifically, there is a distinct lack of research directed toward understanding communication technology usage from the perspective of perceived risk during the communication process. Our proposed framework is able to explain how the use of a communication portfolio can manage perceived communication risks to achieve effective communication. Ultimately, the aim of the framework is to provide better insights into the complex relationship among technologies, communication processes, and the perceptions of the organization members in the workplace. In addition, using the shuttle Challenger incident, we have also illustrated how the risk factors may accentuate the different types of communication risks and how the size, content, and structuring mechanism of the communication portfolio may be effective in managing these risks. Thus, from this study, we have taken an important first step to expand our knowledge on the impact of risk perceptions of the communication processes on the communication portfolios used by organization members.

REFERENCES


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