DISSERTATION

EXPERIENCING INFORMATION: USING SYSTEMS THEORY TO DEVELOP A THEORETICAL FRAMEWORK OF INFORMATION INTERACTION

Submitted by

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ABSTRACT

EXPERIENCING INFORMATION: USING SYSTEMS THEORY TO DEVELOP A THEORETICAL FRAMEWORK OF INFORMATION INTERACTION

This study outlines the construction, development, and initial testing of a proposed theoretical framework and measure for information interaction. To address the challenges associated with experiencing information, I synthesized existing literature from complementary and multidisciplinary domains of cognitive psychology, computer science, and organizational communication. I initially proposed theoretically driven components of information interaction based on a literature review, followed by a multimethod evaluation to further develop and refine the framework. Quantitatively, I researched organizational practices used for managing the information environment. Empirically, I collected data using multiple samples to test the psychometric properties of a proposed measure of information interaction. I used structural equation modeling to assess relationships associated with information interaction to develop its nomological network. The findings of these studies have implications for research and practice by establishing a new theoretical space in Industrial and Organizational Psychology, using a systems approach to construct development and application, and providing organizations with a mechanism for constant, minimally obtrusive collection and assessment of the information experience of members within the organizational system.

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THE NEED FOR A MEASURE OF INFORMATION INTERACTION

Technological advancements and rapid globalization have created an increasingly volatile, uncertain, complex, and ambiguous environment for organizations and its members (Bennett & Lemoine, 2014). The problems facing today's workforce call for a systems perspective of organizations, built on solid foundations of multidisciplinary linkages to create collaborations in research and practice (Kozlowski, 2017). Several trends associated with an increasingly complex world call attention to the need for understanding how people interact with information in organizations. These trends include the accumulation, usage, and quality of data for decision making.

The first trend is illustrated in organizations recognizing the need for greater perspective of operations in their own ecosystem within a broader societal context (Aguinis & Glavas, 2012). Building perspective and awareness requires seeking feedback on services provided, or functions performed, to better understand the client/customer base. But, rather than conduct lengthy assessments that produce a small volume of very detailed data, companies have turned to using short and simple feedback mechanisms designed to gather large volumes of data; a trend of using big data in an attempt to improve decision-making (Janssen, van der Voort, & Wahyudi, 2017). For instance, the placement of groceries at a grocery store is noted in the bar code of each product. Each time someone buys an item the bar code is scanned and tallied providing instant feedback to the store on how many of those items were bought that hour, day, or week. The purchase volume provides feedback on whether the placement on the shelf (e.g., top, middle, or bottom) is good or bad. If the store moves the item to a new location, new purchase trends can be monitored and compared to product placement and how customers may notice the item. Thus,

the combination of all shoppers' purchasing behaviors across products and stores provides voluminous, varied, and high velocity data, otherwise known as *big data*. Hence, big data are gathered to inform decisions related to offering consumer goods and services, such as advertising, internal communication, or other organizational functions.

A second trend of information within organizations is in making sense of all that data, which can be enhanced with data visualization, or the graphical representation of data. Data visualization is now recognized as one of the top requirements for organizational development, especially for communicating the importance of analytics to support data-driven decisions (https://www.siop.org/Business-Resources/Top-10-Workplace-Trends). The trend toward data visualization is also associated with a greater appreciation for and use of informational cues or displays focused on creating a logical, interactive experience for the information user. Visualization of information has been highlighted as a tool to enhance appeal, comprehension, and retention of information (Alsheri & Ebaid, 2016). When done properly, data visualization serves as possibly the most effective communication tool available to convey information (Toth, 2013), and make sense of data. Examples of data visualization include the time-progressive maps of worldwide spread of COVID-19 developed by Johns Hopkins University (https://coronavirus.jhu.edu/data/animated-world-map), which various organizations have been using to make decisions about how to address the associated pandemic. Another is an animated simulation of how adults in the U.S. spend their time during a single day (https://flowingdata.com/2019/03/06/women-men-timeuse/), which could be used to influence decisions around when people might be more available to participate in activities, to shop, or engage with electronic entertainment.

Informed decision-making also relies on access to quality information, which marks the third trend arising from a more complex world. Quality information refers to that which the user considers as useful or valuable for decision-making. Quality information may reduce uncertainty in decision-making, which could make individuals more confident and increase their willingness to take risk in the face of complexity or ambiguity. However, organizations typically have limited assessment mechanisms that focus on the value of information and how that information is communicated throughout the organization. Thus, while today's organizations use and share more information across all levels of the hierarchy and all functions of business than ever before, the information may not be quality controlled. Big data are not necessarily quality data.

In sum, the last decade has revealed work environments as becoming increasingly more complicated, causing organizational leaders and their followers to rely on massive amounts of information to make increasingly complex and system-wide decisions. Yet, the literature on how users interact with that information, use it to make effective decisions, and work efficiently as a result, is underwhelming, leaving a critical gap in the linkage between practice and science. Thus, I propose a new theoretical framework for understanding how the design and utility of information, contextualized by the information environment, is associated with an organization's use of and value placed on information, deemed *information interaction*. Put simply, the framework explains how people interact with information and what happens as a result of that interaction. The three trends of (1) accumulating and understanding vast quantities of data (big data), (2) making sense of what the data represents (data visualization), and (3) the critical need to understand the value/quality of the information communicated, alongside the increasing use of such information across and within all levels of an organization, highlight the necessity for a framework derived using a systems perspective. To test the validity of the framework

adequately, I will first create a measure that assesses the value of information to a given user within their information environment, since no generalizable measures currently exist that use a systems approach to capture utility, design, and context for information at all levels within an organization.

Developing a Conceptual Definition

My framework for information interaction provides a foundation for how individuals interact with information at the micro, meso, and macro levels of organizations, and how the usefulness of the information may change as it traverses organizational units. Because information is shared, used, and made sense of across and within multiple levels and functions of an organization, I ground my approach in organizational systems theory (Katz & Kahn, 1966), which applies a systems theory perspective (Bertalanffy, 1951) to organizations, viewing them as a broad system encompassing many interdependent components. Consistent with a systems perspective, my framework will specify how information interaction is associated with outcomes in every organizational function (e.g., leadership, training, teams), providing propositions for exploring the interconnectedness that drive an organization. The use of propositions is recommended when consolidating multiple perspectives, especially for advancing general scientific research, in order to summarize main ideas and provide focus for advancing the construct being studied (Gioia, Corley, & Hamilton, 2013). I conceptualized the propositions using a measure designed to operationalize information interaction. I designed the measure in line with the demand for quick, non-invasive measurement practices that can be embedded into everyday actions and collected and incorporated into artificial intelligence (AI) systems.

Approach

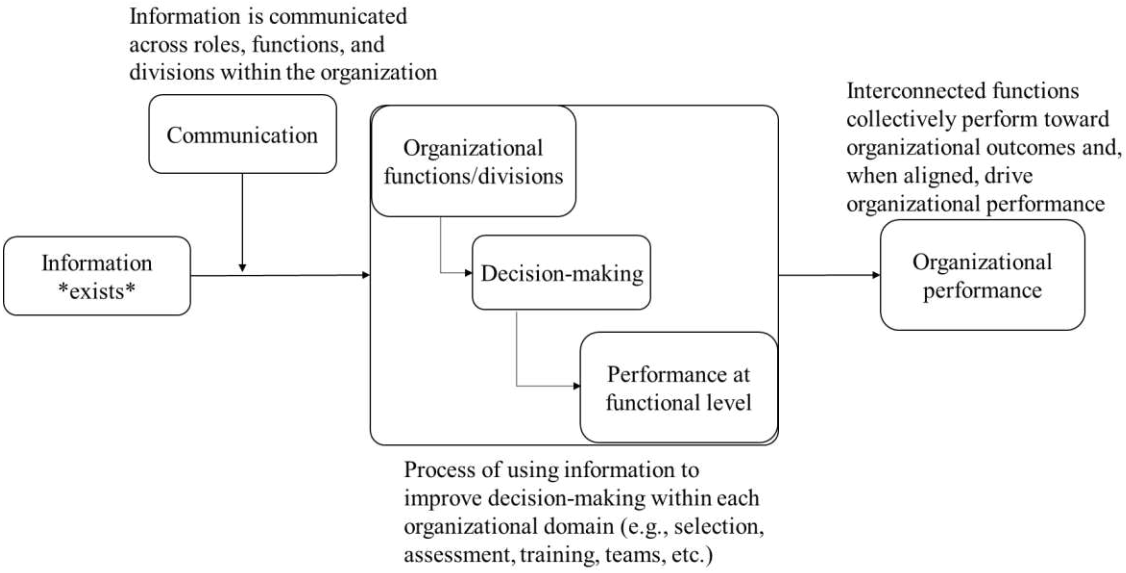
I developed my conceptual definition of information interaction using a multi-stage approach recommended in methods research (Podsakoff, MacKenzie, & Podsakoff, 2016). First, I identified potential attributes of the concept based on theoretical representations of information experiences from existing literature. For example, cognitive psychology, communication studies, and computer science each offer research findings on related concepts, yet they are unique and do not directly address the information experience within organizations. Therefore, I draw from concepts within these disciplines to inform the development of information interaction and to recognize related research in other disciplines. This multidisciplinary approach establishes a systems perspective through understanding human information processing, patterns and style of communication in a system, and theories for building a shared logic and language that empowers end users. Additionally, I conducted case studies and interviews to further understand potential attributes of the information experience. Next, I organized attributes based on thematic content, condensing them into a concise framework of dimensions based on shared criteria. Using the proposed framework, I developed a preliminary definition of information interaction, along with supporting attributes, dimensionality, and relation of my construct to other concepts. Finally, I tested the concept through feedback from peers and subject matter experts, exploratory and confirmatory factor analysis, and through testing in organizational settings to assess the nomological network; the interrelationships of observable manifestations linking concepts and theories (Cronbach & Meehl, 1955).

IMPETUS FOR DEVELOPING A FRAMEWORK AND MEASURE OF INFORMATION INTERACTION

The driving need for a new framework and measure of information interaction comes from demand within both research and practice. At a recent conference, corporate human resource (HR) officers acknowledged the need for a better understanding of how organizations adapt to new information in the wake of advancing technology in the workforce, such as AI and global connectivity (2019 SIOP Horizons project). Similarly, a task force of researchers and practitioners in Industrial/Organizational (IO) psychology recently called for new methods to incorporate AI and big data approaches to increase access to more usable information (SIOP 2017 futures task force). Additionally, researchers recently noted a need for "tackling big problems…[at] individual, team, and higher-level performance – in complex, technology enabled, organizational, and trans-organizational systems" (Kozlowski, 2017, p.5). Lastly, scholars have proposed the future for IO psychology must address organizations as systems, incorporate multidisciplinary research, and develop online, unobtrusive measures capable of dynamically capturing multilevel states (Salas, Kozlowski, & Chen, 2017). Cumulatively, the push for understanding how users interact with information is coming from scientists and practitioners across a number of disciplines.

Applying a systems perspective, I illustrate in Figure 1 how information interaction connects all organizational functions.

Figure 1.



Micro to macro perspective of information to organizational performance

Note. This figure depicts how information originating at the micro level can be accessed, communicated, and transformed throughout various levels and functions in an organization to ultimately drive organizational performance at the macro level.

Background and Developmental Framework

To develop my framework and the measure of information interaction I draw from the foundations of related disciplines' understanding of information. These disciplines include cognitive psychology, human factors, computer science, and communication studies. While each area has advanced an understanding of information and its use, each discipline approaches the topic from its unique perspective, which does not include an organizational perspective. To incorporate an organizational perspective, I use organizational systems theory (Katz & Kahn, 1966) as the foundation for connecting the findings from the various disciplines.

In this next section, I first explore the basic principles of systems theory and how it provides an approach for considering organizations as a collection (or system) of components. Second, I frame the individual level, or micro level, of my model using research in information processing and decision-making from cognitive psychology and human factors. Third, I expand to the macro level and use computer science research as the foundation, which exemplifies how the application of logic and interface design are utilized to create and structure ever-expanding networks. Finally, I frame the meso level by drawing from theories in communication studies. The principles of organizational communication demonstrate how information is transmitted to connect the micro (people) and macro (decisions or processes) levels of organization. After reviewing how each discipline has approached the study of information, I synthesize the findings to frame my initial theory of information interaction. The synthesized findings are collectively captured in Appendix A, visualized as a series of propositions from each discipline, which feed into the dimensions reflecting information interaction.

Organizational and System Theory

Organizations represent socially constructed systems that direct and combine human activities toward shared objectives and outcomes. Organizational members engage in interdependent activities embedded in the organization, which serve to combine personnel and resources (Scott & Davis, 2015). These activities are interwoven through information sharing and connect personnel with resources and with each other. Drawing from sociological systems thinking (Boulding, 1956), organizational systems perspectives focus on interrelationships of the organization, viewing the organization as a whole with interconnected patterns. This view is in contrast to considering organizations in snapshots or within single functional areas. Thus, viewing the organization as a system allows for appreciating the "whole" of a system, while

simultaneously requiring acknowledgement of the various components that combine to make the whole (Whitten & Bentley, 2006). Although each organizational domain (e.g., marketing, sales, or administration) may have unique functions and tasks, these functions work together to ultimately drive and fulfill the mission or strategy of the organization.

Taking a systems perspective to understand information interaction is necessary for building a framework for how information is understood, valued, and used in organizations. Prior research into the distribution and sharing of information has previously focused on network structure and nodes to explain organizational change and performance (Nebus, 2006; Shaw, 1954). However, networks alone do not capture the value of information existing in the network, nor the transformative process of organizations in response to information. Rather, networks are reflect communication mechanisms and structure designed to manage information flow. Networks carry or transmit the information, but do not provide insight into whether the information is valuable or how it might change as it is transmitted from point to point. Thus, I propose that the influence of information is better captured by explanations grounded in systems theory (Bertalanffy, 1951), than by transmission modes (i.e., via networks) or a singular focus on transmission purposes.

The use of systems theory is not meant as a catch-all to predict and control organizational events (Jones, 2014). Rather, systems theory provides a lens to help understand connections within and beyond an organization, and how organizations engage in a continuous transformation process. Systems theories highlight the interaction of all functional areas within an organization, and the role of information as a key enabler of the feedback process that energizes each area and drives transformation within the organization. Organizations have used systems thinking in strategic decisions, managing organizational interdependence, and to sense

environmental changes that impact the organization and the world around them (Aguinis & Glavas, 2019; Jones, 2014). From an organizational system view, the system comprises a macro level of both social structure (environmental pressures, shared values and expectations) and physical organizational structure. The development of organizational structure informs organizational design, which in turn governs the flow of information within the system.

Organizational systems theory (Katz & Kahn, 1966) has been pivotal in shifting the focus of research from collective organizational output to an appreciation of the full organizational process. This theory proposes an approach that uses feedback cycles and information input as signals of environmental conditions associated with how organizational elements adapt. Importantly, the conceptual model of information input, processing, and output is similar to the systems view proposed in cognitive psychology for information processing, and the computer science perspective of information development, both concepts explored later in this paper, and both of which inform the framework.

Furthermore, organizations are informational systems built around a need for improved decision-making capability to increase performance. The magnitude of decision-making power increases as information value and the ability to act on information increases (Katz & Kahn, 1978). Attempts to improve decision-making lead to greater emphasis on communication or information exchange. However, exchange of information is not simply a product of the amount of information present or hierarchical level of communication between two entities. Unrestricted communication can lead to inefficiency or noise in a system (Bruine de Bruin, Parker, & Fischhoff, 2020). Organizations seeking to maximize information exchange may instead use structure to govern the patterns of communication that dictate directionality and control of information. For example, bureaucratic systems implement a series of reviews and approvals to

filter information sent up hierarchical levels of decision-making. The review and approval process is a communication pattern intended to reduce extraneous information presented to high-level decision-makers, while maximizing the usefulness of information presented for action (Lee & Edmondson, 2017).

Communication patterns are created based on a desire for efficiency (speed and accuracy), the nature of communication, and the fit of communication with organizational functions (Roberts & O'Reilly, 1974). By considering directionality, along with formal versus informal communication opportunities, communication practices can serve to limit information overload while providing necessary information for decision making.

Organizations as decision machines (organized social systems) are designed to enhance rationality and efficiency toward common goals and objectives (Nassehi, 2005). Decisions are tied to organizational goals and objectives, characterized by their specificity, reach, and duration of outcomes. The effect of decisions is continually assessed within the greater organizational system using feedback measures – thus feeding the cycle of inputs, processing, and outputs, that govern the transformation of an organization as a system (Katz & Kahn, 1978). The value of information in this decision cycle can determine the quality of the decisions made and the effect of the decisions on future organizational transformation.

Building the Micro-level of the Framework: Cognitive Psychology

Research in cognitive psychology and human factors has advanced our thinking about individuals operating in a system, processing information, and communicating, and how these mechanisms work together to support decision-making. Within cognitive psychology and human factors, a person is viewed as an operator within a larger physical system and is represented by variables such as functions and tasks they perform, and the knowledge, skills, and abilities

(KSAs) they possess. Taking the operator concept further, people are individual processors within the system; taking input, engaging and communicating with it, and producing output. To this end, people interact with information in a system through the search for information, processing of information, problem solving and decision making, and task engagement. To understand human information processing (as opposed to machines), researchers have examined how adequately people use information as it was intended to be used; a ratio that represents the reliability of information processing (Cowan, 1988). To achieve adequate use, the person must be able to interact with and process the encountered information in a usable and efficient way.

Information Theory and Signal Detection

Research by Shannon (1948) used information theory to explore information intake, engaging with information as it was intended to be used, and concluding with a decision or solution to a problem. Information theory quantifies the amount of information that can flow through communication channels (Garner, 1962; Shannon, 1948), essentially identifying the capacity limits of the channel. Since its introduction, information theory has been applied across a variety of disciplines including psychology. Psychologists applied information theory to human performance using signal detection theory (Fitts & Posner, 1967; Macmillan & Creelman, 2004) to facilitate understanding a person's experience with information. Signal detection theory explains the cognitive process of identifying signals as a function of (a) the discriminability of a signal, and (b) the criterion an individual sets for the amount of evidence needed to identify a signal. Discrimination refers to ability to identify applicable information given noise, or ancillary information not directly related to one's current thought process. Individual response criterion reflects internal processes that may alter how an individual decides to react to a given piece of information, such as a doctor deciding whether or not to operate based on an ambiguous CT

scan. Specifically, signal detection theory explains how people respond to information given their environment and their internal processes. For example, signal detection theory has been used to quantify individuals' reaction to uncertainty based on the presence or absence of information (Strange, Duggins, Penny, Dolan, & Fristin, 2005) and to complexity of operations in controlled spaces, such as the control room of an electrical power plant (Kang & Seong, 2001).

Although the signal detection approach has been useful in explaining human behavior as "operators" in response to the information environment, this approach to information measurement is based on recognizing absolute judgments (the presence or absence of signal). With signal detection theory, information is treated as the reduction of uncertainty and measured based on the occurrence of information events compared to the potential likelihood of that event occurring (Shannon & Weaver, 1949). Signal theory in this case has been focused on the human as a transmitter of information and as a behavioral response dependent on the amount of information available. Recent work in signal detection theory is exploring the operating characteristics of the receiver, such as confidence of the individual. This avenue of research represents an opportunity to expand understanding of the subjective experience of the person during an information experience. As illustrative, individuals may assign quality/value to information, regardless of whether or not the information is acted upon. For instance, an individual may participate in a required training session for work: they may click through online training, complete all the tasks, and even achieve a perfect score on the training assessment. However, they may regard the information in the training as not valuable to them and may make no effort to retain or put the information into practice unless forced. Thus, while signal detection

theory provides insight into how people respond to accessible information in the environment, it does not capture the full context of how people use information.

Information Load and Capacity

Information load and capacity are key concepts of information theory and signal detection theory, which both treat the human as an *information channel* (Wickens, 2014), and are a component of the value of information. Specifically, information load refers to one's ability to handle the available information within a given context, comprising bandwidth, loss, and noise. An individual's bandwidth is calculated by the amount of information transmitted from a stimulus to the response. Bandwidth is the capacity for response and the time needed to respond and may be reduced due to loss and noise. Loss occurs when information fails to traverse from stimulus to response. Noise occurs when additional information conflicts with or is added to the relationship between stimulus and response, making it difficult to extract the relevant stimulus. Bandwidth, noise, and loss provide insight into individuals' capacity to use information and are thus important elements for conceptualizing information interaction. Current assessment of information load and capacity is heavily focused on task analysis, such as sequential processing and basic tasks or behaviors such as typing or using a control panel, in order to understand the effects of bandwidth, noise, and loss in relation to task completion. The task analysis framework does include a weighting function, though the scope is somewhat limited in accounting for the extent of information flow, multiple layers, or different information channels in an organizational system (Laming, 2010). The capacity of an individual information channel is a building block for understanding information value in an information environment. To this end, information load and capacity can contribute a measure of other attributes of information that individuals consider

in their efforts to filter, store, and use information. Specifically, the contribution may be in the form of quality/value of information, which in organizations is essential to decision-making.

Decision-making

The value of information may become more important when the information is used for decision making. The major processes of an organization, such as attraction, selection, and attrition, can be viewed as a network of interdependent decisions (Cascio & Boudreau, 2016). Decision making can be viewed from the perspective of rationality of choice, use of available information, and cognitive processing and mental models such as heuristics (Wickens, 2014). These perspectives of choice, information usage, and cognitive processing models share important features of information processing, which point to an inherent value of information itself in the context for which the decision is made. First, information is used in decision making to reduce uncertainty and assess a level of risk associated with the outcomes of one's decision. Second, the act of gathering and using information depends on the time and pressure associated with the decision one must make. The amount of time and level of pressure may dictate information seeking behaviors and influence the value one associates with the available information. Finally, individuals may value information differently depending on their expertise and level of familiarity with the information that is available, and the context of the situation requiring a decision (Hammond, Hamm, Grassia, & Pearson, 1987). These features of information processing (uncertainty reduction, information gathering, and expertise) are useful for understanding decision making. I intend to build on information processing research by expanding perspectives of decision making in an organizational system and its corresponding information environment.

Cues and decision-making strategies. Cues in the environment inform us of the usefulness (diagnosticity) and believability (reliability) of information (Mosier & Fischer, 2010). While observing cues is important for assessing one's situation, multiple constraints exist that make it difficult to extract information value from cues (Mosier & Fischer, 2010). The characteristics of a cue that draw attention may differ across individuals. Additionally, the value of the information cue is associated with whether or not an individual attended to the cue in making a decision and the outcome of the decision. In this case, the value of information from the cue is largely dependent on the decision-making skill of the individual. The difficulty in adequately assessing a situation through cues highlights the complexity of characterizing "optimal" decision making and the information necessary to make a "good" decision (Kahneman & Klein, 2009).

Strategies for improved decision making involve attention to and processing of information. These strategies typically focus on increasing confidence in one's choice through deliberate reasoning, acceptance of uncertainty, and reflection of one's thought processes (Klein, 2008). Training and guidelines are used to help individuals learn how to identify cues, use feedback, or even utilize a series of rules or procedures that guide decision making through decomposition of choices (Larrick, 2006). Research has even demonstrated the positive effects of infographics on selective attention as a tool for aiding the decision-making process (Mosier & Fischer, 2010). Importantly, efforts to improve the decision-making process attempt to address the cognitive filtering process people use as they experience information. More information leads to a more time-consuming process of filtering as it becomes difficult to determine what is useful. When people seek more information than they can adequately process, they may experience analysis paralysis and degradation of decision ability (Klein, 2015). Moreover, if paralysis does

not occur, more information does not necessarily lead to better decisions. Attempts to assess information load have shown that decision performance generally does not increase after two information sources have already been used (Allen, 1982; Klein, 2015).

Data Design for Ease of Use

Within cognitive psychology and human factors, the study of language and communication in human information processing introduces important considerations for the context and design of data, specifically with regard to the ease of use and comprehension. Processing of information is reflected in a combination of bottom-up or top-down attention given to information, and considers the intensity and context of the stimulus (Schneider & Chein, 2003). Research with information processing has focused on a context vs data tradeoff, which informs data design considerations, such as quantity, quality, timeliness, and efficiency. For instance, Shannon-Fano coding (Seridan & Ferrell, 1974) guides information efficiency by matching the proportionality of information provided to the content of the message.

The Shannon-Fano coding, used for data compression, highlights the usefulness of coding schemes (e.g., zip codes) that convey meaning in relation to how the information is presented. The use of Shannon-Fano coding addresses issues with information proportionality, the amount and level of detail of information used to represent a concept or entity. Information proportionality has major implications for the amount of detail being conveyed at different information levels, which drives the design of how information is conveyed to maximize understanding with minimal information interaction. The implications of proportionality have been applied organizationally in the form of structural design (e.g., departments or divisions) and even contact information (e.g., e-mail design) to increase ease of processing and comprehension of available information (Rau & Salvendy, 2001). The research on proportionality further aids

our understanding of information processing by providing useful guidelines for establishing best practices in data visualization and communication of information. Specifically, helpful data visualization requires some data compression through forms of coding of the data to simplify its presentation so that it can be quickly understood and used.

Many of the best practices observed in research on communication and information processing focus on presentation of information to facilitate comprehension. The emphasis in these practices is on design and is based on the premise that it is necessary for individuals to attend to and make use of the provided information. For instance, principles of instructional design focus on making instructions easy to follow, memorize and implement (Smith & Haney, 2011). Similarly, other research has focused on maximizing comprehension with readability formulas, debating word and sentence length vs. linguistic structure and function of the text (Zarcadoolas, 2011). Researchers have even explored the optimal communication medium based on information content and task, suggesting graphics for spatial relations and verbal communication for abstract information (Mayer, 2002).

The research on information processing largely focuses on comprehension; specifically, whether information is noticed, read, understood, and acted upon (Wickens, Lee, et al., 2004). The aim of such research is on establishing guidelines that help increase the activities and behaviors an individual may engage in to process information. While these guidelines all serve to make information more readily comprehensible and appealing to an individual, they do not necessarily account for the inherent value one may attribute to the information. The care and attention given to visual or instructional design may do little to increase the value of the information to an individual, especially if they had no desire or perceived use for the information, or if the information was not meaningful in the time or context in which it was

received by the user. In this vein, even the most beautifully crafted information may have little to no value to an individual. For this reason, opportunity exists for additional assessment of the value and use of information in an organizational system.

Summary of Cognitive Psychology Review

Overall, I can derive the following conclusions from the literature in cognitive psychology and human factors to inform the micro-level of my framework of information interaction: 1) Information quality/value is a key concept for the decision-making process, 2) individuals may respond to information differently based on their expertise, and on contextual effects of time and pressure, and 3) individuals' experience with information may vary based on the quantity, timeliness, and usefulness of available data, and the relevance of the available data based on information needs. The major takeaways from cognitive psychology and human factors in conceptualizing information interaction at the micro level includes the effort required for individuals to cognitively sort and filter information, and the role of data visualization and information design for improving individual ability to create, utilize, and transform data.

Building the Macro-level of the Framework: Computer Science

Some of the most engaging work on building a better system of information exchange comes from the work in computer science on developing a semantic web (logic network) and ontological frameworks (shared conceptualizations) to build a streamlined user-interaction experience. The semantic web and ontology point to the foundation needed for computer systems to build and benefit from interconnections. This groundwork houses some of the most insightful lessons for the "how" behind information interaction in a system.

The pervasive presence of networked devices and web services stems from the work done to make systems learn from and speak with one another, while also maximizing the interaction

and ease of use of humans as the end user (Devedzic, 2016). For instance, the psychology of human-computer interaction has driven changes in training, task and workload analysis, and reinforced the concept of humans as information processors and transmitters (Dix, 2017). Maximizing the human-computer interaction requires system design based on the values of the user and, in work settings, the motivation a user has for more usable and useful systems (Bannon, 1995). In short, it requires understanding how individuals interact with information.

The goal of increasing utility to the end user has led to an explosion of behind-the-scenes work conducted by scientists and engineers to automate the processing, retrieval, and encoding of information in systems and devices, which are then presented to the end-user in a format designed for usability. The primary research areas responsible for this growth generally came from artificial intelligence, machine learning, and semantics (Cummaudo, Vasa, Grundy, Abdelrazek, & Cain, 2019).

An enormous challenge in computer science is that information must always be translated from computing language to the visual, comprehensible language of an average user. But before any of that happens, programmers need to agree on what information is useful for a system, which programs should talk to one another, and whether or not programs and systems should be talking to each other (Devedzic, 2016). Note the similarity of considerations for information flow in computer systems to that of information flow in organizations. For organizations, what divisions, departments, roles, or even other organizations should be talking to each other? The information within an organization must then be transformed into something useful for its clients or customers, in a way that is valued and allows for interaction that creates a worthwhile (typically resource-based) exchange. For computers, the programs must talk to and understand each other, then transform information for the user. Typically, the more valuable the information,

the more a user/client is willing to engage in or interact with the system (for both organizations and computer programs). However, it can be unclear whether the value resides more with individual components or with the system as a whole.

Reductionism in science has been used in both organizational systems and computer research to understand how underlying components work together to create a greater whole. Computer programming has a fortunate advantage of reducibility down to a universal language (1's and 0's), but the way in which programs make sense of received information highlights the struggle to understand the value of information.

In an effort to identify meaningful information, computer scientists pass information through filters until no meaningful information remains (Steeg & Galstyan, 2016). This information sieve approach demonstrates how a machine, given a specified outcome, can filter through an enormous amount of information to reduce and then construct or recover a structure (Steeg, Gao, Reing, & Galstyan, 2016). As noted earlier in the cognitive psychology research section, human potential for information processing can be limited by the amount of information that can be filtered. Using the knowledge of information filtering in a computer system, combined with information processing for humans, I explore the need for understanding filtering of information in an organizational context.

Semantic Web and Ontologies

Understanding how a bridge from computer systems to organizations can be made requires some background in how computer science had to bridge the microscopic state of a system or network to the macroscopic properties found in a larger information environment. Three major components have accelerated the growth of computer system interconnections; voluminous data access, the semantic web, and ontologies (Battle & Benson, 2007). The

semantic web represents an effort by the World Wide Web Consortium to create a network of data in which computer systems are able to talk with and understand each other at both the syntactic (language) and semantic (logic) levels (Melnik, Mitra, & Decker, 2000). The interaction between computer systems is achieved through the use of ontologies, a set of knowledge or concepts that convey the essence of a system and the interconnected relationships of that system (Hendler, 2001). Essentially, ontologies make up a common language that enable computer systems to talk to one another. As more systems become connected through the internet, new concepts must be introduced or created in ontologies, which then connect systems or devices using the semantic web. A similar chain of events exists in an organizational framework. Within an organization, multiple functional areas have a set of concepts and a language that dictate the service or work produced in that area. The interconnection of each work domain depends on a commonality of understanding of the concepts and language used across domains. In this way, information is communicated throughout the organization to facilitate knowledge sharing and a common understanding across people and applications, which is foundational to an organization's knowledge management capability.

Information as a resource. Information in computer systems is treated as a resource. As a resource, information is integrated into universal storage and retrieval systems using resource-based commands (Battle & Benson, 2007). This universality, as a resource, provides the framework for the conceptual mapping used in the ontology of web language, which is then translated to a web service (e.g., Amazon). For example, Amazon's online service uses information to create a taxonomic set of products using nested identifiers based on product categories. This drives the design and navigation of their site, the portrayal and review of products, and helps identify and personalize user experience based on the user's history on their

site and other browsing history. This design of service is intended to increase information usability and access in a way that provides a positive user experience, elevates the user sense of a more informed decision, and ultimately increases the likelihood the consumer will repeat service. Thus, the semantic web connects all information pertaining to the web service (e.g., your product preferences and search history) to create a streamlined user interaction with the information at hand, which in turn is meant to increase decision-making power for the user (Devedzic, 2016).

The information communicated or exchanged in the workplace can be considered a decision-making resource that is consumed, managed, and organized within organizations (Feldman & March, 1981). As technology has driven communication capabilities the exchange of information has amplified outside organizations as well, creating new opportunities to understand information protection and projection. Researchers have taken note and applied the management and use of information to organizational tasks. For instance, when applied to task analysis, information is designed and measured based on the goals of users in searching for and accessing information. The search behaviors are then used to determine how to better structure, display, and convey information to maximize efficiency of discovery and use (Jamieson-Proctor, Watson, & Finger, Grimbeek, & Burnett, 2007; Endsley, 2015). This same approach of observing search behaviors and maximizing information discovery and usage is applied in the realm of computer information systems and computer engineering.

In an organizational context, individuals are often expected to connect information across functional domains. When viewed through a network lens, social connections are seen as links and nodes to better understand communication patterns in an organization. While understanding that kind of network is useful, it often fails to account for the value of information being distributed in the network. By failing to give value or meaning to information as a resource,

network analysis alone does not explain the value of the interconnections that are created by a semantic web.

Patterns. Observation and design of patterns is another commonality between computer systems and organizational system theory. In computer program ontologies, patterns serve as a framework to connect domains with user requirements and tasks (Gangemi, 2003); a pattern represents interrelationships between domain tasks and the competencies required to complete the tasks. The pattern is the focus of design for conceptual mapping in ontologies. By using modeling, configurations, and a system of interrelationships of components, computer programs are designed to recognize and incorporate patterns that combine multiple parts of a program into a representative structure allowing systems to build on each other into a greater whole. For example, development on an ontology uses patterns at each level of parameterization, starting with task patterns for a given role, realization patterns of information to complete the task, situation patterns to identify when information is used, and object patterns to understand how to design information for specific situations. This concept is nearly identical to organizational systems theory, which recognizes that each domain interacts to connect the role of an individual or group in carrying out required tasks (Katz & Kahn, 1966).

Computer system ontologies are built out of complex patterns from various domains and associated domain tasks. The high-level outcomes (macro level) of a domain, such as a responsive graphical interface, guide the lower-level tasks (micro level) that serve to accomplish objectives that are tied to the higher-level outcomes (Gangemi, 2003). The structure of a design pattern is then built based on types of tools/information available, the context of how users interact with the tool, and the information needed to allows users to use the tool to accomplish the objective. For example, creating a hotel-booking website might establish an officially booked

reservation as an outcome. Next, information is designed on the website to best present a user with availability of rooms, dates, and various other choices presented in a logical manner. The use of patterns can guide programming by observing how users typically progress through the booking process, and also how to handle information being shared by other websites, such as a different booking service or through an affiliated travel partner.

The use of ontologies for computer modeling of tasks is similar to a strategic work analysis or competency modeling, which involves systematically investigating role requirements and the competencies associated with role execution (Sanchez & Levine, 2009). However, instead of identifying individual KSA's, ontology modeling in computer science identifies the required information interaction necessary to complete a task. Additionally, the structure behind creating a design pattern for a computer system shares similarities to that of work analysis and the larger organizational system framework. In organizations, job analysis or competency modeling may be used to identify the purpose, focus, and performance level of a given role (Sanchez & Levine, 2009). For example, a newly hired faculty member for a university may be evaluated on their teaching and research skills based on how they contribute to the development of their program, department, college, and potential impact to the university. Similarly, a computer system ontology considers the roles and responsibilities of a system, the tasks required for goal accomplishment, the norms and behaviors within the system, and also the design of each role and dependencies of components that must work together within a system (Gangemi, 2003). A simple example would be the programming in a smart thermostat, designed to recognize patterns of usage based on time of day, seasons, and foot traffic, while also having a dependency on activating other heating/cooling systems within a building. In both the organizational and computer system examples, the goal of aligning individual (person or program) tasks to system

outcomes is similar, with the main differences being in size, scope, and where the human interacts or engages with the process.

Data Visualization

As organizations seek to engage in continuous learning while remaining agile in a complex and uncertain environment, the ability to use information effectively and efficiently becomes increasingly important. Efforts to improve information utilization have led to new trends in data visualization and the use of infographics, using visuals to convey complex information (Otten, Cheng, & Drewnowski, 2015).

The goal of data visualization is to make important information accessible and appealing, while reducing information load and time required to reach understanding. Recently proposed practices in data visualization focus on presenting patterns or trends to increase information interaction through easy comparison of groups or quantities (Frankel & Reid, 2008). The use of visualization has also been recognized as an integral feature of communicating and discovery in nearly all scientific fields as part of an effort to more effectively produce and share information (Healy & Moody, 2014). More than just better charts and graphs, data visualization has been used to advance important research discoveries. For example, the use of 3D modeling led to a breakthrough in explaining the effects of structural instability in a quantum system (Dogra, Landini, Kroeger, Hruby, Donner, & Esslinger, 2019). Just as data visualization is advancing quantum theory, organizational science can benefit from advanced visualization of information interaction within an organizational system. As a method of increasing information usability, data visualization practices act as an important bridge between the producers and consumers of information (Otten, et al., 2015).

The demand for better data visualization highlights people's drive to engage with and understand complex data, and the desire to share that information with others. Computer science has made great progress in improving the information interaction experience. One major theme for new advances emerging from my review centers on the importance of communicating information to and among humans in the loop. Drawing on data visualization practices, the methods used to convey information should be based on and tailored towards the communication setting (Otten, et al., 2015). Similarly, organizations are increasingly seeking feedback on whether they are conveying the right information, both internally to their members as decision makers, and externally to their clients or customers.

Utility, Access, Control, and Time

Principles of user interaction represent a value placed on how the end user interacts with information in their environment. Computer systems and applications are designed to facilitate efficient retrieval and interpretation of information for the end user. However, in an organizational context, individuals may be expected to utilize platforms, tools, or engage in administrative processes laden with informational inefficiencies. Rather than time spent in an area of expertise, individuals may be forced to seek information to perform ancillary tasks for which they have no expertise and that may inadvertently decrease overall productivity. For example, traveling on behalf of one's organization may involve an individual completing required paperwork or information that is difficult to find (information access), difficult to navigate and complete (information utility and time), and require a complex process that is far more difficult than simply completing the task oneself (information control). This example highlights how organizations may expect individuals to piece together information across

multiple systems – a task that could be accomplished with help through structural support prior to being presented to the individual as an end-user.

One major success of the Internet and the systems that use it is the level of accessibility to information it has created for individuals. It is typically the responsibility of the content publisher or the system developer to use formats or designs that are readily usable and easy to understand for the consumer. If users struggle to access or interact with content or a system, they may experience a diminished sense of value for the information with which they are interacting. That said, if an individual perceives the outcome or information associated with the content important enough, they may be more willing to apply the necessary resources to use/interact with that information. For example, the process of applying for a mortgage can be complex and unwieldy, but people persist in navigating the process based on the value of the outcome. Therefore, information value may determine the degree of effort a user exerts in accessing, using, and interacting with resources. However, if new methods or systems ease the burden of information interaction, users are likely to gravitate toward the new source.

Information value may point to how individuals seek out and use different systems or services, but it also highlights the potential for using information inappropriately – such as controlling others (Xu, He, & Li, 2014). The pervasive presence of interconnected devices and systems in everyday life allows people to increasingly interact with each other to share knowledge and cooperate toward common goals (Atzori, Iera, & Morabito, 2010). However, there is also concern for the increasing presence of systems and devices that are always listening and collecting information (Li, Xu, & Zhao, 2018). Some uses of an increasing presence are positive, such as tracking the consumption of products to better manage logistics, and ultimately reduce waste and costs (Xu, Xu, & Li, 2018). However, other uses are questionable, such as a

smart city initiative by “Sensing China” used to monitor citizens for social compliance and control the information that is broadcasted, transmitted to, or accessed by its citizens (Li, et al., 2018). Information interconnectivity is useful as a tool for aligning efforts and working toward common goals, but caution should be taken if information interaction is being used as a means of control within (or outside) the organization.

Machine Learning

Rapid progress in the realms of artificial intelligence highlight the positive application of learning associated with access to information. The goal of machine learning is to continuously improve automatic learning over time, improving inference and decision making while dealing with uncertainty (Jordan & Mitchell, 2015). However, machine learning capability is highly dependent on the data to which it has access and to the programming (human in the loop) designed to help the machine learn from experiences. Similar to training people, learning patterns are considered supervised or unsupervised based on the level of structure provided in the learning environment. Machine learning is based on constant and consistent learning; given an organizational framework and with multiple data streams the machine must continuously produce useful structures and models from which to learn and apply (Jordan & Mitchell, 2015). This paradigm is remarkably similar to the practice and research trends in organizational development that call for organizations, and the individuals within, to be engaged in continuous learning and adaptation in order to perform in increasingly volatile, uncertain, complex, and ambiguous operating environments.

Summary of the Computer Science Literature Review

Overall, I can derive the following conclusions from the literature in computer science to inform the macro-level of my framework of information interaction: 1) information is a resource

that is created, utilized, and transformed within a system, 2) information is modified to enhance quality/value to end users, 3) information experiences can be structured through patterns within a system to align individual tasks with system-wide outcomes, 4) information is organized through ontologies and networked through semantics to enable interconnections of information processes, and 5) organizational information practices can be viewed through the information processing lens of information utility, access, control, and time.

Building the Meso-Level of the Framework: Organizational Communication

Apart from interaction, information exists in a vacuum. It is through the communication process that information is generated, retrieved, articulated, and ultimately used. The communication process includes conveying or representing information between entities, making it an important emphasis in our study of information interaction. Communication represents the complex and multifaceted exchange of information between one or more individuals, whose goal may be to convey understanding or exercise influence (Poole, 2011). Seen as a central component for organizations, some have argued that an organization's structure is primarily held together by communication relationships among its members (Simon, 1976). Indeed, communication has been framed as the glue that holds organizations together (Poole, 2011), serving as the critical link between organizational functions. Given the role of communication in interconnecting organizational domains (e.g., strategy, training, leadership), people, and processes, one might assume the topic at the forefront of organizational psychology. However, the communication literature is marked by disagreements in definitions, philosophical perspectives, and evaluation method (Keyton, 2017), making its use in organizational psychology challenging to say the least. To clarify the perspectives most important to moving

organizational communication forward, I first review the background associated with current issues in the field.

Review of Communication Theory

One area of agreement for communication scholars is the role of organizations in creating, maintaining, and dissolving social collectives – a continuous set of organizational processes (Weick, 1977). This definition sets the tone for organizational communication studies, establishing a focus on the social aspect of the phenomenon. Early studies of organizational communication focused on the social construction of knowledge, and how communication skills, networks, and relationships influenced the development or expression of knowledge, interpersonally and organizationally (Allen, Gotcher, & Seibert, 1993). Since then, there has been a shift away from simple interpersonal exchange to recognizing a shift of narrative in communication among individuals and organizations at a macro level (Mumby, 2014). Still, the definition of communication centers on how people use verbal or nonverbal messages to generate meaning.

Research focus is divided between intent/purpose of the message versus quality of judgment or evaluation (Keyton, 2017). Currently, organizational communication has focused on functionality, viewed through the purpose it serves in socializing groups or individuals, structuring of processes, and coordinating activities (McPhee & Zaug, 2001). The future of organizational communication will largely be shaped by how well scholars can connect the various perspectives, theories, and methodologies of communication.

Advancing the understanding of organizational communication will require creative thinking about how systems and networks form and develop across the micro-macro dimension (Mumby, 2014; Poole, 2014). One method for exploration involves identifying the patterns of

information being communicated across the organization (Keyton, 2017). These patterns include non-communicative elements (e.g., financial systems), which still rely on communication to function (Poole, 2014). The identification and use of patterns is similar to the best practices of ontological and semantic frameworks built on patterns, previously described in my review of the computer science literature. Exploring patterns at multiple organizational levels will be an important part of developing information interaction as a construct. The organizational communication literature can be further explored through the multiple perspectives used to define the communication process, which will help shape the development of a framework for information interaction.

Perspectives on Organizational Communication

Information and communication share a common assessment challenge. The rapid advances of complexity and diversity in communication and information capabilities over the past decades have strained the ability for both research and practice to comprehend the influence of these processes on organizations (Grant & Nyberg, 2011). The rapid growth of communication and information capabilities also led to increasingly diverse theories of organizational communication. While new theories emerged, they largely focused on the products of communication (such as culture or structure), with little research addressing underlying dynamics – the network holding the domains together (Deetz & Eger, 2014).

The perspective of communication as organizing focuses on the use of language as an authoritative resource for influencing relationships, transmitting knowledge, and creating action (Taylor, 2006). From this perspective, the use of language assumes that organizing occurs at the point of communication. Taking it a step further, communication theorists argue that it is through communication that the structural elements of an organization are held together – that

communication is at the essence of creating and sustaining the organizational processes we observe or work within (Seibold & Myers, 2006). As members of an organization engage in the common language and structuration within the organization, a meta-conversation begins to emerge, creating a context for the information conveyed throughout the organization (Robichaud, Giroux, & Taylor, 2004). The relative value or usefulness of information may change given its relation to the circumstances of time and place – that is, the location of the information within the larger meta-conversation of the organization. The idea of information in a meta-conversation involves understanding how information moves within the micro-macro framework within an organization. The communication perspective of structuring, similar to that of organizing, further builds on micro-to-macro organizational processes to explain how individual interactions become reflected in the whole of the organization.

Communication as structuring implies that structures are dualities, providing the means for members to communicate, while the process of communicating reinforces and reproduces the structure by confirming it as meaningful for interaction (Poole, McPhee, & Seibold, 1996). Thus, an organization's structure provides a mechanism for conveying information, while also changing or adapting as a result of information being communicated, with the level of change dependent on the value of information being conveyed. The organizational structuring phenomenon can be observed through three mechanisms (Poole et al., 1996); microlevel interactions by organizational members, the patterns of structure use by members, and how structures are manifested within the organization. The organizational structuring mechanisms highlight communication as a process that connects individuals (micro-level) to the larger organization (macro level) by observing patterns of information interaction within structure (meso level) across members and member groups.

The micro to macro perspective from communication is similar to the reliance on patterns that serves an important role in building ontologies and linking computer language to human visualization. The ontological perspective from computer science supports the application of communication as serving both a structuring and organizing role. Specifically, the phenomenon of organizing is guided by communication, which produces and sustains a structure, enabled through the patterns of communication and information interaction, taking place at the individual and interpersonal level. This process of micro to macro perspectives, or viewing the interconnection of organizational domains, is resonant of systems theory. The systems approach serves as a strategic link between organizational communication and the full scope of organizational dynamics.

Communication and Systems Theory

The systems approach has been praised as the DNA of organizational communication, representing the complexity of organizations and communication through a set of interdependent components that form an organized whole (Poole, 2014). The systems theory of organizational communication bears a resemblance to organizational systems theory (Katz & Kahn, 1966). Organizational communication systems theory uses the concept of organizational components to represent functions of system units, with nesting of units from lower to higher levels. Additionally, the system is governed by a structure, with associated interdependencies and feedback mechanisms, all within an environment that characterizes the boundaries of an organization's system (Burton, DeSanctis, & Orbel, 2006).

Communication and organizational systems theories are inherently complementary, both considering organizations from an open-system approach with feedback cycles and information interaction patterns associated with the evolution of organizational elements. Additionally, both

organizational systems theory and communication systems theory conceptualize information through an input/process/output framework; an integrated series of causal and functional links which develop and change over time within the system (Poole, 2013). These systems rely on information interaction to coordinate activities while simultaneously supporting decision-making within a system (Krippendorff, 2009). Given the similarity of theories, I further explore the principles and perspectives behind communication systems theory, both as they relate to information interaction and to organizational systems theory.

Communicating information has been viewed as a source of organizing and sense-making to members (Weick, 1977, 1995), while also being considered a driver for dysfunction in unstable systems (Rice & Cooper, 2010). In explaining the process of communication, information experiences have been viewed as a property of the system network, connected via nodes and roles (Monge & Contractor, 2003). Similar to my critique of communication as organizing and structuring, the systems perspective of communication tends to focus on communication outcomes and the presence of a process to guide outcomes. The systems perspective of communication lacks focus on the individual information experience, including the quality/value of information itself. Building on shared systems perspectives, I will explore how information interacts within a system as a whole using the principles of system complexity and agency.

System complexity and agency. The concepts of complexity and agency represent the interaction of the human and the system as a whole. Complexity refers to the make-up of an organization's system; the structure, components, domains, and interactions existing within the system (Miller & Page, 2007). An organization's complexity is associated with its communication practices that can alter the availability and usability of information within the

system. For instance, the formality of processes that control information may dictate the speed of information sharing, creating potential constraints that make information more difficult to create, retrieve, or use (Miller, 2003). Agency represents an individual's sense of freedom or permission to participate in self-governed communication behaviors in an organization, exhibited by one's level of responsiveness, and typically determined by the members' level within the organization (Miller & Page, 2007). Higher agency represents higher potential levels of self-governance for communication processes, and therefore potential for greater autonomy of information interaction.

Recognizing human agency is a means of understanding organizational communication patterns. Organizations adapt in response to shifts in the patterns of interorganizational networks created by knowledge, information, and resources (Monge & Poole, 2008). The process of creating and sustaining meaning from information as it is shared reflects organizational discourse; an interpretive focus of related experiences and shared understanding (Grant, Hardy, Oswick, & Putnam, 2004). This process of sense making as explained by communication is associated with the concept of organizational culture that similarly aims to explain shared experiences of organizational members through values and norms that are communicated, verbally or non-verbally, within an organization (Schneider, Gonzalez-Roma, Ostroff, & West 2017). The role of human agency, through social interaction, is an important consideration for creating and sustaining the interconnections within an organization through shared meaning and sense making. However, one final consideration must be made for supporting organizational discourse. The ability to organize, create meaning, and allow for human agency stems from information exchange, which is best explained through communication structure.

Structure. The concept of structure in organizational communication focuses on the basic properties of information exchange. Specifically, communication involves transmission of a message, via a sender, to a receiver, taking place through a network. The message is considered the signal, while anything that interferes with receiving and interpreting a message is considered noise (Poole, 2011). This concept of signal and noise shares the same underlying theory of signal detection (Fitts & Posner, 1967) in cognitive psychology research. In the cognitive psychology literature, the focus is on information processing, whereas the communication literature focuses on the network through which the signal travels. The structure of a communication network has implications for how information is designed to flow, or interact, within an organization (Monge & Contractor, 2003). Communication structure can be observed through links and nodes. Nodes represent points of communication convergence, while links represent the connecting action between the nodes that make up the network. The communication network can often be mapped onto the outline of an organizational structure, with the properties and configuration of an organization's network often mirroring the structure of the organization. Discrepancies between an organization's structure and the communication network are associated with changes in operating mechanisms. That is, new networks emerge as organizational members establish new patterns of communication, whether out of self-interest or operational necessity (Monge & Poole, 2008). Thus, while an organization may dictate the structure or configuration that guides the communication network, members of the organization may influence changes to the network based on their patterns of use, either reinforcing or adapting the existing structure. To understand how communication networks adapt within an organization, I re-explore decision-making in the context of supporting organizational outcomes.

Communication as Decision-making

My review of communication theory, thus far, has centered on communication processes and how they develop within an organization. Communication processes, guided by the structure and social interaction found in organizational communication, ultimately support organizational outcomes. Organizational outcomes are achieved through information exchange to increase knowledge and support decision making – a phenomenon referred to as intellectual capital (Kuhn, 2014). The practice of greater information sharing and communication in decision-making is considered an evolution in patterns of information practices, as organizations recognize the need to address challenges that are beyond the scope of single organizational domains, or even the organization itself (Koschmann, 2013). The shift in practice from controlling information to a collaborative model of information sharing has been termed emergent decision-making, in reference to the shifting nature of the volatile and uncertain environment within which organizations are operating (Deetz & Putnam, 2001).

The concept of emergent decision-making has shaped the way organizations view and utilize data, and has driven a need for improvements in knowledge management practices (Kuhn, 2014). Specifically, organizations want information to be more "actionable;" that is information must produce knowledge or "knowing," which enable individuals or groups to engage in better decision-making processes. This desire by organizations for actionable information links to the information processing consideration from cognitive psychology. The outcome from that conversation is relevant to this application, which is the need to better understand the value of information. In the context of emergent decision-making, information considered to be actionable should share a similar level of value, leading to greater contribution to the organization's knowledge management system; the generation, coordinating, and sustainment of

knowledge that supports organizational practices. As seen in earlier arguments, information is foundational to both organizational and communication processes associated with outcomes in every organizational domain. As just noted, the desired increase in decision-making capability at every level is guided by knowledge management practices that are ultimately created and sustained by information interaction within the organization. Therefore, the value of information, and requisite role of information interaction, must be better understood in order to further advance mechanisms for improving knowledge management and decision-making processes.

How Communication Assessment Supports Information Interaction

Some positive efforts have been captured in communication research to better understand decision-making processes, which will help inform the development of information interaction as a construct. First, practices of communication audits (Downs, 1988) lay out guidelines for capturing the context of communication and how information is used to make decisions that advance organizational outcomes. These guidelines include relating communication to organizational processes, assessing flow and adequacy of exchange, observing communication mediums, and identifying the function and quality of communication relationships. The combination of these variables can help to explain complicated communication dynamics. For example, the communication dynamics between supervisors and subordinates may dictate expectations of frequency and style of communication. Some individuals may view greater communication frequency and detail as a positive form of gaining role feedback, while others may perceive the same communication style as micro-managing. Another key practice from communication audits is the importance of sampling from both links and nodes; collecting data from the points at which information is transmitting (links) and points where it congregates (nodes). This practice has been echoed in network theory and serves as a key component to

understanding information flow within a given system. Any effort to develop an understanding of information interaction should address the communication network to contextualize the information environment under observation.

The organizational communication literature has served an important role in exploring how information is exchanged at the individual, interpersonal, and organizational levels. I have identified best practices from studies of organizational communication focusing on the transmission of information between an organization and its members, and information exchange between members of the organization (Price, 1997). However, in my efforts to develop the concept of information interaction, I need to address some of the shortfalls or limitations stemming from communication research, especially as it pertains to information exchange.

Shortfalls of communication research. While past communication studies are informative, I anticipate future growth must focus on information at a foundational level, avoiding overly technical or limited organizational relationships. For instance, early scales of organizational communication (Penley & Hawkins, 1985) focused primarily on relationships between individuals and their level of responsiveness, task-related communication, and amount of personal communication used in interactions. While useful for understanding the quality of communication between supervisors and subordinates, these efforts did not capture the depth and breadth of communication across the organization. Roberts and O'Reilly (1974) proposed a communication framework featuring the following dimensions: directionality of information flow, accuracy of information, modalities of transmission, and gatekeeping, information overload, and communication satisfaction. Unfortunately, the rapid pace of technological expansion, information availability, and organizational evolution outgrew the scope of this early conceptualization. Their efforts, however, have established an important framework for

developing the theoretical space for information interaction in the context of systems theory framework.

New efforts to capture the full scope of communication require a flexible structure that researchers can use as a common starting point and adapt as necessary based on application. Modern challenges in communication theory include the push for inter-disciplinary cooperation and a drive to innovate conceptualizations of communication beyond the intraindividual perspective (Jones, Watson, Gardner, & Gallois, 2004). This includes recognizing communication as part of a broader practice of acquiring, processing, and using information.

My current research approach uses common starting points through the six core communication processes of organizations outlined by Poole (2011): 1) command, control, and coordination of information, 2) socialization, assimilation, and identification, 3) use of information in decision making, 4) participation and empowerment in information exchange, 5) communication that conveys culture, community, and support, and 6) interorganizational communication. These core areas will be the main focus for building how one might observe, interpret and seek new methods for measuring information communication. Additionally, I will use the structure of communication networks proposed by Monge and Contractor (2003) for identifying information flow among links and nodes within an organization. This framework utilizes observable phenomenon such as centrality, number of links, proximity to others, and even roles within a network (e.g., liaison) that help form a picture between the micro level and the many linkages configured at the network, or macro, levels of the organization.

Summary of the Communications Literature Review

Overall, I can derive the following conclusions from the literature in organizational communication to inform the meso-level of my framework of information interaction: 1) the act

of communicating represents the flow between micro and macro levels in an organization, 2) Communication patterns are indicative of the information experiences for individuals in organizations, 3) the structuration process, reinforcing or changing of organizational structure based on communication, is associated with the quality/value of information as experienced by individuals, 4) communication and information experiences vary based on the level of organizational complexity and individual's sense of agency, 5) Communication connects the interdependent components within a system or organization, 6) Communication processes and mediums are dynamic and require adaptation to changes in social, technological, and organizational developments, and 7) the structural and interpersonal communication networks are indicative of an organization's information environment.

A Way Forward

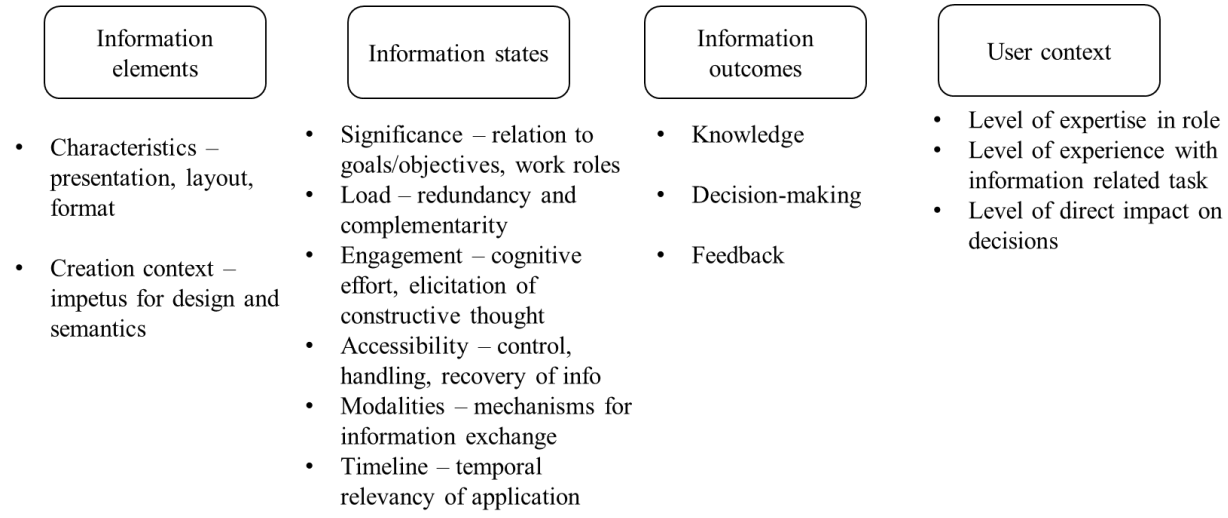
Information exists at all levels of a system; micro, meso, and macro. Information can be highly controlled or openly available in a system, with organizational structure designed to manage access, verify accuracy, and encourage correct usage. Information can be tailored from a completely raw, unaltered state to a masterfully crafted demonstration or visualization of elements designed to convey a direct message, engage learning, or support decisions. The systems perspective is ideal for framing the information experience as it enables one to view the connections that information creates, starting at the individual level, then traversing and connecting organizational domains as the information is used to ultimately achieve organizational goals and objectives.

A NEW THEORY FOR EXPERIENCING INFORMATION INTERACTION

Following the recommended initial stage of concept design (Podsakoff et al., 2016) I consolidated key conclusions from my multi-disciplinary literature review (see Appendix B). I then identified potential themes based on the attributes or characteristics of the information experience derived from each literature base.

Based on the review and thematic analysis of related theoretical literature, I am proposing four major dimensions of information interaction: 1) information elements, 2) information states, 3) information outcomes, and 4) user context. Each dimension represents a unique aspect of information interaction that combine to form the superordinate construct of information interaction. The model presented and tested in this paper proposes the theoretical framework of information interaction based on how an individual experiences information in a system, and how that experience is related to other organizational components. The basic information interaction model is presented in Figure 2.

Figure 2.



The representative dimensions for information interaction

Defining Information Interaction

I propose that information interaction is an individual's manifestation of utility for information as it is experienced. Every interaction one has with information produces a response. Responses may vary on the degree of action (use) or inaction (ignoring) to the information, and on the timing of action; whether in the present moment or set aside for later use. Therefore, if information is attended to, then interaction occurs. Interaction does not occur if information is not attended to; that information would experience a complete loss of signal, leading to a lack of ability for the receiver to experience it. So, importantly, the concept of interaction in this theory implies that an individual perceives and attends to a signal, or piece of information, and thus experiences the information in that present moment. When an individual experiences information, they then begin an interaction process that establishes value or meaning of the information in order to maximize its utility given the user's context. Importantly, information must be attended to for the application of value and meaning to occur at the interaction level. Applying signal theory, irrelevant information that is filtered out and unattended to would be considered noise. Therefore, information interaction applies only to the signal, information that is actively attended to, whether out of interest, duty, or compulsion, which requires an individual to take action in response to the information stimulus.

Information is an all-encompassing term for the details, figures, facts, or data that reduces uncertainty for individuals. In an organizational context, information represents data that is created, used, and modified to support organizational goals or objectives. When used to accomplish specific tasks or responsibilities, information is often operationalized as knowledge. When used for the purpose of assessment, analysis, and application to problems, information is typically viewed as a decision-making tool (Feldman & March, 1981). Information can also be

used as a feedback mechanism for personal development of individuals, or for development and change within the organization. Regardless of how it is used, information has identifiable properties associated with its constitution or existence. I anticipate the information experience can be measured by identifiable properties, which in combination will form multiple dimensions reflective of a general information interaction experience.

Propositions

I propose that information interaction will emerge as a multidimensional construct as each of the four dimensions reflect distinct but related components of a singular theoretical concept. Multidimensional constructs reflect the combination of several dimensions that are conceptually unique, yet share relationships that reflect a single theoretical concept (Law,Wong, & Mobley, 1998). Multidimensional constructs have been demonstrated in other concepts and measures such as job performance as an aggregate of job criteria, or personality traits as dimensions (Edwards, 2001). Building on the concept of a multidimensional construct, information interaction will be considered a superordinate construct; a general conceptualization of specific dimensions that provide a holistic representation of complex phenomena (Edwards, 2001). The multidimensional construct approach is especially useful in conceptualizing information interaction through the lens of systems theory, as multidimensional research is useful for matching broad predictors with broad outcomes.

Furthermore, I expect each dimension of information interaction will have several factors. Thus, each dimension may be measured as its own scale. However, I anticipate the combination of dimensions as a full measure will provide the most comprehensive assessment of information interaction.

Hypothesis 1: Information interaction is a superordinate construct; a higher-order conceptualization of specific dimensions.

The first dimension of information interaction is based on the most observable features of the information; its design, or identifiable properties. I propose that the identifiable properties of information can be represented by information elements, comprising characteristics of the information and the context in which the information is created.

Information Elements

The information elements, its characteristics and creation context, are a potential indication of how information design is associated with potential usefulness of the information. The role of information design has been recognized as a means of improving information flow, such as the level of effective communication in organizations (Miller & Monge, 1985).

Information Characteristics. The characteristics of information include the presentation, layout, and formatting of the information itself. The characteristics can be thought of as information structure, which is a key concept in data visualization. Specifically, information characteristics involves designing the conveyance of information in a manner that maximizes the utility of information to the end user. An information experience with highly positive characteristics would mean the user is able to easily make sense of the information, how to use it, and to recognize important associated relationships the information has to other items of interest. Of note for information characteristics is the impetus of design to make the information more readily accessible, understandable, and usable to the information user. The design of information characteristics is associated with the context for the information creation and usage.

Information Context. Information context is the creation narrative behind the information itself. Context explains why the information exists, its intended use, the source or

origination, the original semantic and ontological relationships, and the impetus behind the form in which it is delivered. Therefore, it is important to understand the context for why the information was originally created and the context for how the information is currently being used.

Hypothesis 2: Information elements comprise related but distinct factors of a) characteristics and b) context.

Information States

The next sequence of assessing information interaction lies in the experience itself, what I will call the information *state*. Regardless of original intent or crafting of the information, the user experience may be altered by the state at which the interaction occurs. This is best explained using tenets of signal theory. The signal carries the information. The information exists via the dimensions originally assigned to it upon creation. However, as the signal travels between sender and receiver, it encounters noise within its environment. The environment represents the elements that may alter the condition of the signal, and therefore change the experience of the receiver as they interact with the information. Implicit in signal theory is the role of the receiver in attending to and interacting with the signal.

In an organizational context, the interaction is likely predicated on the ability to use the information to complete tasks or responsibilities related to one's role. Organizational communication systems theorists refer to this transmission process as information exchange (Price, 1997). However, measurement of information exchange from the communication literature focused primarily on the relationships between individuals and their level of interpersonal responsiveness. While interpersonal factors are relevant for information exchange, the information state component will focus on an individual's interaction with the information.

That value of information is a reflection of the experience of information, the reason for the interaction, and the usefulness of the information in its current state. Specifically, I want to address the value or usefulness of information in an organization as represented by the significance of the information for use, the current load of information experienced by a user, information engagement, the ability to access information, the modalities used to transmit the information, and the immediacy of potential use.

Information Significance. Information significance is a perception of the degree to which information is related to a potential goal or objective. This includes the potential relevancy of the information to accomplishing a specific task or responsibility, or generally to an individual's work role.

Information Load. Information load is based on the amount of incoming information, and the redundancy or complementarity of new information. The practice of providing extra (same or similar) information through multiple means/channels is sometimes used to increase accuracy at the expense of processing speed (Wickens, Prinet, Hutchins, Sarter, & Sebok, 2011). However, the constant bombardment of information makes it difficult to determine what is useful and how people choose to make use of information provided.

Information Engagement. Information engagement represents how information is designed or delivered to increase interest or mental stimulation. This includes the degree to which information may be challenging enough to elicit constructive thought, while not being so challenging as to exhaust cognitive effort.

Accessibility. Accessibility represents control of information. For instance, whether the information resides behind layers of protection (security), paywalls (financial access), or is buried in multiple layers of complex architecture. Additionally, the user may experience varying

degrees of control over the information. Accessibility is likely governed by structure related to communication and knowledge management. This includes potential protocols for handling the information, or the level of effort involved in searching for or recovering useful information.

Modalities of Transmission. Modalities of transmission are the mechanisms for sending and receiving information within the work environment. This includes any potential medium used for communication such as e-mail, phone, or other application-based platforms. Any measure of these should be addressed in a generalizable format to avoid overly-specific applications, referring to modalities as platforms using text, voice, video, in-person, or some representative combination.

Timeline. Timeline represents the temporal nature of information interaction. This specifies if the information is best applied in the current situation, the future, or if the application is ongoing. Additionally, the relevancy of time may change alongside the potential context/usability of the information.

Hypothesis 3: Information states are characterized by related but distinct factors of a) information significance, b) information load, c) information engagement, d) accessibility, e) modalities of transmission, and f) timeline.

Information Related Outcomes

Information related outcomes represent the purpose for information being sought, used, and shared in an organization. Information is generally considered as a means for advancing an individual's knowledge, decision-making ability, or feedback for the purpose of development. I propose that the information characteristics as defined by the elements and states described earlier are associated with the information related outcomes. Individuals will likely perceive stronger outcomes from information with greater potential to shape future experiences. The

information related outcomes address how an individual makes use of the information they experience through building one's *knowledge*, use in *decision-making*, or as *feedback*.

Knowledge. Knowledge related to information interaction is reflected in an individual's demonstration of learning, application or awareness of subject content. I expect that information designed for usability and understanding will be associated with higher levels of knowledge application by the users. For instance, information designed for ease of learning will likely be more easily applied. Additionally, I anticipate individuals will easily apply information that is directly tied to important outcomes or objectives. Conversely, I expect that if individuals view information as always different, changing, or conflicting, they may regard it as not worth the cognitive effort to store, encode, or learn, leading to associated lower levels of individual knowledge or efforts to incorporate into organizational knowledge management.

Decision-making. Individuals may seek information or be provided information to improve their decision-making competence related to their work environment or work roles and responsibilities. Individuals hoping to improve their decision quality and timeliness may seek information that has greater value or spend more time interacting with accessible information. The stress of decision-making in the workplace can create high cognitive demand, especially with increasing complexity of rules, options, or time pressure (Edwards, 1954; Payne, Bettman, & Johnson 1993). A positive information experience should help prompt rational and critical thought directed toward the decision outcome, while helping to consolidate options, providing an individual with informed choices and a good understanding of the implications of each choice (Bruin, Parker, & Fischhoff, 2020). Therefore, information that is seen as more valuable or more useful for a particular decision should be associated with reducing cognitive demands for that decision.

Feedback. Individuals may change their interaction behaviors based on how the information provides feedback on an individual's performance or development. For instance, employees may scrutinize and attend to information provided for an official performance review more carefully than feedback from daily interactions. Similarly, advice from a co-worker about organizational norms will likely be seen as more useful for developmental feedback than information exchanged during casual social interactions. I expect feedback potential for information interaction to be associated with the potential for increased effectiveness of job performance related to the clarity and applicability of the feedback. Specifically, information will be sought and used more actively as it more closely matches the user's needs.

Hypothesis 4: The dimension of information outcomes is characterized by related but distinct factors of a) knowledge, b) decision-making, and c) feedback.

User context

Level of Role Expertise. The value of information may change based on the expertise an individual may possess with their work role. Expertise in one's work role is based on the acquisition and practice of domain-specific knowledge, based on experience and learning related to one's role (Dane, 2010). As individuals gain greater expertise, they are better able to search for, access, and apply information related to their role (Kahneman & Klein, 2009). An individual with higher role expertise than a co-worker in a similar role may be able to more efficiently filter, recognize, and apply information pertinent to their role. Therefore, level of role expertise may be associated with the perceived value and usefulness of information.

Task Experience. Task experience may also change how users interact with information. Individuals may be required to perform tasks at work that have little to do with their role or expertise. Many administrative tasks fall into this category. For instance, employees may be

required to complete timekeeping paperwork to track hours worked in order to be paid appropriately. The timekeeping system, and tasks required to utilize it, may represent information that is important to the user, and while not related to their role expertise, is a task associated with their work role that they must perform. As individuals gain more experience with tasks, they are likely to better understand how to identify the difference between information that is new or meaningful versus information that may be less helpful or redundant. If a task is new, all information about the task may seem potentially useful. As the novelty of a task is reduced, individuals may better filter the information useful to them for accomplishing the task.

Decision Impact. I anticipate the level of impact one's decision has at different organizational levels is associated with the effort one will apply to information interaction. Individuals may feel more responsible for utilizing information as best as possible when they feel that more people will be affected by the decisions they make. Information may be more heavily scrutinized as potential influence rises, starting with impact at the personal level, to interpersonal, then groups or teams, and finally to impact or implications at the organizational level. Whereas some form of information may be considered sufficient for making a personal decision, the same information may be deemed inadequate for making a decision that affects all personnel in an organization. For instance, a department manager may make an informed decision not to come into the office when they are feeling ill. They may have considered their current condition, the impact of them not being in the office, and their potential to spread sickness as information to guide their decision. However, in the wake of a potential pandemic, the same department manager deciding to ask everyone to stay home (or conversely to establish a safe working environment), would require greater levels of information to work with in order to come to a decision.

Hypothesis 5: User context is characterized by related but distinct factors of a) role expertise, b) task experience, and c) decision impact.

Organizational Application

The purpose for developing the construct of information interaction is two-fold. First, I wanted to present a construct that combines the qualities of communication, information theory, decision-making, and data visualization to provide a conceptualization of how information is utilized within an organization. Second, I wanted to create a tool for organizations to better identify the intricate connections among organizational components through measurement of information experiences at all levels. I propose that a measure of information interaction can be developed to assess information experiences in organizations. The information interaction construct can guide new organizational approaches to the creation, transmission, usage, and transformation of information. With the development of a measure for information interaction, I anticipate organizations implementing a constant, low obtrusion collection of information experiences to build a large volume of data to understand patterns of information interaction; a database for tracking and developing information related phenomena. The use of AI to engage in continuous assessment could allow for diagnosis of information hot spots or conflicts and could aid identification of patterns of information value/usability to improve performance system-wide. Further, constant and voluminous data collection efforts could improve the lexicon, allowing for evolving ontology of key information exchanges in an organizational system. Finally, these developments could be implemented through a continuous improvement process addressing better organizational semantics (logic flow) to increase the user experience at every organizational level. The goal would be to improve data visualization, creation, and usability for

all workers. The improvements to the information framework would be continuously assessed for effectiveness using an information interaction measure.

Developing a Measure of the Information Interaction Construct

I use a multidimensional approach to develop a measure for information interaction, treating information interaction as a superordinate construct; multiple dimensions represented as a single theoretical concept. To measure a superordinate construct, I treat the dimensions as first order factors with measures of observed variables, while I treat the construct of information interaction as a second-order factor reflecting the sum of the first order scores. This method allows for observation of systematic variance among dimensions (Edwards, 2001). Based on the proposals covered from theoretical review, I developed an initial item pool for consideration in the measurement of information interaction (see Appendix C). This initial conceptualization was further refined based on feedback and analysis accomplished through a qualitative assessment in Phase 1 of the measure development. This included case studies and interviews to guide the exploration of practices for managing the information experience in support of organizational goals or objectives.

Hypothesis 6: Reliability of scores can be demonstrated with a measure of information interaction.

Hypothesis 7: A newly developed measure of information interaction contains items indicative of each of the four first-order dimension: a) information elements, b) information states, c) information outcomes, and d) user context.

Proposed Nomological Network for Information Interaction

The use of systems theory in developing information interaction indicates there is a potential association of information interaction to nearly all organizational components.

Information interaction is designed as a construct that captures experiences ranging from micro to macro levels. To demonstrate the potential relationships across an organization, I will examine correlations of information interaction with variables at each organizational level: organizational structure (macro level), leadership (meso level), and psychological empowerment (micro level).

Relationship with Organizational Structure

Organizational structure serves as the mechanism that builds a work environment and connects all organizational components by establishing organizational policies, procedures, and other administrative and guiding functions (Miller, 1987). Specifically, organizational structure refers to the persistent characteristics of an organization reflected in the distribution of organizational units, lines of authority, and the systematic governance of the relationship of organizational components (James & Jones, 1976). For example, the degree to which jobs are divided into specialized roles or not, whether authority is centralized or decentralized, how many employees a manager is responsible for, and how employees are supposed to communicate (formally, informally) within the organization are all features or aspects guided by organizational structure (James & Jones, 1976). The study of information interaction at the organizational level is important because information processing by organizations is largely fragmented and often lacks direction (Joseph & Gaba, 2020). Researchers propose an ecological perspective of information processing is required to understand the information experience at the organizational level (Chen, Liang, & Lin, 2010; Puranam, Raveendran, & Knudsen, 2012). This includes understanding the difference between information flow within a bureaucratic structure versus a more organic holocracy (organizations with no formal titles or hierarchy). Differences in structural styles of organizations may point to systems of epistemic interdependence in how individuals collectively experience information based on characteristics of the organization. I

propose that organizational structure serves as a useful representation of the macro level of an organization, and that structural elements (e.g., centralization of power) will be associated with changes to individuals' information interaction.

Hypothesis 8: Balanced organizational structure types (using both bureaucratic and holocratic tendencies) are positively related to information interaction.

Relationship with Leadership Style

Leadership is the power and influence one has to change, strengthen, or support the behaviors of others (Lord, Day, Zaccaro, Avolio, & Eagly, 2017). The concept of leadership has been studied through various approaches, including theories of leadership as a trait, as behaviors, as a product of the situation, and based on relationships, with the potential for both negative and positive ramifications (Avolio, Walumbwa, & Weber, 2009). I will focus primarily on the behavioral and relationship aspects, and the more positive outcomes, of leadership. Supportive leadership behaviors and relationships are associated with increased involvement from those being led (Judge & Piccolo, 2004). Additionally, leaders can be seen as an extension of organizations, providing opportunity, challenge, and upholding the policies and procedures outlined by organizational structure (Hunter, Bedell-Avers, & Mumford, 2007). Some leaders, such as one's immediate supervisor, become a lens through which employees perceive aspects of the organization (Eisenberger, Karagonlar, Stinglhamber, Neves, Becker, Gonzalez-Morales, & Steiger-Mueller, 2010). Finally, leaders may establish feedback and communication expectations (e.g., frequency and style) that affect the relationship with the leader and could influence the information experience of individuals associated with the leader. Therefore, I propose that leadership serves as a useful representation of the meso level of an organization, and that

leadership behaviors that are rated positively will be associated with positive information interaction.

Hypothesis 9: Leadership qualities (behavior and relationship) are positively related to information interaction, such that as leadership qualities are viewed more positively, information interaction is regarded more positively.

Relationship with Psychological Empowerment

Psychological empowerment is a conceptualization of an individual's motivational response to work – the combined meaning, competence, self-determination, and impact employees believe they have at work (Spreitzer, 1995). Researchers have used psychological empowerment to explain individuals' responses to their perceptions of the structures, policies, and practices associated with their work role (Spreitzer, 2008). As individuals evaluate how their role fits within the greater organization, they may seek information that helps them make meaning of the work environment (Ashforth & Mael, 1989). Individual communication and information sharing practices are related to the level of self-determination, competence, and impact an individual might associate with their work role. An individual who desires greater autonomy and responsiveness of information sharing is likely to feel they have greater impact, competence, and freedom to shape and carry out the responsibilities of their work role. Additionally, individuals may seek feedback as a means of improving their sense of self-determination and impact based on the visibility and recognition of the work performed in their role. Psychological empowerment is a personal experience to the work environment based on the work role. Therefore, I propose psychological empowerment represents the personal, micro level response to one's information experience, demonstrating how an individual's perception of their role may be associated with their information experience in the work environment.

Hypothesis 10: Information interaction is positively related to psychological empowerment.

Specifying the Nomological Network Model

A nomological network represents a series of interconnected relationships among variables. Specifically, it characterizes the observed scope, size, and direction of relationships between a variable of interest and other associated variables. Importantly, the relationships are not simply a collection of independent connections, rather a set of relationships that account for all correlations together in a model centered around the variable of interest. In this case, information interaction is the variable of interest, and the relationships between information interaction, organizational structure, leadership behaviors, and psychological empowerment should be explored together in a structural equation model.

The direction of relationships in a structural model is specified through theoretical support and, when developing a new construct, the anticipated operationalization of the construct. Based on the theoretical review guiding the propositions and initial development of information interaction, and my anticipated operationalization of the construct, I expect information interaction is an antecedent to all other observed variables; organizational structure, leadership behaviors, and psychological empowerment. Notably, while organizational structure and leadership are often considered as antecedents, the systems framework approach to crafting information interaction places the emphasis of observed phenomena on the information experience. Specifically, focusing on the information experience creates a user-centric perspective, a lens that may govern how individuals then perceive leadership behaviors and organizational structure. Previous research in similar areas supports this conceptualization. For instance, while organizational structure may be dictated through rules or procedural guidelines,

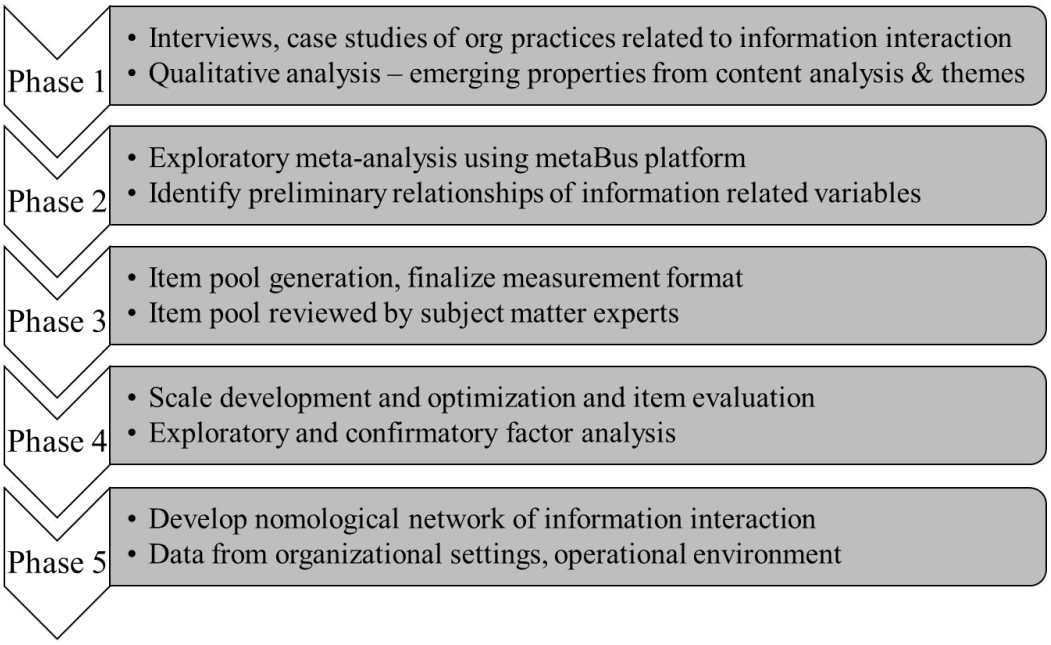
the context surrounding enforcement of such guidelines, and therefore the structural environment may appear ambiguous (Oldham & Hackman, 1981). Individuals may use their information experiences to create a context through which they perceive the organizational structure in practice rather than as defined on paper. For leadership behaviors, increased dependence on information technology and lack of physical co-presence between leader and subordinate has increased the importance of the information experience, while traditional hierarchical leadership has been mitigated by virtual environments (Hoch & Kozlowski, 2014). Information interaction may help explain why an individual would change their perceptions of a leader's behaviors in response to information experiences they have associated with that leader. Finally, individuals' response to information experiences such as the timeliness in which they receive information and the mechanisms for receiving information, may alter their feelings of impact, meaning, or self-determination, which are key components of psychological empowerment (Spreitzer, 2008). In summary, the construct of information establishes a context for how individuals perceive their other organizational experiences.

METHODS

I used a mixed methods approach to develop and test the proposed measure of information interaction. My approach, therefore, included combining elements of quantitative and qualitative viewpoints to better understand scale formation and the potential ramifications of how the construct relates to other domains. Exploratory qualitative analysis was used to identify current practices of information interaction as seen in organizational settings. After developing a measure, I sought subject matter expert (SME) feedback, and combined the qualitative analysis with quantitative factor analysis and structural equation modeling to develop facets of the nomological network associated with information interaction. The mixed methods approach provides rich data to support the creation and application of the information interaction measure with follow-on use in operational settings.

I conducted this study across multiple phases over six months to allow for the collection, analysis, and incorporation of data gathered throughout different stages (Figure 3). In Phases 1-3, I used case studies and interviews (phase 1), an AI-driven exploratory meta-analysis using the metaBus platform (phase 2), and SME review of the proposed set of indicators for the scale (phase 3). Next, in Phase 4, I conducted exploratory and confirmatory factor analysis to develop and refine the scale. Finally, in Phase 5, I explored the nomological network of information interaction through data collection from participating organizations.

Figure 3.



Five phase process for development and testing of information interaction

Samples

Samples for data collection varied by phase. In total, I collected three different case studies, 37 interviews, 142 organizational participants, and 855 Prolific workers. Prolific is a form of crowdsourcing, whereby individuals sign up to be workers, paid for online tasks generated by requestors. Online sourcing mechanisms similar to Prolific generally represent a diverse mix of workers across industries and geographic locations (Goodman, Cryder, & Cheena, 2013; Landers & Behrend, 2015). Initial power analysis for a 95% probability of effect indicated the need for a total sample size between 300 and 350 participants for each round of factor analysis, and between 250 and 300 participants to test the hypotheses related to the nomological network.

In Phase 1, I collected data using three case studies that highlight organizational practices associated with information interaction. I also conducted 38 interviews, reaching qualitative data

saturation of personnel in key roles for managing information and directing communication within organizations.

In Phase 2, I used data based on the output provided by the metaBus platform. I narrowed the initial 14,000 records related to the information construct down to 45 articles with correlations for information experiences with decision making, communication, and knowledge.

In Phase 3, I gathered participant data consisting of a mix of SMEs based on knowledge of IO Psychology and/or operational experience who can provide insight on the value and use of information in a system, and the interconnections of domains within an organizational system.

In Phase 4, I collected participant data using Prolific to produce a large and diverse sample reflective of a population with work experience across many different occupational specialties.

In Phase 5, I collected data from a variety of organizations interested in the concept of information interaction. The participants in this phase represented a wide variety of roles across different levels of the organization, and many different types of organizations. The items used to measure constructs in the proposed nomological network can be found in Appendix D.

The series of approaches captured by each phase provide a diverse array of methodological and sampling strategies designed to identify and assess a robust conceptualization and measure of information interaction. The design, scope, and outcomes of each phase are addressed below. I address results and some discussion points for each phase individually to clarify how phases inform and build on one another. Phases one through three focus on model refinement and measurement specification, while phases four and five focus on development and optimization of the measure.

Phase 1: Model Refinement and Measurement Specification

The first phase of this study builds on theory by exploring organizational practices that contribute to the perceived effectiveness of information interaction. The use of qualitative methods, such as case studies derived from interviews, are useful for highlighting important examples or unique characteristics of research topics and useful for advancing the field of IO Psychology by providing context and a rich representation of the data environment (Cortina, Aguinis, & DeShon, 2017). Some considerations for collecting useful qualitative data include investigating phenomena in their natural setting, considering the context of the phenomena, studying ordinary behavior, and favoring identification of emergent themes over a-priori structure (Lee, Mitchell, & Sablynski, 1999). To apply these practices, I noted additional, pertinent information throughout the interview process, including a description of the context surrounding the example, a determination of whether or not behaviors are common, and a collection of the themes/concepts that emerge from the data collected.

Case studies were selected based on my experience and personal contacts with experience using specialized system processes, tools, or procedures designed to enhance the information experience of organizational members. The case studies ranged from strategic organizational processes to small everyday examples of interaction that can improve user quality of life. Here I consider quality of life based on the amount of frustration versus ease of use an individual might experience while interacting with information. In case study 1, I explored the process used by a large organization to share information and expertise in a combined planning model, integrating multiple other organizations in large-scale humanitarian relief efforts. In case study 2, I explored the process used by a large network of hospitals to store, share, and visualize data for both hospital staff and patients. In case study 3, I explored a strategic planning process used by a large governmental organization to link strategic outcomes to task-level objectives.

Phase 1 Sample and Procedures

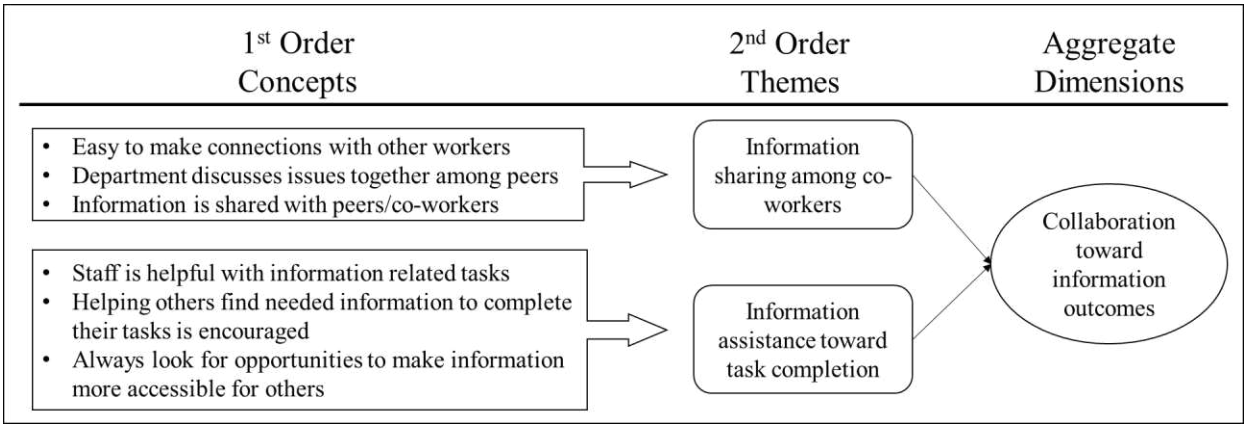
Interview candidates were selected based on their experience with managing information processes. Identified candidates held roles that represent key nodes for the flow of communication, use of knowledge management tools, and responsibility for routinely (weekly basis) making decisions that have impact at the organizational or group/team levels. Interviews were conducted with individuals one-on-one, in a private space free from distractions (as much as possible), largely over video conferencing technology. The interviews consisted of a structured set of questions (see Appendix E) developed to walk-through the individual's decision-making processes, their use of knowledge management tools, their communication process, and their understanding of how the organization manages information interaction. Interviews were recorded, with the permission of the interviewee, to facilitate transcription of interviews and context for interview notes to support initial analysis.

Phase 1 Data Analyses

The data from the case studies and interviews were independently analyzed for both content and themes, followed by a comparison of themes, using multiple reviewers. I used grounded theory (Gioia, Corley, & Hamilton, 2013) approach to qualitative analysis. Grounded theory involves an iterative process of generating categories from emerging properties of the data, relying on rich details and descriptions to move from specific examples to general categories that inform representative concepts from the data (Fairhurst & Putnam, 2019). The process of creating a data structure involves moving from base level, 1st order concepts, then combining similar 1st order concepts into 2nd order themes, and finally combining similar 2nd order themes into aggregate dimensions (Figure 4). First, two coders separately reviewed the interview data to determine 1st order codes; elements of the interview that describe processes or

components that specify organizational practices related to information interaction. The 1st order codes are sometimes referred to as informant terms as they are a direct reflection of the participants' words. For example, interviews on information experience produced a 1st order code of "we don't even know where to begin looking for the right information." Next, the 1st order codes were reviewed by both coders to reach convergence and determine 2nd order themes emerging from the content identified in the 1st order codes. The 2nd order themes represent the combination of multiple related 1st order codes based on theoretical similarities. For example, multiple 1st order codes were thematically linked based on similar descriptions of how individual's experience frustration with their ability to gather desired information. The collection of 1st order codes describing the frustrating experience established a 2nd order code called "information access." Finally, 2nd order codes sharing similar thematic elements were combined into aggregate dimensions. For instance, multiple 2nd order codes related to information accessibility may aggregate to the dimension of "information environment." The observations gathered from the case studies was compared to the interview data for consistency of thematic elements. Finally, themes from this qualitative analysis were compared with the initial theoretical assumptions of information interaction.

Figure 4.



Example of a Qualitative Analysis Data Structure

Case studies and interview data presented multiple themes derived from content analysis of the substantive responses to open-ended questions and review of organizational practices. I collected data from 35 interviews across sources in medical organizations, humanitarian services, and the Department of Defense, to learn more about how their information experiences shaped their organizational practices Additionally, I performed an in-depth exploration for each type of organization on a unique information management process they used. Each exploration was documented separately as a case study on information experiences in operations. The main concepts from each case study are described below, with the full case studies available in Appendix F.

Case Study 1. This organization focuses on humanitarian relief effort, with major work done on bringing multiple other organizations and lines of effort together to magnify the impact of their humanitarian efforts. The case study organization is well-known for their cultural and political sensitivity in providing support while maintaining the dignity of the recipients and paying respect to local ways of life, and working closely with both local and national governments. The organization excels at logistical planning and execution, providing an avenue

of relief effort for other support organizations lacking the organic capacity to execute international missions. Interview responses reflect the challenge of information logistics in working with multiple other organizations while also executing culturally sensitive relief efforts. Information congestion points include: 1) slow-moving information systems by bureaucratic governments, hampering responsive relief efforts, 2) lack of access or full awareness of needs in recipient population, and 3) the balance of providing temporary relief versus long-term relief, the latter requiring extensive resource investment to build and maintain structure, while training the receiving population in how to operate and maintain the new resources.

Case Study 2. This organization has been a leader in the medical field for over two decades, specializing in providing care to children. The organization attempts to balance the importance of information sensitivity and security regarding patient health alongside the need to rapidly respond and maximize situation awareness of health issues and current patient needs. One example of an organizational practice to enhance information management is the use of customizable internal web pages. Staff members are provided multiple options for data visualization based on the programs and information most relevant to their role and daily tasks. Interview responses indicated a general theme of information balance being important to the organization. Information balance refers to the practice of providing as much usable information to both staff and patients as possible, while also controlling sensitive information and tailoring information flow to prevent overload.

Case Study 3. This organization has an extensive history of evolving and experimenting with information management practices. Typically, participants indicate a heavily bureaucratic organizational structure that has been utilized to control the flow of information, with a focus on information being packaged and transformed for consumption and decision-making at

centralized, upper levels of management. The process for executing strategy does have a common theme across the entire organization, being guided by official doctrine that specifies an overarching set of procedures using a "strategy-to-task" process. The strategy-to-task process works by establishing strategic objectives and then designing nested objectives and tasks that ultimately work together to support overall objectives. Generally, interview participants indicated the bureaucratic approach made it difficult to create, share, use, and transform information in response to rapidly changing, dynamic environments. However, the information structure of the planning tools was viewed positively, with participants noting the flexibility of the tool being an important component for reacting to different environments, while the guiding structure of the process provided a generalizable format that made it easy to track the flow and build on information through the process.

Qualitative Themes

Through the course of the interviews a familiar narrative appeared. Participants described the information environment as increasingly complex, dynamic, and cluttered. They indicated that information must compete for attention, and therefore a positive experience means that information is tailored to helping individuals understand, process, and manage it, being designed for functionality and ease of use. Four dimensions emerged based on the common narrative shared across participants: *Information environment, human processing, information design, and information utility*. Each dimension is represented by multiple themes characterized by participant perspective of information interactions in the workplace. The feedback leading to dimension development is presented here first through the context of the interview structure itself, followed by the congregation of responses into appropriate themes, and ending with an explanation of how each dimension emergence based on commonality of thematic elements.

Participants conveyed multiple information experiences by responding to prompts building on unique personal experiences, information at different levels of the organization, and preferences for how information is utilized (see Tables 1 & 2). For example, almost all participants reflected on e-mail as their primary means of interacting with information at the personal level, while also suggesting that mass-distribution e-mails were their primary means of interacting at the organizational level. While personal e-mails were mostly seen as a positive experience, or at least useful, almost all mass e-mails experiences were viewed negatively. However, when reflecting on interpersonal and team information experiences, modalities such as phone calls and in-person meetings were reflected more commonly than impersonal digital modalities. Participants also created context surrounding elements of information itself. For instance, a set of major themes were noted on how often participants mentioned their experience dealing with information systems and tools, which were designed to control, organize, and otherwise manage information.

Participants were also asked to provide an example of an information experience that had substantial meaning to them. The stories highlighted the diverse experiences surrounding information interaction, while also indicating similar themes across many workplaces. One story, from an executive at a large organization, communicated issues that resounded in every interview. The leaders at this organization (I will refer to as Org X) were concerned the information environment was out of control. As a component of a larger organization, Org X was unable to provide a common operating picture (a succinct display of relevant information across multiple organizational components) for either senior leaders, or for the units that depended on Org X for plans and orders. Their decision cycle, referred to as the battle rhythm, was bogged down with over 700 monthly meetings throughout the organization, with limited ability to

connect the outputs of those meetings. A working group was established to constantly evaluate the usefulness of meetings, and to monitor information flow within the organization. Through efforts to improve information sharing, the number of monthly meetings was reduced from over 700 to the mid-20s (dependent on month). New processes were created to capture, share, and act on information at all levels within the organization.

The executive of Org X reflected on the major lessons learned from their re-organization of the battle rhythm. As noted, the first effort was to scope down the cadence and size of work meetings by changing expectations of information flow. For instance, they implemented a practice of reaching out as needed to SMEs, rather than force attendance at meetings where the SME's relevance is a sliver of the meeting scope. Additionally, they recognized a need to be more deliberate with information flow, providing better guidance, and making information more "actionable," or immediately useful/applicable for those receiving it. Improving information flow also meant creating better structure to help people navigate information sources, and to easily educate and train people on how to access and use information for their roles. Finally, they recognized that dynamic environments required more flexibility with information management and decision cycles, leading to a focus on quality and designing information for greater utility. The story shared from this interview exemplifies the elements that drove themes and aggregate dimensions, which further refined my characterization of information interaction.

Using grounded theory, the coding team extracted over 850 first order codes; reflections considered as substantial, stand-alone statements in response to interview prompts. The coding team further analyzed the interview responses for generalizable elements in first order codes, identifying 36 distinct themes related to information experiences. Themes varied in appearance and consistency, capturing the degree to which elements of information experiences are

perceived across different roles and types of organizations. I describe the generalization of themes based on their reflection of information interaction as captured by the dimensions emerging from the interview data.

Information Environment Dimension. The first dimension, information environment, is characterized by individuals' perception of how information flows within a system (Table 3). Specifically, participants noted how organizational processes may dictate how information is shared or managed, and that communication and information practices are prone to modification based on special events, unique circumstances, or through changes in technology. The most prominent theme ascribed to the environment was the importance of *collaboration and interdependencies*. Responses related to this theme focused on the importance of information connected across disciplines and specialties. Similarly, the themes of *shared information environment* and *specified information events* support the importance of information interaction being a shared experience that can align efforts and increase engagement on shared goals and objectives. Nearly every participant remarked on the importance of sharing and collaboration, describing connections as "essential to success," and "the only way to overcome compartmentalization of information." As one participant stated: "the world has increasingly become more interconnected, relationships and connections are essential."

In contrast to themes of a shared, open information environment were distinct themes related to the ability to acquire, share, or control information. The themes of *access* and *mechanistic process* captured the difficulties and frustrations experienced in the workplace with attempts to gain, manage, or disseminate information. For instance, one interview on military processes relayed the challenges of accessing systems with multiple levels of protection: "I had to obtain a new badge, verify my top-secret clearance, request special permissions, create a new

account and password, and log in to three separate systems, all just to download and sign an unclassified document." Another participant expressed how lack of information access led to work stoppage:

> I have never been more frustrated than when telework started and I couldn't access, use my network or systems to do what I needed. Tasks were piling up but frustration was overwhelming because I could not properly work on them. Every small task became time intensive, taking far more time than it should have.

Another major theme focused on the *changing nature of work/dynamic information environment*, which reflects the uncertainty that people may feel in the workplace regarding information flow. A dynamic environment captures an acknowledgement by workers that change is continuous, and that a certain level of adaptation is necessary in keeping up with the changes. Similarly, participants consistently noted a preference for guidance on the management and use of information, resulting in a theme of *expectation management*. On multiple occasions, participants conveyed the importance of good guidance in helping to reduce the uncertainty created by the dynamic/changing information environment. Guidance was also described as important for overcoming a lack of discipline in the information environment. As one participant noted: "One common issue I see is the tendency to 'fire and forget' when requesting or providing information, which creates misinterpretations or unanswered questions."

Human Processing Dimension. The second dimension, human processing, recognizes human involvement in the information experience (Table 4). Themes for human processing portray how information connects individuals, and how the personal experiences or circumstances of an individual may alter their information experience. Reflecting human interaction, the theme of *interpersonal dynamics* appeared the most in this dimension, with participants sharing the multitude of considerations present with information exchange.

Similarly, *knowing your target audience*, and *storytelling*, are themes that suggest the importance of enhancing information engagement with others. Participants described interpersonal engagement as "intimate," and "the most important form of communication for clarifying and understanding information." Concerns were also expressed, such as the interpersonal process being "personality driven," "relationship dependent," and "requires paying attention to details of the exchange." One participant reflected on the benefits of interpersonal information: "If I know the other person is invested in relationship, I am willing to share and be open, improving my communication and developing that relationship."

The next set of themes in the human processing dimension focused on the action and ability to process information. The themes *bandwidth*, and *filtering relevant information*, capture an individual's ability to attend to new information, based on the relative importance of information and the sense of saturation given the amount of information the individual is already experiencing. As one participant noted: "I don't have time to deal with emails full of drawn-out, lengthy monologues. I need the important information up front, and I need actions separated so I can properly respond to and organize how I attend to the message." Last, *expertise* emerged as a theme for capturing the experience and knowledge that individuals bring to their information experience, which may change how well they are able to react and engage with the information. A participant with over 30 years of experience suggested "Very little phases me anymore. I know where to look and who to talk to. But I can't imagine how hard it would be to start over in this role with the amount of information to navigate and manage."

Information Design Dimension. The third dimension, information design, is characterized by the process of constructing and conveying information (Table 5). Themes based on design convey the structure and presentation of information, to the methods used to project

and distribute information. Three similar themes emerged related to distribution: *information dissemination*, *information mediums/modalities*, and *organizing structure*. Information dissemination specifically focuses on transmission of information in practice, and how the information moves, or flows, within that system. One example includes communication of role behaviors and needs: "I was not getting the resources I needed from my supervisor. Later I came to find they were not passing my requests up the chain to be processed at the next level." Information mediums/modalities focus on the tools used for creating, using, disseminating, and modifying information. When participants were asked about information tools they overwhelmingly referred to email as the "communication tool of choice," "a necessary evil," and "basically the only way that anything is done anymore." Organizing structure is the set of techniques, practices, and procedures prescribed by an organization for controlling and guiding information use. Structure was viewed positively when it provided order, certainty, or a guide for action: "our recall rosters are an easy way to know who is responsible for communicating with who during an emergency." Structure was viewed negatively when it appeared overbearing, or only seemed to be helpful for those at the highest levels of hierarchy: "The task management tool is the absolute worst thing we have to use. All the work happens outside of this tool, so it only adds a layer of extra, unnecessary work." One story especially stood out about the difference between "real" work being done versus "work" done using information systems:

> We had to prepare for moving all remaining aircraft at our location out of country and into a new country, which required a memo to be signed as an official order. We staffed the memo using the task management system, and then waited, and waited some more. After a month we still did not have a signature, but we knew the planes had to be out of the country. So, all the planes moved anyway, without the stupid signed memo. Two months(!) after the planes were moved, we finally had a signed memo. What good is at that point? Another document to add to some historical file which no one will ever see again? What a waste.

The remaining themes for information design focus on how information is used to capture the attention of individuals, and associated actions and response to information. The themes of *transparency* and *reinforcement* reflect the desire to increase engagement based on clarity of and opportunities to interact with information, respectively. One participant noted the downside of poor transparency: "Some people use a lack of transparency to drive behaviors and control information, then say 'just quit asking why,' because they don't want to be questioned." The themes of *information transformation*, and *compels attention or engagement*, reflect production of information, with intentionality for how the information will be used. Information transformation refers to the process of modifying existing information to change how it is used, such as distilling large and complex concepts into simple graphics. To compel attention or engagement refers to the sensation cues that direct attention to particular elements of a piece of information, or to an information source as a whole. Participants conveyed a desire for information that is "consumable," and "intuitive to use," being "presented in a way that is user friendly." One participant expressed design in relation to their role, stating: "I am expected to use best attention practices, ensuring that other people are easily able to visualize, interact, and respond to the information I provide." Another participant quipped: "the higher you go in the approval chain, the more pictures you have to use to communicate important information." Information design based on its intended use shares some elements with the dimension of information utility.

Information Utility Dimension. The final and largest dimension, information utility, is characterized by the apparent usefulness of information, and utility of managing information for an individual's roles and responsibilities (Table 6). I deliberately separated information utility from information design to highlight unique aspects of each; namely that design represents form,

while utility represents function. There are similarities to thematic elements from information design, however design is focused on the creation process and the information itself, while themes of information utility are action-oriented, based on the user experience interacting with information. Themes corresponding to information utility largely represent the most important piece of information experiences: the interaction itself. The themes convey how individuals react to information, and what they believe makes information more or less useful. The largest theme is *guidance with direction/intent*, which captures the desire people have for knowing what to do with the information they receive. Every participant made a comment about appreciation of good guidance and the consistent desire for more guidance in their workplace, noting that it provides "clarity," and that it demonstrates "levels of coordination and buy-in from appropriate parties." The negative side of poor guidance was considered detrimental to performance, "[poor/lacking guidance] introduces noise into decision making, and makes load worse when there are competing projects and tasks."

Additional major themes of the information utility dimension include *ability to engage or act on information*, *information as a resource*, and *purposeful information*. These themes reflect a desire for information interaction to be meaningful. For instance, participants noted how certain elements of an information experience can invite greater depth of engagement, such as built-in hyperlinks leading to more material, or opportunities to provide immediate feedback. Additionally, information that is considered purposeful has perceived utility, making it easier to know how information should be used toward goals or objectives in the workplace. Participants expressed frustration with information that lack purpose, noting "we just throw words to the wind," even going as far as saying "communication is a privilege." When considered as a resource, information gains meaning in the form of power projection, along with importance for

how effectively the information is managed and applied. One participant, an expert in psychological operations, noted: "information is power, a resource, not simply a valuable job resource. It is a domain which creates an environment touching all aspects of social interaction."

Two themes of the information utility dimension, *information management*, and *information systems/tools*, specifically address the process of organizing and handling information. *Information management* reflects the concerns individuals may have with being able to make sense of and keep track of the information they receive. Most participants considered their information load "overwhelming," describing their information management attempts as a "losing battle," and a "constant sense of overload." *Information systems/tools* refer to the organizing structure provided by programs, such as knowledge management platforms, for managing information in a system. A system or tool may alter perceptions of information utility based on how easily information is managed, implying that organizational structure, which can dictate system/tool use, may affect perceptions of information utility. The importance of information systems/tools was represented in a range of reactions throughout interview responses. Positive reactions referred to information systems/tools as "the best thing that could have happened to our team," and "[systems/tools] are the most important piece of how we track requirements and maintain contact with our customers." Negative reactions to information systems/tools labeled them as "requiring more time and attention than they are worth," and "not flexible…one of the first things to stop working well when things get busy."

Some themes of the information utility dimension gave special focus to judgement and suspicion of information. *Accuracy* arose as a theme out of concerns for integrity of the information and conformity to a standard for getting the right information. Similarly, *trustworthiness* emerged from concerns of information credibility based on source, its purpose,

and whether ulterior motives may exist. The theme of *information seeking* conveys how, when presented with some piece of information, the need arises to identify and gather additional information. This is distinct from processing of information as the utility of the information creates the need for individual action to seek additional information. As one participant noted: "it feels like a trail of breadcrumbs, like I'm constantly pulling a rope to get all the pieces of information I need."

The final themes of the information utility dimension revolve around characteristics of information. *Timeliness* was consistently expressed as an issue people attributed to their information experiences. Participants described how information was "behind the power curve," or "the biggest impediment to progress," and that "we could never seem to get the information we needed ahead of schedule, it was always late or arriving at the 11th hour." The theme of *clarity* reflects how respondents wanted information to be readily useable. For example, one participant relayed her frustration with excel sheets that would come from one department, which were full of acronyms, broken links, and multiple tabs that she would have to piece together in order to make sense of and use the information provided. Finally, respondents also expressed a desire for *personalization*, when possible, as a means for making information more meaningful to individuals. As one participant stated: "Generic messages and newsletters may help reach masses, but taking the time to consider people individually, and to convey that in writing, can make all the difference in how people respond."

From Themes to Dimensions

Many of the themes identified through qualitative analysis contained overlapping elements that created difficulty in deciding how themes would aggregate into higher-order dimensions. One concept on information operations introduced during interviews and case

studies echoed the challenges of understanding information experiences. Specifically, the US military categorizes operations based on three "operating" domains; 1) physical, 2) information, and 3) cognitive. These domains are used to guide plans, actions, and other requirements associated with the full spectrum of organizational operations. The information domain is considered the most nebulous and ill defined, leading to a recent emphasis on refining the scope and understanding of the information domain, especially in relation to the cognitive and physical domains. Each domain shares elements related to information experiences, which are important for conceptualizing the interconnectedness across operating domains. These multi-domain elements include 1) the system element – characterizing the operating environment, 2) the human element – representing the role of individuals, 3) the information element – characterized by the existence of information in the system, and 4) the element of interaction – characterized by the engagement between human, information, and the system/environment. These elements provide a framework for understanding and delineating information experiences.

The four elements of system, human, information, and interaction, served as guides for combining themes into aggregate dimensions during our coding process. Themes were categorized into dimensions based on the level of representation of each element in the theme. For instance, the theme of *shared information environment* contained all four elements: humans were doing the sharing, information was being shared, and interaction was happening as a result of sharing. However, the system, or environment that contributed to information sharing, was the main focus of the theme, and therefore the theme was aggregated under the dimension of information environment. This process of comparing themes to elements of the information domain was used until all themes were aggregated into the final list of dimensions of information interaction (see Table 7).

Discussion of Qualitative Analysis

The four dimensions identified through interviews reflect the consistent elements shaping information experiences in the workplace: *Information environment, human processing, information design, and information utility*. These dimensions, derived from the interview data, reflect the elements of information experiences I proposed and consolidated based on theoretical review and initial conceptualization of information interaction*: Information elements, information states, information outcomes, and user context*. The similarity between the theoretical dimensions and those emerging from qualitative analysis suggest that the most basic elements of information interaction are reflected in both research and practice. Additionally, these findings suggests that the refinement of the information interaction construct, as informed by data analysis, may emerge differently than predicted in Hypotheses 1-5, though with similar underlying elements.

The data from the case studies and interviews were used to refine the conceptualization and measurement of information interaction. The dimensionality of the interview data provided perspective on my initial proposal of information interaction by presenting the information through an applied lens. I updated the model of information interaction to echo the new dimensions emerging from the qualitative findings. The new dimensions are a better reflection of connection between the information domain and the cognitive domain. Information environment reflects the system element; the surrounding contextual factors related to the information transmission, reception, and ability to use as information is experienced by the user. Human processing represents the human in the loop; the perception of an individual of their own ability to handle, use, or manage information at the point of experience. Information design reflects the element of information itself; the intentionality of planned efficacy during the

information creation, modification, or transformation process. Information utility reflects the element of interaction; the perceived value, usefulness, and action potential of information as determined by the user. Together, these dimensions capture the scope of the information domain, and the range of potential characteristics of information experiences. Additionally, the dimensions continue to represent the micro, meso, and macro levels of organizations, maintaining the systems perspective of information interaction.

Interestingly, all participants were overwhelmingly positive about the interview and the questions being asked. Every participant commented at least once during the interview that "I haven't really thought through this in such detail before." Participants expressed appreciation for reflecting on their experiences, and were generally excited to share their thoughts, and even more excited about potential developments in a process to better understand and measure their information experiences. One participant even remarked: "We constantly gripe and moan about our frustrations with information, but rarely do we capture these thoughts in writing or do anything about them." Another comment captured appreciation for intentionality of creating shared information experiences: "the diversification of backgrounds and perspective helps to think through what is shared, what is important, and how to get points across."

Participants also noted the relevance of information interaction to other organizational phenomena. For instance, one participant connected information interaction to an organizational change effort. He described the importance of information at each stage of the change process. For instance, information flow is imperative before change initiation evens begins so that everyone is prepared, and so that advocacy can be built for information management. Once change begins, the information experience may dictate the sense of a common operating picture, and whether everyone is on the same page. Feedback about the changes requires clear

information exchange to allow for refinement and responsiveness to change efforts. The clarity of information, as enhanced with clear outcomes and direction, supports individuals who need to act on new information as part of their roles and responsibilities. As change can invite chaos, open communication and continuous assessment can provide a sense of control or understanding of effort during the change process. The participant who relayed these points was fresh off a failed change effort in his organization. In frustration he quipped "this was garbage in, garbage out from the start. Our systems don't even talk to each other, but we are expected to create a cohesive information picture. I know how you get things done, and it's not the structure." The change effort had been implemented through a task management system, with poor guidance, limited opportunity for feedback, no planned assessment, and no buy-in. The participant relaying this story reflected on our interview and my research effort: "if we could better conceptualize and measure information interaction, perhaps we could avoid disastrous change efforts by better informing leadership of the information management issues in the organization."

Following refinement of the model, I made changes to my measurement approach based on interview feedback. Using the findings from interview data, I developed 39 new survey items for addition in the initial measurement testing. The new items reflected the thematic elements of the interview data, with at least one item generated for each theme. I also updated the prompt at the beginning of the survey with new language in the information experience primer to better reflect the common experiences conveyed from interviews.

Alternative Structural Equation Model. Interview participants reported views of information experiences that largely supported my initially proposed structural model, with information interaction as an antecedent to all other measured variables. However, participant feedback also informed another potential model. Notably, the organizational structure and

leadership behaviors may actually be antecedents to information interaction, as both structure and leadership behaviors may frame how an individual experiences information in the workplace.

The concept of structure appeared repeatedly in the dimension of information design. While structure of design speaks to the information itself, many participants noted how organizational policies or procedures may direct, for better or worse, common forms of information design experienced by the individual in their work role. Additionally, under the dimension of information utility, the themes of information management and systems/tools are largely governed by the resources an organization applies to managing the flow, storage, and sharing of information, specifically with information technology. These themes imply organizational structure may be an antecedent to information interaction.

The concept of leadership behaviors was a point of discussion in every interview. Leader behaviors commonly appeared in the themes related to acting on information (expectation management, and guidance, direction/intent), and interpersonal themes (interpersonal dynamics, transparency, and trustworthiness). Additionally, within the interviews, participants noted how their frustration or appreciation of their supervisor at times dictated the way they might respond to or use information from their supervisor. The potential for leadership behaviors to alter responses to information experiences implies that leadership behaviors may be an antecedent to information interaction.

The presence of organizational structure and leadership behaviors as antecedents, and psychological empowerment as an outcome of information interaction, implies mediation; specifically, that the effects of structure on empowerment, and leadership on empowerment, are explained (at least partially) through information interaction. The formalization of an

individual's roles and responsibilities through structure, reinforced through leadership behaviors, can alter the sense of meaning, self-determination, and impact an individual perceives in the workplace (Spreitzer, 1996). Organizational structures with greater flexibility, and positive leadership behaviors have been associated with increased feelings of psychological empowerment (Dust, Resick, & Mawritz, 2014).

Information interaction may explain part of the relationship between structure and empowerment, and between leadership and empowerment, based on how an individual feels they can act on the information. For instance, an organic structure may provide greater decision-making authority to an individual. In this situation, information interaction may partly explain increased empowerment based on the utility of information provided, which would drive perceived meaning and impact of decision-making, and an information environment that promotes access or sharing, characteristic of organic organizational structures, which may drive feelings of self-determination associated with empowerment. Leaders can encourage a sense of meaning, self-determination, and impact for individuals through helpful guidance that aligns objectives to actions, and by conveying the importance of an individual's work (Piccolo & Colquitt, 2006). Importantly, these interpersonal exchanges reflect an information experience taking place between two individuals. Specifically, information interaction may represent a supervisor putting their words into action. Rather than just conveying a sentiment, leaders have an opportunity to enhance feelings of empowerment by creating a positive information experience by providing individual's with information that is well-designed, high in utility, or by fostering an information environment that encourages sharing, collaboration, or access to promote functionality for individuals in their work roles. In summary, information interaction represents how information experiences created by organizational structure and leader behaviors

may lead to feelings of meaning, impact or self-determination, and therefore information interaction is a potential mediator of the relationship between structure and empowerment, and the relationship between leadership and empowerment.

Phase 2: Exploratory Meta-Analysis

*__Disclaimer__. The metaBUS platform (as of January 2021) has limited capacity for meta-analytic results. The output in this phase should be treated as exploratory, not a full meta-analysis. The results demonstrate potential relationships and associations based on articles and data available in metaBUS. I have written this phase to maximize replication of results, demonstrate supportive research findings, and to inform future efforts exploring information-related constructs.

An exploratory meta-analysis was performed using metaBUS, an AI-powered, cloud-based platform dedicated to curating and maintaining social science findings on the largest possible scale. The metaBUS tool was designed with the intent of allowing scientists to efficiently visualize research findings on a large scale (Bosco, Field, Larsen, Change, & Uggerslev, 2019). This platform produces meta-analytic findings utilizing practices outlined in the overview of systems frameworks and computer science research. Specifically, the platform is engineered to automatically extract findings from research stored in a massive, shared database. The findings are then classified based on study characteristics and used to develop a field-level ontology allowing for a branching taxonomy to navigate and explore interconnected topics across domains. The metaBUS platform includes findings from over 14,000 articles in major psychological and management journals from 1980 to 2015.

The initial steps in using metaBUS involve exploring the taxonomy of concept terms to identify potential variants of the construct name under investigation. Related terms are presented

hierarchically to help the user identify how the variety of terms are nested within the metaBUS platform, thus ensuring the user can search the database using the most encompassing term knowing that the desired nested terms will be included in the search. The taxonomic hierarchy is also useful for telling the system to remove potential undesired terms from a personalized hierarchy. Using an identified set of constructs, the platform also supports text-based targeted queries to demonstrate bivariate relationships between constructs, providing rudimentary meta-analytic estimates useful for exploration of new variable relationships or models. This approach to meta-analysis results has been praised as an important tool for researchers to more easily explore construct relationships and even identify overlooked findings from traditional meta-analyses (Bosco, Uggerslev, & Steel, 2017).

Researchers have compiled a set of guidelines for enhancing the metaBUS experience and obtaining the most useful results (Bosco et al., 2019). The main emphasis of the guidelines is to start broadly and narrow the constructs and relationships as the taxonomy is explored. Once you have identified the constructs and resulting taxonomy you wish to explore, you can specify the exact relationships you wish to explore using taxonomic identifiers, providing an informative yet rudimentary meta-analysis. Using a broad scope, I initially explored the taxonomy using the following terms: “Information,” “organizational communication,” “decision-making,” and “knowledge management.” From the resulting hierarchy I filtered out terms or constructs not related to the current study in order to specify my desired set of relationships for meta-analysis. Using the determined taxonomic identifiers, I explored the bivariate relationships of information related constructs to identify the trends of those relationships. For this purpose, I used metaBUS, which applies Schmidt and Hunter’s (2014) meta-analysis approach, relying on R package software scripts built in to the metaBUS platform.

Data Collection

The metaBUS taxonomy for beginning an exploratory meta-analysis has 11 initial nodes designated as the major categories under which all variables fall. This includes 1) Person characteristics, 2) Attitudes/Evaluations, 3) Behaviors, 4) Organizational characteristics, 5) Contextual characteristics, 6) very miscellaneous, 7) Intentions, 8) Dyad/group characteristics, 9) HR practices, 10) Cognitions, and 11) Occupational characteristics. The full scope of the taxonomy is represented by 3000 separate nodes in a hierarchical structure, representing a comprehensive set of variables across psychological and management research.

The search function provides the initial mechanism for exploring the taxonomy. Once a search is performed, the metaBUS taxonomy highlights the nodes with corresponding matches. Selecting each node builds the network of connected variables related to the initial search (Appendix G). I performed a query on the taxonomy database using four search terms related to information experiences in the workplace: 1) information, 2) decision making, 3) communication, and 4) knowledge management.

The initial search of the metaBUS taxonomy produced 23 potential nodes (variables) related to information use in the workplace, represented in over 6000 potential articles. There are no widely recognized terms for information experiences in the workplace, as compared to more common terms found in domains such as motivation or personality. Therefore, I used "information" broadly in the first search to explore the full scope of how information may have been characterized in research. The types of information related variables ranged from *information related behaviors* to attitudes about *information complexity*. Table 8 contains the output of the metaBUS search listing all potentially relevant information related variables and taxonomy codes.

I explored the taxonomies for the remaining terms specified as being related to information experiences. For the search term of decision-making, six variables of interest were identified, including attitudes toward *decision making autonomy*, and behaviors of *participation in decision making*. For communication, 10 potential variables were identified, ranging from contextual characteristics such as *communications general work activities*, to person characteristics, such as *communication ability* and *work communication network*. The search term for knowledge management produced no results. Using the broader search term of knowledge, four variables were identified, such as behaviors of *using knowledge*, and attitudes toward *knowledge characteristics*. Full results of the taxonomy searches for decision making, communication, and knowledge can be found in Tables 9, 10, and 11, respectively. After exploring the taxonomy for each variable, I identified the nodes of interest for comparison using the "targeted meta" function of metaBUS. Note, metaBUS does not function using taxonomic codes or specific nodes when conducting targeted meta-analysis. Rather, I had to use the broad search terms I had initially used to explore the metaBUS taxonomy.

Targeted Meta-Analysis within metaBUS

I performed three targeted meta-analysis using the broad term information compared against decision making, communication, and knowledge. The initial output of the targeted meta-analysis provides a comprehensive list of articles, studies, and effect sizes with potentially relevant findings of a relationship between the variables of interest. However, each article must be examined individually to ensure the variables are correctly represented, defined, and measured consistent with the parameters of the desired comparison.

The targeted meta-analysis of information with decision making initially produced 33 articles. However, inspection of the constructs used in each study reduced the number of useful

articles to 13. Most reductions were the removal of articles related to vocational behaviors for career field decision making. The articles included in the final analysis focused on characteristics of information and the information environment used in aiding decision-making processes.

The next search was for communication studies related to information experiences. Initially, exploring information with organizational communication returned only one article. Next, I queried the metaBUS system for information with the broader term, communication, which returned 38 initial articles. However, only 15 articles contained consistent conceptualizations of communication issues with information experiences. The articles removed from the search had tangential relationships based on information and communication technologies in the workplace, and associated outcomes such as norms, stress, engagement, or techno-overload.

The last search I performed was the relationship between information experiences and knowledge management. My first query using the term knowledge management with information produced zero results. Therefore, I next used the broader term of knowledge with information, which initially produced 144 potential articles. The majority of these articles were related to consumer studies and marketing, exploring how consumers access and interact with information about products to make more knowledgeable purchasing decisions, along with the efficacy and reach of advertising toward consumers. While many of these studies represented information experiences, my focus was on information used in the workplace. I filtered the query results to 20 final articles that focused on the information use in the workplace, and how information was used to increase role, team, and organizational knowledge.

Results of the Exploratory Meta-Analysis

Results of the exploratory meta-analysis, including the uncorrected correlation (*r*), number of studies, (k), sample size (n), standard deviations, and 95% confidence intervals are presented in Table 12. The largest correlation exists between information and decision-making (*r* = .54), supporting the initial conceptualization of information interaction. There is a moderate positive correlation between communication and information (*r* = .418), supporting the characteristics comprised in the proposed dimension of information states. The positive correlation between knowledge and information (*r* = .354) supports the characteristics of the proposed dimension of information utility. The overall results of the metaBUS output, while limited, support the theoretical assertions gathered from the multi-disciplinary review used to develop initial propositions and elements of information interaction.

Discussion of metaBUS Output

The effects of information experiences are broad and far reaching. I utilized the metabus platform to explore the breadth and strength of published connections between information experiences and related constructs of decision making, communication, and knowledge management. The results are consistent with my proposed conceptualization of information interaction (Figure 2). The correlations between information experiences with decision-making, communication, and knowledge are consistent with the important elements used to establish the framework of information interaction. Each construct (decision-making, communication, and knowledge) may represent different aspects of information experiences, which could be explained through information interaction.

While metaBUS displayed a multitude of connections for the information taxonomy, the targeted meta-analysis returned a set of studies with limited useful comparability. The metaBUS tool is first and foremost a search engine, providing a useful initial step in conducting a

systematic review by instantly visualizing and aggregating a topic of interest, its connections with other topics, and the associated correlations. However, metaBUS is reliant on the coding performed by workers inputting the articles and defining the constructs for coding, as well as the lack of articles prior to 1980 and those after 2015.

Additionally, there are no published meta-analyses that support a codified approach to aggregation, definition, or operationalization of information experiences in the workplace. In a review of the literature, one meta-analysis stood out for capturing information-sharing practices on teams (Mesmer-Magnus & DeChurch, 2009). However, the focus of the article was on team outcomes, and the literature representing information practices revealed a disparate variety of approaches for defining and measuring information sharing. Notably, none of the studies identified in the meta-analysis used the exact same scale to represent information experiences. Each measure had variations on the conceptualization of information characteristics and the information environment. I found no other relevant meta-analyses for information experiences in the workplace. While metaBUS exploratory meta-analysis relies on aggregating and comparing correlations, the strength of these comparisons is limited by the lack of standardized measures related to information experiences.

Given the limited number of articles reflecting the conceptual relationships of interest, I manually explored journal databases seeking articles that may not have been included in the metaBUS database. For instance, a prominent organizational communication measure by Roberts and O'Reilley (1974) did not appear in the metaBUS query. I reviewed every study citing the use of Roberts and O'Reilley's (1974) communication measure to identify potential articles for inclusion in the meta-analysis. However, I found that most of the follow-on studies focused on exploring directionality of communication flow, relationship factors between communicators,

and satisfaction with communication practices. I did not find additional studies exploring the relationship between communication and information experiences in depth; how participants characterized information, its usefulness, and the information environment from which they operated. My experience with the decision making and knowledge management literature was similar, revealing no new studies of substance above what had been identified in the metaBUS search. Throughout my manual search of journal databases, I noted a specific lack of studies exploring a full scope of information experiences related to performance in one's work role. Rather, most studies linking information experience with work performance maintained narrow focus on individual pieces of information, decisions, or used a measure specifically crafted for one organization or event.

Despite the effort to consolidate pertinent studies of information experiences, the research is widely mixed in the approach to defining, measuring, and comparing an information experience. It appears most research efforts have thus far focused more on what is done with information than how one experiences information. The results of this review suggest that future research could benefit from a formalized construct of information interaction, and a measurement approach allowing for generalizability and flexibility across different organizations and circumstances. Information interaction theory provides an avenue for expansion of information research, using the organizational framework as an initial reference point for building understanding of the potential relationships between information experiences and other constructs.

Phase 3: Subject Matter Expert Review

The items, survey design, and methodology were reviewed by 14 SMEs, with 10 completing effectiveness ratings of each item, a sample size recommended in measurement research (Lindell, Brandt, & Whitney, 1999). The SMEs, recruited through personal connections, consisted of a mix of practitioners who specialize in communication and information management, as well as individuals with expertise in IO Psychology. I generated the initial item pool using the propositions set forth in the review of practices from other disciplines, the identification of themes from Phase 1, and taxonomical relationships identified in Phase 2. Items were crafted to assess the full content domain for information interaction to fully encompass the behaviors and considerations engaged in the information interaction process. All SMEs offered verbal and written feedback of my efforts in measuring information interaction. I used SME feedback to refine the measure through re-wording of items and directions, editing survey design, and eliminating items out of scope for the information interaction construct. The final product after SME review was used to test the developmental sample used for exploratory factor analysis. The full set of items for SME review can be found in Appendix H.

Phase 3 Procedure

The initial item pool generated for this scale was based on the compilation of theoretical contributions from the review of cognitive psychology, computer science, and communication studies, along with the practices and feedback gathered from case studies and interviews in phase 1. All items were designed to measure an individual's perception of information experiences within the context of their work environment. Response options use 7-point Likert scales ranging from 1 – strongly disagree to 7-strongly agree. A Likert-type response scale seems most appropriate for information interaction because it allows respondents to indicate their levels of agreement or endorsement of items. Level of endorsement is appropriate for this scale because

the scale is designed to assess an individual's response to specific information experiences rather than their frequency of experiences with the information; i.e., frequency responses are unlikely to capture the nuances of each information experience. Additionally, using a 7-point option helps to provide discrimination of response (Nunnally, 1978). The information experience is generally not the same for all people, and is subject to a high degree of variation in response. Therefore, a Likert-type response scale should best capture the variability of responses to specific information experiences at different levels within an organization.

SMEs rated how effectively each item reflected the dimension being measured, given the specific definition of the dimension and the overall construct of information interaction. The SME ratings were used to calculate interrater agreement (r_{wg}), an index between 0 and 1, with higher scores representing higher levels of agreement among raters. An interrater agreement of greater than .70 is desired to demonstrate the convergence of rater perspective of the effectiveness of an item (Cohen, Doveh, & Eick, 2001). Agreement between SMEs contributes to content validity evidence, showing that, collectively, the items are believed to capture the true essence of the construct (Murphy & Davidshofer, 2005). Additionally, I calculated the content validity ratio (CVR), which reflects the number of expert ratings for "extremely effective" or "very effective" on an item, compared to the overall number of ratings for the item. Expert review is also useful for helping determine item clarity, wording, and on the potential for additional items pertinent to the content domain (DeVellis, 2012).

Experts were presented with the proposed definition of information interaction and the list of potential items and dimensions. Each SME rated the item's relevance to the given definition on a 1-to-5-point scale, 1 = not at all relevant, 2 = minimally relevant, 3 = moderately relevant, 4 = substantially relevant, and 5 = extremely relevant. SME's were also provided space

to comment on clarity, wording, or any additional modifications needed. The SME feedback was used to refine the list of items, either removing or modifying items as needed.

Results of SME ratings

The results of SME ratings are presented in Tables 13-20. The majority of items had high levels of interrater agreement and CVR. All items had a mean greater than 3.0, reflecting all items being better than "moderately effective," with the lowest item mean being 3.6. In total, 7 out of the 111 items reviewed did not meet the desired cutoff of .70 for interrater agreement. However, those ratings below the threshold were all greater than .60, with most being above .65, which led to additional discussion with SMEs about their ratings and reflection on each question. After discussing ratings, rationale, and feedback with each SME individually, I reworded the items that had the lowest agreement. After item refinement I contacted each SME for final feedback on the rewording of the items rated below the threshold, resulting in agreement for effectiveness of the new edits. Additionally, minor edits were made to other items based on SME review, but were not substantial enough to merit additional review and feedback.

Each SME was also asked if the construct was being fully assessed as defined, and if the methodology of assessment seemed reasonable. Some additional items were recommended and were added to the measure, after discussion with other SMEs, to further capture perspective of information interaction. Three items were added to the dimension of information states, which reflected 1) ease of access to information, 2) how information is filtered prior to reception, and 3) potential bias of information received. One item was added to the information design dimension to address information presented in a way that requires specialized training to understand. Finally, one item was added to the information utility dimension to address information support for making sense of one's experiences. These items shared some redundancy with established

items, but were considered to contain enough variation to be useful for inclusion in the factor analysis phase.

Discussion of SME feedback

SME feedback helped shape consideration for the design and scope of the survey for the exploratory and confirmatory factor analysis stages. All SMEs agreed that the measure in current form, with over 100 items across 11 separate sections, was robust as a tool for in-depth analysis of information experiences. However, SMEs also agreed that a much shorter set of items would be more ideal in practice for gathering constant, consistent data about information experiences. Anticipating the desire for a short version, and the benefits of a long version, I conveyed my intention to conduct the exploratory factor analysis with the full set of items and sections, to provide data on the full scale for later refinement. My intent would be to first use the factor analysis to create a smaller, more succinct version of the scale for confirmatory factor analysis. Thus, I would remove entirely the measurement sections for rating communication sources and modalities. Additionally, while I had approached item development from the perspective of 8 different dimensions (4 from theory crafting, 4 from qualitative analysis) I intended to reduce the number of dimensions present in my final model based on similarity of items. All SMEs concurred with this approach; the value in two separate measures, gathering data on the full scale during exploratory factor analysis, and aiming to reduce the size and scope of the measure for confirmatory factor analysis.

Phase 4 - Scale Development and Optimization

Phase 4 Effort

The scale development effort utilized multiple samples to accomplish exploratory and confirmatory factor analysis, item evaluation, and scale optimization. During this phase, data were collected using Prolific to produce two separate samples used for the factor analysis; one sample for exploratory factors analysis (EFA) and one for confirmatory factor analysis (CFA). When conducting scale development, a sample of 300 is useful for producing adequately sampled fit statistics (DeVellis, 2012). Exploratory factor analysis with a sample size of 300 responses is generally sufficient for producing a factor structure for one scale (DeVellis, 2012). Preliminary power analysis conducted to sufficiently perform confirmatory factor analysis indicates a sample size between 250 and 300 for a 95% probability of effect. Based on conceptual design of information interaction, I anticipated high communality of factors, and a determined structure of about three factors, and about three to four indicators per factor. Using guidelines for EFA from MacCallum, Widaman, Zhang, and Hong (1999), the anticipated minimum sufficient sample is at least 200 for the aforementioned factor structure, with a sample closer to 300 recommended based on my desire for the small number of factors and indictors per factor.

Phase 4 Sample

Two unique samples were collected at different time points, using Prolific, a worker sourcing website designed to match researchers with participants. The diversity of Prolific workers provides adequate representation of organizational experience over a sample of undergraduate students or employees within a single organization (Ramsey, Thompson, McKenzie, & Rosenbaum, 2016). Prolific workers were selected based on the qualifications that (1) they have at least two years of full-time work experience, (2) they are currently employed in full-time status outside of Proflic, and (3) that they were proficient in the English language (to

reduce item ratings based on poor translation). Current employment and work experience are required for this project as participants need to relate to the process of using information in an organizational setting.

Participants were asked to provide ratings based on their current organizational experience. Prior to rating, participants described an information experience pertinent to their work role to promote reflection on their work environment when responding to the measures. Survey questions were randomized within similar question blocks to minimize response priming and patterns associated with potential common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Additionally, I used varying response options, balanced positively and negatively worded items throughout the survey, and provided instructions that attempted to reduce socially desirable responding (Podsakoff, MacKenzie, & Podsakoff, 2012). Prolific workers were paid a total of $2.75 for their participation, a rate consistent with the U.S. Federal minimum wage, and with typical pay rate given task type and survey length of approximately 20 minutes (Goodman, Cryder, & Cheema, 2013).

Consistent with standard practice in collecting data from online participant sourcing mechanisms (Cheung, Burns, Sinclair, & Sliter, 2017; Eickhoff & de Vries, 2011, 2013), attention checks (e.g., 'Please answer 3 on the Likert scale for this question'), minimum time for completion, and a time limit for completion were used to ensure high quality responses. Also consistent with practices for using Prolific, I informed participants that I would not compensate them for completing the survey if they failed these checks.

Phase 4 Procedure

The two samples were collected independently. Sample two was collected after analysis of sample one, and refinement of the information interaction model. The first sample of 331

participants, sourced through Prolific, responded to the comprehensive list of items generated through the process described in phase 3. This initial item pool was intended to represent the full potential content domain for information interaction. Using the responses, I conducted an exploratory factor analysis to reduce the number of items and modify the scale based on the emerging factor structure (DeVellis, 2016).

The second sample of 324 participants, sourced through Prolific, responded to the modified list of items for information interaction, based on model refinement from exploratory factor analysis. I conducted a confirmatory factor analysis (CFA) using the new sample to verify the factor structure of the scale, to test the emergence of a higher order factor of information interaction, and to assess the reliability of scores using the factor structures based on the refined model.

Phase 4 Data Analyses

The preliminary information interaction measure consisted of 110 items. All items were reviewed for generalizable thematic elements. Based on this review, 55 items were identified as potentially representing the information environment/context, while the remaining 55 items were identified as potentially representing information characteristics. These two sets of items represent major dimensions, or potential second-order factors that I expected to emerge from the data. Splitting the items into these two groups of 55 items each allowed for a more refined approach to exploratory factor analysis. The two dimensions, or second-order factors, were then assessed for dimensionality as a super-ordinate construct by loading the dimensions onto one another and comparing the fit statistics of the model. Thus, I conducted two exploratory factor analysis with maximum likelihood estimates using Mplus version 8.3 (Muthén & Muthén, 1998-2019). The first factor analysis on item group one, with items representing information

environment/context, and item group two, with items representing characteristics. by grouping items into two sets based on the dimension each item was intended to assess.

Exploratory factor analysis in Mplus requires specification of a number of possible factors. I specified up to 10 possible factors, allowing the system to consider a range of possible factors from 1 to 10 for the measurement model. I also used a parallel analysis using 500 random data sets, similar to bootstrapping, which uses a correlation matrix of the randomized data sets to determine when factors no longer add unique information to the model, thus suggesting the most appropriate number of factors for the model (Ford, MacCallum, & Tait, 1986). Next, I assessed factor loadings, removing or modifying any item with less than a 0.4 factor loading (Tabachnick & Fidell, 2012). I also reviewed content for any items resulting in significant cross-loading or item-total correlations, since my goal was to develop a measure with distinctive dimensions. I followed strategies outlined by Stanton et al. (2002) for reducing length of self-report scales, such as selecting items that provide variance of score range while maintaining relevance to the construct domain. Additionally, I practiced controlled heterogeneity by incorporating different aspects across items to converge on intended constructs across my proposed information interaction dimensions. Lastly, I reviewed the wording of each item for each factor structure, and each item being removed, to ensure consistency of representation in the measurement.

I evaluated the fit of the scales using the commonly accepted fit statistic standards set by Hu and Bentler (1999): the comparative fit index (CFI) and Tucker–Lewis Index (TLI), where values over .95 are considered good, the root mean square error of approximation (RMSEA), considered good with values .06, and the standardized root mean square residual (SRMR), where values less than .08 are preferred. The 90% confidence interval for the RMSEA will be reported with all fit statistics and shown within brackets. I will also use the Chi-Square test of model fit to

assess fit of the model to my data, wherein a non-significant statistic indicates good fit. The Chi-Square statistic will be interpreted with caution as it sensitive to large sample sizes and, therefore, often significant even when the fit is good.

Exploratory Factor Analysis Results

Item Group 1 - Information Environment. Initial analysis on the 55 items I set aside to measure information environment configured into a 6-factor structure, though with substandard fit: $\chi^2 = 2034(1170)$, $p < .001$; CFI = .888; TLI = .857; RMSEA = .047 [.044, .051]; SRMR = .036. The full list of items was assessed for extreme responses, low item total correlations, and high correlations with other items. No item means were above 6 or below 2 (Table 21); therefore, no items were discarded for extreme responses (DeVellis, 2012). Following guidance on factor loadings from Oosterhof (1990), I removed any items with a factor loading less than .4, and reviewed all items with cross-loadings above .30 to identify which potentially redundant items should be retained. The remaining item response data were subjected to an EFA with oblique rotation, as I expected factors to correlate with one another. The newly refined scale was 18 items configured in a four-factor structure. While fit was adequate, $\chi^2 = 152.78(87)$, $p < .001$; CFI = .965; TLI = .938; RMSEA = .048 [.035, .060]; SRMR = .027, some items significantly cross-loaded and were therefore removed. The final model, a 12-item, 3-factor structure demonstrated good fit: $\chi^2 = 22.95(25)$, $p = .58$; CFI = .999; TLI = .999; RMSEA = .001 [.001, .040]; SRMR = .016.

Item Group 2 - Information Characteristics. Initial analysis on the 55 items I set aside to measure information characteristics indicated a 4-factor structure, though with substandard fit: $\chi^2 = 2828.75(1271)$, $p < .001$; CFI = .859; TLI = .836; RMSEA = .061 [.058, .064]; SRMR = .040. The full list of items was assessed for extreme responses, low item total correlations, and

high correlations with other items. No item means were above 6 or below 2 (Table 22), therefore no items were discarded for extreme responses. I removed any items with a factor loading less than .4, and reviewed all items with cross-loadings above .30 to identify which potentially redundant items I wanted to retain. The remaining item response data were subjected to an EFA with oblique rotation. The newly refined scale was 18 items in a four-factor structure. While fit was adequate, χ^2 =152.78(87), p <.001; CFI = .965; TLI = .938; RMSEA = .048 [.035, .060]; SRMR = .027, some items continued to cross-load higher than desired and were subsequently removed. The final model, an 11-item, 3-factor structure demonstrated desirable fit: χ^2 = 22.95(25), p =.58; CFI = .999; TLI = .999; RMSEA = .001 [.001, .040]; SRMR = .016.

In sum, both scales were slightly modified by removing problematic items, which improved fit statistics and overall model structure. The comparison of factor structure fit statistics is shown in Table 23. The addition of new items and possible dimensions from phase 1 has changed the potential factor structure initially predicted in hypotheses 2-5. While the names of the dimensions and underlying factors are different from those hypothesized, many of the thematic elements are similar to the original conceptualization of information interaction. The comparison of hypothetical factor structures with those emerging from the data is further explored following confirmatory factor analysis.

Confirmatory Factor Analysis Results

I conducted a confirmatory factor analysis on the resultant scales from the EFAs using a new sample of 331 participants, distinct from the EFA sample. The CFA was to confirm the overall factor structure of the scales, information environment and information characteristics, which represent information interaction. Both scales were tested using Mplus version 8.3, with

maximum likelihood estimation. Differences between the results of this CFA and the originally hypothesized factor structure are addressed in the discussion below.

Information Environment. A three-factor structure was fit to the data for information environment. The model displayed reduction of fit from prior analysis. Items 1 and 10 were removed due to loading on multiple factors and creating cross-loading with other items. The new, 10-item, three-factor structure demonstrated good fit: $\chi^2 = 70.507(32)$, $p < .001$; CFI = .975; TLI = .965; RMSEA = .061 [.042, .080]; SRMR = .037. Items in factor one are related to information access, items in factor two are associated with information relevance, while items in factor three are characteristic of information sharing. These three factors that make up the dimension of information environment do not follow the originally hypothesized factor structure in hypotheses 2-5.

Information Characteristics. A two-factor structure was fit to the data, and while the fit statistics were acceptable, two items (item 5 and item 7) were problematic. Namely, item 5 did not substantially load on either factor, while item 7 was cross-loaded with three other items; hence, both items 5 and 7 were removed. The new 6-item, 2-factor structure demonstrated excellent fit: $\chi^2 = 15.488(8)$, $p = .05$; CFI = .994; TLI = .988; RMSEA = .054 [.000, .094]; SRMR = .018, with no additional item issues. Items in factor one are associated with information utility, while items in factor two are associated with information engagement. There two factors, together represented by the dimension of information characteristics, are not consistent with the originally hypothesized factor structure (hypotheses 2-5) for information interaction.

Information Interaction. I combined the dimensions of information environment and information characteristics to test the efficacy of a five-factor model, with information interaction as a higher order construct represented by the dimensions of information environment

and information characteristics. The higher order test produced adequate fit, $\chi^2 = 240.09(98)$, $p < .001$; CFI = .945; TLI = .937; RMSEA = .067 [.054, .080]; SRMR = .046. The emergence of a superordinate construct of information interaction supports hypothesis 1. A superordinate structure was explored further using organizational data collection and nomological network development in phase 5. Additionally, while the dimensions are characterized differently than originally hypothesized, the measure of information interaction does contain items indicative of information elements, information states, information outcomes, and user context; consistent with hypothesis 7, that information interaction exists as a superordinate structure.

Reliability of scores. I used Cronbach's alpha to assess interrelatedness of items (Cronbach, 1951) and Omega (McDonald, 1990) to assess homogeneity of items. Both alpha and omega are indicators of reliability of scores, demonstrating the replicability of items in measuring a single dimension across samples. For information characteristics, both factors showed good reliability of item scores: factor 1 $\alpha = .86$, $\omega = .88$; and factor 2 $\alpha = .82$, $\omega = .84$. For information environment, all three factors showed decent reliability of item scores: factor 1 $\alpha = .80$, $\omega = .82$; factor 2 $\alpha = .78$, $\omega = .79$; and factor 3 $\alpha = .83$, $\omega = .84$. The reliability of scores for these measures is consistent with hypothesis 6.

Discussion of Factor Analyses

A multidimensional measure of information interaction emerged from the factor analyses process. Item grouping facilitated the testing of separate factor structures for the dimensions of information environment and information characteristics, consistent with the modified structure of information interaction informed by outcomes from the first three phases of this study. The original dimensions for information interaction were hypothesized as H2: information elements, H3: Information states, H4: Information outcomes, and H5: User context. Each dimension was

hypothetically comprised of multiple factors. For instance, information elements comprised a characteristics factor and a context factor. The data collected in phase 1 informed a refined conceptualization of information interaction, with new dimensions of 1) information utility, 2) environment/context, 3) information design, and 4) human processing. The new dimensions and refined conceptualization guided the factor analysis and corresponding structure. Therefore, the new dimensions that emerged from factor analysis are represented by a mixture of elements identified in the dimensions that arose from the phase 1 data analysis. While the original hypotheses 2-5 are not supported, the new factor structure, based on the refined conceptualization of information interaction, shares similar theoretical components to the originally specified model of information interaction.

The full measure contains 16 items (Table 24), intentionally designed for generalizability and flexibility across situations and organizations, with wording designed to avoid obsolescence given the dynamic nature of the information domain. I prioritized the development of a short measure to maximize usability for current implementation in organizational practices. My counterparts in practice conveyed a desire for measures that are brief but informative and that could be easily paired with other forms of data collection, such as unobtrusive measures. Importantly, the two dimensions capture the experience of the information itself, and the context surrounding the experience, providing depth of insight from the scores on each factor. Additionally, the higher order construct of information interaction suggests that individuals take a multifaceted approach in reacting to their information experiences.

Phase Five - Building a Nomological Network

The first four phases of this project provide construct validity evidence for the information interaction measure. The purpose of this fifth phase was to collect data to support the conceptual nomological network for the newly developed measure of information interaction in organizational settings, and test hypotheses 8 through 10. Specifically, hypothesis 8 proposed that balanced organizational structure types are positively related to information interaction. Hypothesis 9 suggested that leadership qualities are positively related to information interaction, and hypothesis 10 proposed that information interaction is positively related to psychological empowerment.

The theory of information interaction highlights the importance of information as a tool that connects all domains in an organization, moving from simple, interpersonal exchange to macro level interactions at the organizational level. As such, I compared information interaction to measures at all organizational levels, consistent with hypotheses 8 through 10. Specifically, I assessed organizational structure to represent an organizational level variable associated with information interaction. At the individual level, I assessed motivation represented by psychological empowerment. Addressing interpersonal relationships, I assessed perceptions of leadership associated with information interaction. Additionally, I asked individuals to report their position within the hierarchical level of the organization. This ranking was used to represent organizational levels across the various organizations from which I collected. Lastly, I asked participants for qualitative feedback about how their information experiences affect their decision-making.

As specified from initial hypotheses, the nomological network of information interaction is not simply a collection of individual relationships. Rather, information interaction as a construct exists in a system simultaneously with other variables, implying interconnected

relationships that should be considered together. As previously noted, the information experience becomes a lens through which individuals perceive the other organizational experiences represented in this nomological network. Therefore, I used a structural equation model (SEM) to represent Information Interaction as an antecedent to all other variables in my proposed nomological network, which includes organizational structure, leadership behaviors, and psychological empowerment.

When constructing a nomological network model, alternate models may better explain the relationships among variables. Phase 1 data informed an alternative model with organizational structure and perceptions of leadership behaviors as an antecedent to information interaction, and empowerment as an outcome of information interaction. Information interaction then has a potential mediating effect on the relationship between organizational structure and empowerment, and between perception of leader behaviors and empowerment. This alternative model was specified based on feedback from interview participants who indicated that the organization's structure may change their perceptions of an information experience based on rules or resources that could dictate information sharing, utilization, or accessibility. Additionally, participants noted how leader behaviors may promote information experiences with information utility, design or environment, potentially increasing an individual's sense of meaning, impact, or self-determination. Therefore, an alternative model with information interaction as a mediator was tested for comparison with the originally specified model with information interaction as an antecedent to all variables.

Phase 5 Data Analyses

Using the newly developed measure of information interaction I evaluated the relationship of information interaction to the proposed nomological network constructs

(organizational structure, leadership, and empowerment) as a SEM using Mplus. First, I identified the fit of this proposed model using the same accepted fit standards by Hu and Bentler (1999) outlined in Phase 4. Then, I evaluated the coefficients in the path analysis of the structural equation model (Kline, 2016) for both the initial model and the alternative model.

I tested for indirect effects in the alternative model using structural equation modeling with a bootstrap algorithm procedure (Preacher & Hayes, 2008) using 1000 draws with replacement to obtain a 95% confidence interval for parameter estimates. Bootstrapping is a nonparametric approach that imposes no assumptions regarding distribution shape (Preacher & Hayes, 2008). The bootstrapping procedure computes confidence intervals (CIs) of indirect effects considered more accurate than coefficients derived from regression methods (Shrout & Bolger, 2002).

Phase 5 Measures.

Organizational Structure. The 7-item scale developed by Khandwalla (1976) was used to measure perceptions of organizational structure reflected in organic vs. mechanistic tendencies, a continuum representing structural elements with extremes at either end (Burns & Stalker, 1961). Mechanistic organizations are characterized as rigid with traditional bureaucratic tendencies, such as centralized power and control, while organic structures are characterized by flexibility, open communication channels, and emphasis on adaptability and risk-taking (Burns & Stalker, 1961; Khandwalla, 1976). The emphasis of the mechanistic versus organic organizational structures as ends on a continuum is useful for describing and demonstrating the fundamental differences of structural forms (Ambrose & Schminke, 2003).

Participants rated their level of agreement with statements intended to describe their workplace, with high scores indicating organic work structure. Statements were framed on a

continuum, with a score of "1" representing maximum mechanistic structural elements, and a "7" representing maximum organic structural elements. For example, the statement "a strong insistence on a uniform managerial style throughout the business unit" represents mechanistic, whereas the statement "managers' operating styles allowed to range freely from formal to informal" represents an organic structure. Reliability of scores of $\alpha = .83$ have been reported on similar samples where this measure was used (Ambrose & Schminke, 2003; Slevin & Covin, 1997).

Leadership Behaviors. The leadership behavior measures used for this study are compiled from a combination of questions from the transformational leadership and servant leadership models. Transformational leadership is a theory of leadership focused on enhancing follower performance through motivation, role-modeling, and stimulating follower thought and development; behaviors labeled as *intellectual stimulation, idealized influence, inspirational motivation*, and *individualized consideration* (Bass, 1985). Servant leadership is theorized as a comprehensive approach to leading, comprising the conduct of ethical and developmentally focused behaviors meant to serve the personal and professional needs of followers (Liden, Wayne, Meuser, Hu, Wu, & Liao, 2015). The transformational and servant leadership models were chosen as they are considered conceptually distinct, while both represent positive leadership behaviors meant to encourage followers toward self-development and focus on creating a more positive experience at work (Hoch, Bommer, Dulebhon, & Wu, 2018).

Transformational behaviors, focused on building follower commitment to organizational objectives, were measured using items from the Transformational Leadership Inventory developed by Podsakoff, MacKenzie, Moorman, and Fetter (1990). This leadership measure was modeled after the Multifactor Form 5X questionnaire developed by Bass and Avolio (1997) to

appropriately capture specific targeted dimensions from the full range leadership model. Reliability of scores using the Transformational Leadership Inventory from prior research range from α = .82 to .90 (Podsakoff, MacKenzie, & Bommer, 1996). Servant leader behaviors, focused on development of followers, were measured using items from the servant leadership scale, with reliability scores in prior studies ranging from α = .80 to .89 (Liden, et al., 2015).

Psychological Empowerment. Psychological Empowerment was assessed using the Psychological Empowerment scale developed by Spreitzer (1995). This 12-item scale consists of four empowerment dimensions with three items per dimension. The four dimensions, *meaning, competence, self-determination, and impact*, are treated as first order factors with measures of observed variables. Psychological empowerment as the construct is treated as a second-order factor reflecting the sum of the first order scores of each dimension (Spreitzer, 1995). Reliability of scores from prior research is α = .87 (Dust, Resick, & Mawritz, 2014). Item response options range from 1 (*strongly disagree*) to 7 (*strongly agree*).

Results of Nomological Network Assessment

The dimensions of information characteristics and information environment were correlated with one another, leading to support for a higher-order factor representing information interaction. The composite information interaction score was assessed using a structural equation model with leadership behaviors, organizational structure, and psychological empowerment. Means, standard deviations, scale reliabilities, and correlations for the study variables are shown in Table 25.

Confirmation of Measurement Structures

I conducted CFA to assess the factor structure of each measure used in this study to determine if they retained their hypothesized configurations. Fit statistics for each scale are

reported in Table 26. All models had adequate fit statistics, with some models requiring minor modifications to account for correlated errors, though no items were removed from measures. The measure of psychological empowerment required no modifications, with all factors loading onto a higher order factor as originally demonstrated by Spreitzer (1995). The measure for organizational structure fit the data as a 1-factor solution after allowing errors from two items to correlate due to overlapping content. The measure for leadership behaviors supported a two-factor solution, with improved fit statistics based on correlating error from two items with shared content. The measure of information characteristics data fit a two-factor model, with no required modifications. The measure for information environment fit a three-factor model, with one modification allowing errors to correlate between one set of items. Information interaction emerged with good fit statistics as a higher order construct by combining information characteristics and information environment, $\chi^2 = 185.66$ (97), $p < .001$; CFI = .981; TLI = .977; RMSEA = .041 [.032, .050]; SRMR = .042, consistent with hypothesis 1, as modified after the phase 1 findings from qualitative analysis.

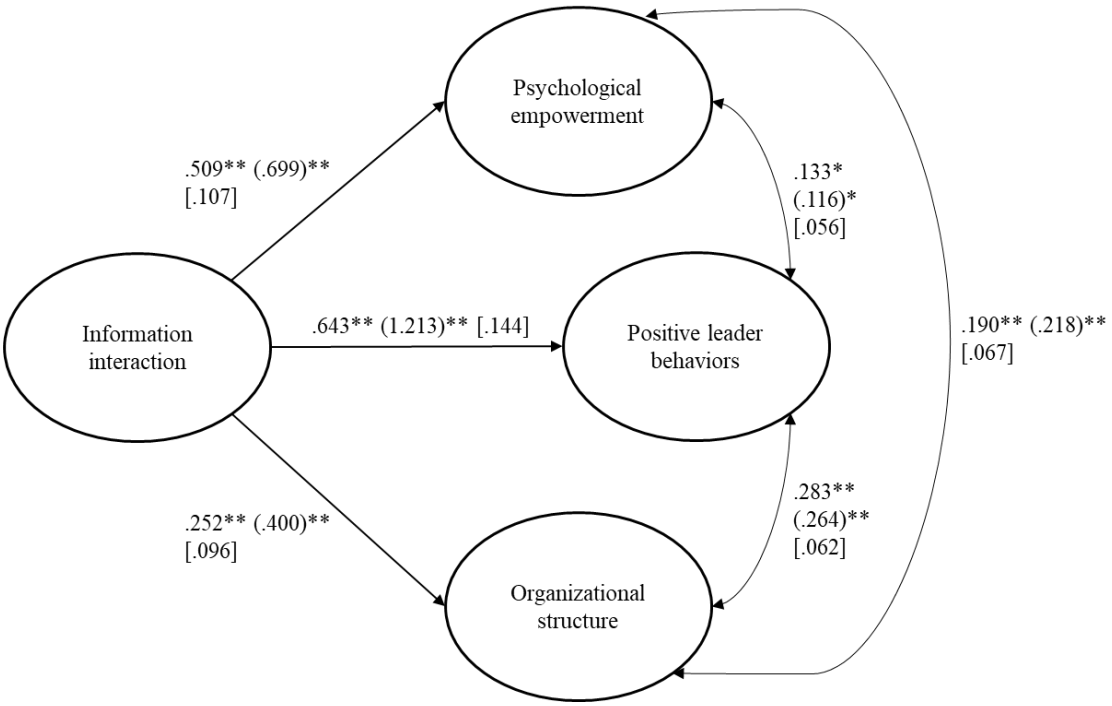
Initial Model Specification

Overall Model Fit. I used confirmatory factor analysis to test the relationship between information interaction and constructs within its nomological net. First, the measurement model was tested with all constructs, demonstrating adequate fit for each construct as defined by its authors. The chi-square test of model fit for the four measures was significant $\chi^2 = 1125.667(719)$, $p < .01$. Overall fit indices were adequate; RMSEA = .036 [.033, .040]; CFI = .960; TLI = .956; SRMR = .053.

Direct Effects. Information interaction, as a higher order construct, was examined for its relationship with leadership behaviors, organizational structure, and psychological

empowerment, all within a structural equation model. Information interaction is significantly correlated to perceptions of organizational structure, leadership behaviors, and psychological empowerment, consistent with hypotheses 8-10, respectively. Further, in the specified mode, information interaction was significant as an antecedent to perceptions of organizational structure, leadership behaviors, and psychological empowerment (Figure 5). A one unit increase for information interaction is associated with a .252 increase in perceptions of organizational structure, meaning as perceptions of information interaction increase, the organizational structure is perceived as being more organic than bureaucratic. This finding represents a medium effect ($\beta = .4$). Additionally, a one unit increase for information interaction is associated with a .643 increase in perceptions of positive leader behaviors, meaning as perceptions of information interaction increase, perceptions of positive leader behaviors increase. This finding represents a large effect ($\beta = 1.213$). Finally, a one unit increase for information interaction is associated with a .509 increase in perceptions of psychological empowerment, meaning as perceptions of information interaction increase, feelings of psychological empowerment also increase. This is considered a large effect ($\beta = .699$).

Figure 5.



Initial Nomological Network Structural Equation Model with Path Beta Weights.

Note. Standardized coefficients shown with unstandardized in parentheses. Standard error shown in brackets. ** p <.001; * p <.05

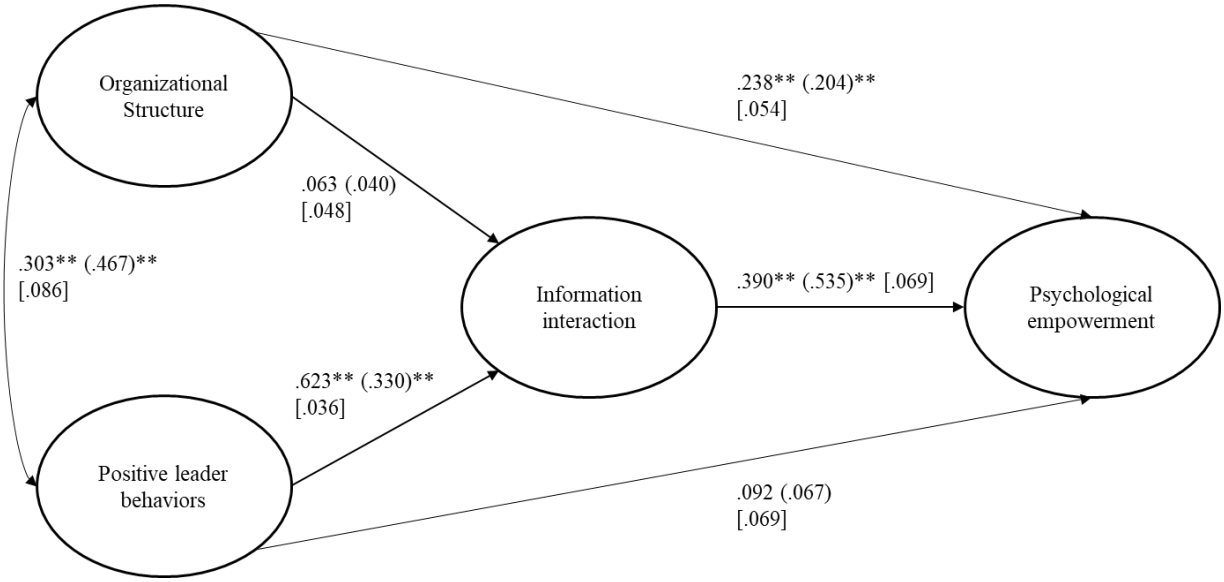
Alternate Model Specification

Overall Model Fit. The alternate structural equation model was tested using a confirmatory factor analysis for information interaction as an outcome of organizational structure, an outcome of leadership behaviors, and an antecedent to psychological empowerment. This alternate model was informed by the data analysis and feedback from phase one of this study. The measurement model was tested with all constructs, demonstrating adequate fit for each construct as defined by its authors. The chi-square test of model fit for the four measures was significant $\chi^2 = 1125.667(719)$, $p < .01$. Overall fit indices were acceptable; RMSEA = .036 [.033, .040]; CFI = .960; TLI = .956; SRMR = .053.

Direct Effects. Information interaction, as a higher order construct, was examined as an outcome of leadership behaviors and organizational structure, and as an antecedent to psychological empowerment (Figure 6). Organizational structure did not significantly predict information interaction (p =.184), indicating that differences in organic vs bureaucratic structure types were not associated with changes in perceptions of information interaction. Positive leadership behaviors predicted information interaction, such that a one unit increase for positive leadership behaviors is associated with a .623 increase in perceptions of information interaction. This is a medium effect (β = .33). Additionally, a one unit increase for information interaction is associated with a .390 increase in feelings of psychological empowerment, meaning as perceptions of information interaction increase, feelings of psychological empowerment also increase. This is a medium to large effect (β = .535). Organizational structure was significantly related to psychological empowerment, such that a one unit increase in structure (more organic structure) was associated with a .238 increase in feelings of psychological empowerment. This is a small effect (β = .204). Finally, positive leadership behaviors were not significantly associated with feelings of psychological empowerment (p =.180).

Indirect Effects. Examination of the bias-corrected bootstrapped confidence intervals revealed different levels of indirect effect across variable relationships. Information interaction had a significant indirect effect on the relationship between psychological empowerment and positive leader behaviors (β = .243 [.151, .334]), indicating statistical mediation. Information interaction had a non-significant indirect effect on the relationship between organizational structure and psychological empowerment (β = .025 [-.012, .062]), indicating a lack of statistical mediation.

Figure 6.



Alternate Nomological Network Structural Equation Model with Path Beta Weights.

Note. Standardized coefficients shown with unstandardized in parentheses. Standard error shown in brackets.

** p <.01

* p <.05

Discussion of Nomological Network Assessment

The results of the nomological assessment demonstrate the link between information and personal, interpersonal, and organizational, as well as the micro, meso, and macro level of an organization. The personal and micro level is reflected in the relationship between information interaction and psychological empowerment. This relationship suggests that information experiences are associated with the sense of meaning, competence, self-determination and impact of an individual in their work role. Additionally, mediation analysis indicates that leadership behaviors are indirectly associated with psychological empowerment via information interaction, marked by full statistical mediation. This indicates that supervisor efforts to increase

an individual's feelings of meaning, impact, competence, and self-determination are associated with how well the supervisor creates information experiences that have engaging, relevant, and purposeful, while promoting an information environment that fosters sharing and accessibility.

The interpersonal and meso level is reflected in the relationship between leadership behaviors and information interaction. The quantitatively assessed strength of the association between leader behaviors and information interaction echoes the qualitative remarks by individuals who consistently emphasized the importance of interpersonal dynamics in transmitting, receiving, modifying, and using information. Notably, the relationship between leader behaviors and information interaction was positive and strong in both tested models, though the antecedent and outcome relationships were different. I expect the interpersonal nature of the relationship between these two variables explains part of these findings. Specifically, when individuals consider information experiences related to their role, they may see those experiences as a reflection of how well their supervisor responds to the information environment, thereby altering perceptions of supervisor behaviors. That is, information interaction becomes a lens through which an individual may see their leader. Alternatively, supervisor behaviors may directly shape how an individual perceives their information environment through efforts to manage information relevance, utility, or accessibility. Therefore, positive behaviors exhibited by supervisors may provide a more positive lens through which individuals view their information experiences.

The organizational and macro level is reflected in the relationship between organizational structure and information interaction. The relationship of information interaction with organizational structure is especially interesting, as the reflection of information experiences appears to affect the perceptions that individuals have on the design and function of the

organization. Alternatively, the model with organizational structure as an antecedent had no significant association with information interaction. So, even though structure is typically seen as fixed entity to direct and manage operations, the way people in the organization have to interact with information changes their perception of how the structure actually works in action. Specifically, people may often feel that they are at the mercy of an organization's structure, and their responses to other organizational measures may create ambiguity between the organization's structure on paper versus in practice. The information interaction measure is designed to promote systematic thinking, and therefore may contribute to understanding alignment between organizational-level concepts and individual behaviors and perceptions.

GENERAL RESULTS

The development and testing of scale items is an iterative process, with each step building on the analysis of previous steps. The qualitative assessment of interview and case study data was used to solidify the conceptual development of information interaction, which was then used to formulate the final list of potential scale items for the initial factor analysis. The exploratory factor analysis was conducted to further refine the scale and reflect on the distribution of items across factors based on communality of items and factor loadings. Lastly, the confirmatory factor analysis and testing of the nomological net provide indicators that the new construct of information interaction can display meaningful associations with other organizational constructs.

GENERAL DISCUSSION

I created the construct of information interaction using the foundations of organizational systems theory, utilizing information conceptualizations from the fields of cognitive psychology, computer science, and organizational communication. The overall premise of understanding how we interact with information is that it can aide how we design, manage, and utilize information. Information interaction is important for organizations seeking to better understand their information environment in order to add value and utility to the information experience of organizational members. An important first step for improving the information experience starts with the conceptualization and measurement of information interaction. The ability to measure a construct allows for meaningful comparison to other known constructs, the association with other variables or organizational outcomes, and a better understanding of the individual's experience in the workplace. Understanding workplace experiences allows for meaningful modifications, informed by research, which may increase worker motivation, satisfaction, and ultimately performance.

I refined the final construct of information interaction throughout the development process. Initial feedback from interviews, case studies, and subject matter experts informed my changes in the naming and scope of proposed dimensions. Information interaction as a construct captures four dimensions, 1) information design, 2) information utility, 3) information environment, and 4) human processing. I prioritized the need for brevity in scale size during factor analysis, further reducing the scope of the factor structure I desired for the initial measure. The final, shortened measure of information interaction contains two dimensions; information characteristics and information environment. The dimension of human processing is not captured

in this measure. Information utility and design are represented under one dimension of information characteristics. Information characteristics captures design elements and associated semantics of the information itself, made up of two factors; utility and engagement. Utility is the perceived usefulness and clarity of information, while engagement reflect how well an individual is able to act on or respond to the information they experience, based on how the information is designed or delivered to increase stimulation. The dimension of information environment represents the perceived context or circumstances associated with the ability to attend to or focus on information. The three factors of information environment include access, relevance, and sharing. Access represents the degree of control or structure associated with gaining desired information. Relevance reflects the competition between the amount of information in a given space versus the information that is actually pertinent to one's role. Sharing is a reflection of the interdependencies and flowing nature of information. Taken together, these five factors across two dimensions emerge as a superordinate construct of information interaction.

The final construct of information interaction captures the important multidisciplinary theoretical considerations noted in the review portion of this paper. Specifically, information interaction represents experiences of an individual at the micro, meso, and macro domains, reflected in considerations from cognitive psychology, organizational communication, and computer science, respectively. These disciplines capture pieces of information flowing among individuals in a system, and individual reactions to and use of information within that system. Information interaction builds on the focus of each discipline by capturing the experience of the *human in the loop* of a larger information system.

Human in the loop is a phrase used in machine learning to indicate that a human reacts and responds continuously to information used for training and testing machine programming

and learning. I am applying the human in the loop concept to the connection between the information and cognitive domains. The information domain largely focuses on actions, such as the creation, modification, and dissemination of information, while the connection to the human component (cognitive domain) is treated as an outcome. The cognitive domain largely focuses on how humans attend to, perceive, or react to information, alongside other psychological and social considerations which drive attitudes and behaviors. Information interaction is a bridge concept, exploring the interactivity between the information and cognitive domains. Importantly, information interaction builds on and clarifies the continuous feedback loop between creating, receiving, and using information that traverses the information and cognitive domains. Specifically, information interaction gives voice to the human in the loop to establish context and value of specified information events within a system.

Human feedback to information processes ties into concepts from cognitive psychology and computer science. For instance, data visualization has grown out of the desire to make information easier for people to attend to, process and use. However, data visualization principles tend to be static and tied to best practices described by people who have noted success in certain circumstances. Using information interaction, the data visualization process can be dynamic, allowing for input and feedback from the users of the information throughout the input, processing, and output cycle. As an added bonus, creating data visualizations may be easier with constant, guided input from users rather than having to guess at what would be most beneficial to the end user. Even more importantly, constant and guided feedback from users may help identify limitations or constraints of a system used to manage and visualize data (e.g., a poorly designed knowledge management system), helping organizations to recognize areas for improvement, such as system-wide task management inefficiencies, that may have otherwise gone unnoticed.

Organizations gathering big data can also benefit from additional feedback provided through information interaction. Volume and velocity, two of the benefits of big data, limit the amount of human feedback provided in big data sets, as humans cannot take time to continuously provide the same levels of input that are provided through other non-obtrusive mechanisms. Information interaction adds value to big data sets by providing important snapshots of information value based on the information environment and the characteristics of specified information experiences. Feedback provided through information interaction can guide big data analysis by highlighting trends based on information events, sources, or systems which are meaningful to the users, the human(s) in the loop. For example, while big data may track the outcomes or behaviors tied to certain decisions within a system, the metrics of human processing, and perceptions of the information environment and characteristics can provide greater clarity on how those decisions are made. For example, some members in an organization may consistently delete system-wide emails based on the sender or the subject matter. Information interaction can further clarify whether the behavior is based on the members' experience, the perception of accessibility or need for sharing the information, or their perception of the information value based on its characteristics

Information interaction expands theoretical insights from cognitive psychology, organizational communication, and computer science. For cognitive psychology, information interaction provides a framework for connecting elements of information design principles with decision-making principles, along feedback that creates a context, all within a systems framework. For computer science, information interaction aligns the world of semantics, computer logic, and ontologies with the brain and behavior of the users. Computer science operates solidly in the information domain. Information interaction provides computer science a

useful bridge to maintain connection with the cognitive domain by accounting for the perspective of the human in the loop. For organizational communication, the construct of information interaction provides an operationalized tool for measuring information experiences related to communication, and how those experiences may change depending on the information environment. Most importantly, information interaction establishes a mechanism for studying alignment of information in a system by providing a framework for understanding information experiences at all levels of an organization (personal to organizational), and across micro, meso, and macro perspectives. Individual experiences (micro level) capture perceptions of information utility, which can be compared to information communication across levels of the organization (meso), all captured within the shared information environment of a system (macro) which informs the semantic and shared logic within a system.

Parameters for the Theory of Information Interaction

Data collection and analysis informed the final set of parameters and attributes for the theory of information interaction. I first want to clarify the interaction process. Information interaction comprises four steps; 1) Attention, 2) Reception, 3) Processing, and 4) Action (ARPA). Attention, the first step, marks the point at which an individual selectively focuses on a piece of information. Rather than discuss the intricacies of attention theory, the use of attention in this context is either 0 or 1, on or off. That is, a cognitive focus has been applied to a piece of information. Algebraically speaking, attention is a multiplier (0 or 1), while the remaining steps of reception, processing, and action are additive, as they represent a sequence of engagement with information once attention has occurred. Reception is representative of the information environment dimension, recognizing the level of access and noise present when interacting with information. The processing and action steps are representative of information design, utility,

and human processing, as these steps capture how an individual might analyze, understand, or modify information in order to decide what to do with it. An illustrative example of this process is seen in a radio. A typical radio goes through the ARPA steps by 1) attending to the signal based on the frequency you set, 2) receives the specified signal amidst a crowded electromagnetic spectrum (the information environment) full of other transmissions (noise), 3) processes [transforms] the signal from electronic bits and bytes into a specific set of signals that make sense to our ears, and 4) Acts by sending the processed signal into speakers, creating vibrations that are easy for us to perceive and recognize (music or talking).

The second set of parameters for information interaction establish boundary conditions for the theory. I want to address two application boundaries. First, information interaction does not capture the "how" behind information design on the front end, structure of the information environment, or the use of information on the back end. Additionally, information interaction does not explain the extent of how information is used or applied once it has been acted upon. The second application boundary specifies that information interaction is observed within a system. It is not meant to capture the full context of society. Rather, an organizational setting establishes a context for each dimension of information interaction. Per design, the theory of information interaction explains how information and decisions are aligned within an organizational system, focusing on the perception and decisions associated with information at the time of interaction.

Philosophy of Science

The theory of information interaction was purposely designed with the intent to identify and explore commonalities with other scientific fields such as chemistry and theoretical physics. Chemistry's first law of thermodynamics specifies that energy can neither be created nor

destroyed. I propose that information operates similarly to energy, being neither created nor destroyed, but rather existing in either a potential or kinetic state. For this thought exercise, knowledge is what we perceive as being created or destroyed, but we create knowledge based on information that exists. The comparison of information to energy applies to an organization as a system. Energy potential in a system is less than its initial state. The same may be true for organizations as systems. The existing information potential within in a system may be less than the initial state of the information. Within a system, information may be gained, lost, used, or transformed, in this way moving from a potential to kinetic state. Information interaction captures this kinetic state of information. At this point, the general theory of relativity from physics provides another layer of conceptualization. Relativity, the opposite of absolutism, specifies that our perception of physical objects is dictated by our exact position in the space/time continuum at the moment of perception (put very simply). Information interaction follows relativity, specifying that the moment of interaction (kinetic information) produces a relative perspective for each individual within a system based on their place in the space, time, and information continuum. I propose that, using these conceptualizations, the theory of information interaction may serve to connect theories between psychological and physical sciences.

Limitations, Strengths and Future Considerations

Several limitations present in this study can be addressed in future research. First, the examination of information interaction took place across multiple organizations, personnel, and levels of responsibility, yet at one time point only. Information experiences are likely to change over time, while other organizational constructs, such as organizational structure, may remain consistent over time. Measuring experiences either routinely, or in response to substantial events

related to one's role, could demonstrate how information experiences change in relation to other organizational circumstances. Therefore, additional studies would benefit from data collection at multiple time points within the same organizations, ideally with representative data from each level of the organization, thus incorporating breadth and depth over time of the construct of information interaction and associated effects. Expanding research and measurement is critical with new constructs, and therefore more research is desired for expanding the understanding of information interaction as a construct.

When collecting data for initial measurement development, the use of Proflic as a sourcing mechanism, though having diverse workers (Goodman et al., 2013), may introduce variables I was not measuring that caused the sample to be more homogeneous than expected. For instance, all participants had to be employed full-time and located in countries where English is the official language. Representation from non-English speaking countries may have reflected differing perceptions of information experiences based on different social or cultural norms, which could be important to understanding information experience on a global level. A language limitation is both constraining and an act of necessity with initial scale development, because I want item variation to reflect content of the items and representativeness of the construct, while language barriers to reading and understanding the items could cause unintended variance.

Strengths of this research study include the proposed construct of information interaction, the multi-disciplinary theory used to define the initial conceptualization, and the qualitative data analysis used to refine and operationalize the model. The creation of information interaction as a new construct is itself was limited by a lack of other constructs to directly compare with this one. However, the I leveraged work from three other major disciplines to create new theoretical space in IO psychology, requiring expansion of perspective to incorporate the construct and measure

into the existing literature. Additionally, multiple methods and samples were used to refine and inform and final conceptual model of information interaction and its measurement. For example, during construct refinement, the case studies and interviews examined different types of organizations, gathering perspectives from personnel at all levels of hierarchy and experience across multiple industries. The construct and associated measure would benefit from continued refinement through additional case study and interview work to increase diversity of perspective and to explore nuances related to other areas of organizational study. For instance, a well-known organizational culture model was developed and continuously refined using case studies from multiple organizations and thousands of interviews across five years of collaboration (OCI, Denison & Mishra, 1995).

Future considerations should be made for the scope of information interaction. While a multidimensional construct was developed to capture the essence of information interaction, the true scope of the information environment is unwieldy, and could fall into the same issues surrounding the debates of the person versus the situation prevalent in personality and social psychology research. However, I suggest that the current conceptualization of information interaction is definitive yet flexible enough to accommodate for information experiences at all levels of the organization, for almost any organizational role, and for most of the ways that people react to information. This includes the use of wording that transcends organizational structure types and communication modalities, allowing the measure to maintain relevance among technological advances and increasingly dynamic work environments. As potential evidence indicates effects surrounding information interaction, it will be important to understand when ratings change based on the person, or based on the information experience. For instance, individual perceptions of information experiences may collectively be worse for organization-

wide information than for information that has been individualized to a user. Therefore, it is important to link the measure of information interaction to a particular information experience whenever possible. This can be done by asking participants to briefly describe the information experience prior to answering questions. Alternatively, measures could be linked to the particular information experience in question, similar to how businesses request feedback from consumers based on a specific or most recent experience. As it currently stands, measuring information interaction is a snapshot in time, indicative of the particular context or set of circumstances shaping the perceptions of the individual for that particular moment in time.

While the construct and associated measure were developed to accommodate the widest range of experiences, the initial data collection of this study likely did not account for the many different types of information interaction experiences or situations encountered in organizations. Future research should explore a wide range of potential experiences or situation for information interaction, including experiences that may be tied to cultural or societal differences.

Future Direction

Information interaction provides a framework for thinking about our information experiences using a systems perspective, currently through the lens of the workplace. The development of a measure for information interaction provides a process for implementation, assessment, and comparison of the concept in practice. I intentionally narrowed the scope of the measure of information interaction to maximize utility for organizations and ease of replication in research. Future iterations of measurement could focus on developing an extensive set of items useful for organizational interventions or experimental settings.

The scope of information interaction should be addressed through increased study of its nomological net across levels of organizational hierarchy, roles, responsibilities, tasks, and

diversity of information experiences. I propose it is particularly important to examine information interaction as a variable that may explain or modify existing relationships in the organizational literature, such as leadership behaviors, further providing organizations with a systems perspective clarifying of the interconnections across organizational components. Researchers should examine broader relationships based on contextual variables such as organizational culture types, and on potential consequences of information interaction such as training and development or even application to team work.

The relationship between leadership behaviors and information interaction provides a new direction for leadership research. The models tested in this research produced positive associations when leadership behaviors were both an outcome of, and an antecedent to information interaction. Additional research is needed to explore the potential reciprocal relationship between these two variables, supporting the call for variables that can help explore the dynamic and reciprocal nature of leadership (Shamir, 2011). Additionally, information interaction acting as a potential antecedent fulfills the call by Hoch et al., (2018) for greater research on antecedents of leadership forms. Finally, the mediation results from this study indicate the potential for information interaction as an explanatory mechanism for how perceptions of leadership behaviors are associated with outcomes such as empowerment, commitment, or satisfaction. The actions taken by a leader to enhance information experiences, such as increasing utility or accessibility, may indicate specific mechanisms or actions that demonstrate how individuals perceive leaders acting out their leadership qualities.

The potential benefits from understanding information interaction can be explored through research at each organizational level. Organizational culture is another organizational-level construct that shares some construct space with information interaction, specifically related

to how individuals collectively share, react to, and apply information in their work environment. The values, assumptions, and norms of an organization's culture represent the shared human experience, or social component (Schein, 1990), which when balanced with structural components of the organization represent some of the greatest potential influence in shaping information behaviors and experiences for individuals.

At the personal or individual level, information interaction should be explored alongside training and development. Training researchers have called for a systems approach to design, delivery, and implementation of training, while increasing training transfer to encourage enduring learning outcomes (Bell et al., 2017). Information interaction provides a systems approach for helping link organizational outcomes and components with training objectives to explore how training and development can be designed to optimize learning and application of new skills and knowledge.

Information interaction was created to help individuals and organizations reflect on information practices, while aligning desired outcomes with work tasks and objectives. Future implementation is well suited for longitudinal work, such as capturing daily ratings of information experiences and using event sampling to monitor consistency of the information environment. For instance, future application to improve information interaction practices could use this new measure as an active, low-obtrusive data collection mechanism for everyday information-related experiences. This could be done by incorporating access to the measure within users' typical work environment, such as on an ever-present background application (app) on a computer, tablet, or other electronic device. For instance, when using e-mail an individual could use the background app to rate the information interaction experience of each e-mail. Ratings of the information interaction could be used to provide feedback at the individual level,

such as to the person sending the e-mail, or at the organizational level, such as a collection of reactions from multiple people on the use of e-mail for sharing information or conducting business. The potential application could be amplified by allowing the background app to pair other data with each user rating of experience; role data about the user such as experience level or scope of decision-making, or data about the information itself, such as whether it is intended for simple awareness or meant to be transformed into new content or decisions. By pairing role and information data with the user experience, across multiple users at many levels and many time points, organizations could develop big data sets that could provide new insights into information practices.

Taking a high-level perspective, information interaction bridges the information and cognitive/human domains, exploring the perspectives of a human in the loop engaged in a system focused on inputs and outputs. Using information interaction captures the intricacies of information flow in an organization by accounting for both the information environment and characteristics from a user perspective, at all levels of the organization. In practical terms, operationalizing information interaction should help develop better common operating pictures within an organization, helping to anticipate the current and potential effects of information flow/use to improve decision making while deterring impacts from poor information management.

Conclusion

Our daily interactions with information are met with constant reflection about how good or bad our experiences may be. We often vacillate between feeling overwhelmed by the information load and then feeling exasperated at the lack of accessibility of useful or needed information. We may describe information as being particularly useful, biased, or simply

irrelevant. We even recognize collective information experiences as being frustrating (e.g., business meetings) or as vitally important (e.g., experiences helpful administrative staff). Organizations often focus on understanding customer trends in attending to, consuming, and reacting to information, while ignoring similar trends for workers within the organization. I propose that exploration of information interaction can foster positive efforts for understanding experiences within the organization. The development of information interaction as a construct is intended to recognize the value associated with our information experiences and to give a voice to everyday interactions, and to provide a way forward for improving those experiences.

TABLES

Table 1

Context of Organizational Level for Interview Prompts

Contextual condition	Example modality	Function/role	Example quotation
Personal	E-mail	Individual interaction with information sources	As I take in new information, I am shuffling pieces, looking for interconnections, second and third order effects.
Interpersonal	Phone call	Information being shared or used among one or two individuals	Totally dependent on relationship with others, big focus on making contacts/connections to accomplish the mission.
Team	Meeting	Information shared or used to accomplish team/group goals	Working groups are best done with a good leader who knows how to utilize subject matter experts.
Organization	Mass email	Mass communication, large-scale knowledge management platforms used by most of all members	Information flows from strategic levels with lots of gaps. Rationale behind processes is not always shared at lower levels.

Table 2

Context of Information Elements for Interview Prompts

Contextual condition	Example modality	Function/role	Example quotation
Access	Systems/tools	Level of control and acquisition of available information	I would rather have access to more and be responsible for determining the legitimacy myself.
Improve	Personalization	Information is concise, focused, and purposeful for the individual using it	I want to know the "why" as much as possible. I thrive when I see all the cards.
Relevance	Requested information	Degree of relation/utility to an individual's role	Everything needs to be aligned to organizational mission and values.
Load	Task management	Voracity and viscosity of information being engaged at a given moment	So many channels I need to monitor. Constantly feel the need to clear my head.
Engage	Information mediums	Tools, structure, or design to support connections and elaboration	I want to see all the information on one screen - not having to pull from multiple sources, consolidate myself.
Feedback	Supervisor	Ability to improve information experiences through support from others	It helps to coach peers and lower on how to structure communication. Use formats to specify background, recommendations.

Table 3

Themes for Information Environment Dimension

Theme	Count	Theme description	Specific (condensed) observations
Access	34	Ability to acquire and source information as needed	Access can prevent pulling all information together and making connections.
Changing nature of work/dynamic info environment	23	The information environment is increasingly complex, and constantly changing	We are constantly updating our information practices and changing the way we operate in this environment.
Collaboration / interdependencies	69	Relationships and connections of mutual support	Creating opportunities to speak, training, development, generating involvement and overcoming discomfort.
Communication	5	General transmission of information	Information goes both ways. Provide constant and consistent feedback to others.
Expectation Management	25	Guidance on what should be done with information	Information needs to be matched with expectations and resources to guide known actions
Information constraints	18	Limitations in conveying, accessing, or managing information	There are communication limits based on the platforms we use - must be an "in" person to ensure good communication.
Mechanistic process	20	Highly controlled method of information sharing and use	Everything has a process and every decision needs to be staffed through multiple channels.
Shared information environment	43	Actions taken to establish a common operating picture	Communicating thoughts and receiving feedback builds common understanding.
Specified information events	10	A non-routine effort to collectively engage in information processing	Conferences to engage in strategic planning.

Table 4

Themes for Human Processing Dimension

Theme	Count	Theme description	Specific (condensed) observations
Bandwidth	41	An individual's availability to attend to or engage with information	Association between experienced load and volume of tasks.
Expertise	14	Individual experience and knowledge associated with their role	I need to be able to talk intelligently if someone asks me a question.
Filtering relevant info	49	Ability to identify and manage information based on usefulness in role	How much do I need to dig into details? Can I avoid irrelevant message traffic?
Interpersonal dynamics	60	The need for relationship, understanding, and dialogue in building connection	Personality driven. Do I share values? Are interactions based on requirements or relationship? Be present! Most desired level of communication.
Knowing your target audience	26	Understanding what works best for others and catering to preferences	Knowing your audience helps encourage perspective, increases relevance for others.
Storytelling	8	Ability to convey meaning, express importance, and invite others to engage	There is a challenge in marketing operations in a positive light. People are excited about the mission, but still had to influence internal dynamics. Power in branding.

Table 5

Themes for Information Design Dimension

Theme	Count	Theme description	Specific (condensed) observations
Compels attention or engagement	29	Presentation of information is digestible, intuitive, and user friendly	Increase ability to interact with presentation of information. Simplified and consumable visualization of information.
Consistency	10	Reliability of message or frequency for communicated information	Promote transparency, avoid information gaps to prevent non-uniform information. Reliable mechanisms for information management to help processes (e.g., turnover).
Information dissemination	25	The process of transmitting information within a system	Layers of information shared using top-down structure. Information distributed through mass communication technology.
Information mediums, modalities	34	Specific methods or technologies used to transmit and manage information	Big difference between digital vs in person interactions. Computer mediated tools are good for managing information, while critical thinking is best done in person.
Information transformation for use	25	Processing of data to articulate ideas, promote understanding, craft a message, or enhance decision making	The translation of language, distilling complex topics for general understanding. Conveying information context, interpreting the information environment.
Organizing structure	34	The use of programs, rules, policies, or guidelines to promote standardized information procedures	Use of knowledge management tool to track resources and responsibilities. Singular entity to align objectives, maintain common practices and priority of tasks and work flow.

Theme	Count	Theme description	Specific (condensed) observations
Reinforcement	7	Utilizing repetitive or redundant communication to increase interaction opportunities	It takes people interacting with information a number of times to really make an impact. Provide as many avenues to reinforce communication as possible.
Transparency	9	Clarity of processes for use and management of information	We often have to dig for information to get senior leaders to disseminate. The strategic reasoning can help inform how senior leaders react and relay information.

Table 6

Themes for Information Utility Dimension

Theme	Count	Theme description	Specific (condensed) observations
Ability to engage or act on information	48	The responsiveness of information for additional interaction or feedback	Information should be interactive to increase usefulness. Interaction with information implies a feedback loop drive by observation, orientation, decisions, and actions. People need to believe they can do something with the information. I need information to be actionable so that I can readily apply it.
Accurate	19	Integrity of the information, conforming to a correct value or standard	Accuracy counteracts the manipulation of the information environment. I am frustrated by lack of conceptualization, or incomplete representations. Lack of information can lead to lack of trust, and create a sense of misinformation.
Clarity	41	Coherent, simple, concise presentation of information	It should not require additional effort to translate or understand what is going on with the information presented. Simplicity in language.
Guidance with direction/intent	83	Clear goals, objectives, and purpose for utilizing information, aligning efforts and priorities	Directed goals and guidelines help us understand our planning and tasking purposes, providing a sense of certainty and way ahead. Provide an elevated perspective, how information fits into the bigger picture. It is difficult to align priorities when everyone has individual needs and differing agendas.

Theme	Count	Theme description	Specific (condensed) observations
Information as a resource	25	The use of information to control, influence, or project as a form of power	We can see territorial, tribal influences in tendencies to stovepipe, not wanting to share information. Information is leveraged as a resource to inform, understand, and strategize.
Information management	49	The process of organizing information for use in a specific role	Management requires dedicated time to maintain and prioritize. Organizing information can take hours each day.
Information system/tool	54	Use of technology or other structure to aide in organizing information	Our knowledge management platform is great for tracking logistics, tasks, and shared information, but requires individuals to input information correctly to be effective.
Information seeking	40	The process involved in identifying and gathering pertinent information	I feel I always need to seek further information to act on what I have received. What information is in the current environment?
Personalization	27	Individualized consideration of others with information engagement	Beware gaining efficiency at the cost of personalization. Personalized communication reflects understanding of what is happening in people's lives.
Purposeful	57	Perceived utility, or information for a specific goal	Minimize unnecessary content, demonstrate priority of effort, and provide exactly the information to complete objectives. Is it something I can use? Does it pertain to me and my role? How is this related to my goals or objectives? Ensure meetings have purpose!

Theme	Count	Theme description	Specific (condensed) observations
Timeliness	32	Information pertinence related to the timeframe for application	Provide the necessary information to make a decision when it is needed. How much time do you have to verify, use, and act on information at your disposal?
Trustworthiness	28	Credibility of the information based on source, motives, and access	People may be unaware of the influence others try to have on them with information. Check your information for legitimacy, accuracy, agenda, and bias.

Table 7

Final Dimensions from Qualitative Analysis

Dimensions	Description of dimensions	Information domain elements
Information environment	The environment dimension captures the interaction of an individual with their information environment. The information environment is in constant flux, represented by changing levels of access, conflict, and flow dependent on structural processes and interpersonal dynamics.	System
Human processing	The human processing dimension captures the human-in-the-loop element of information processing. This dimension is focused on the personal level and abilities or background of an individual, which may affect how they maintain awareness, filter, and utilize information.	Human
Information design	Information design captures how information is structured, developed, or disseminated for use. Design represents intentionality of information flow based on mediums and modalities for information use, consistency of information, and the transparency of information processes.	Information itself
Information utility	Information utility captures the ability for individuals to act on, engage with, or respond to information. Utility is represented by clarity, purpose, and relevance of information for individuals. Utility portrays information as a managed resource that aligns efforts between an individual, their roles, and the organization.	Interaction

Table 8

Exploratory Meta-Analysis Search Taxonomy for Information

Initial node	Final node	Taxonomy code	Records
Contextual characteristics	Manipulation: valence of information	20042	29
	Information generalized work activities	17402	31
Organizational characteristics	Information systems	11503	452
	Information exchange	17928	263
	Amount disseminated	17815	37
Cognitions	Direction of information processing	12132	2
Behaviors	Speed of response to information	17970	409
	Providing information	30778	66
	Acquiring information	17738	159
	Information related behaviors	17780	6314
	Information seeking	40118	3596
	Information sharing	40119	1997
	Changing/manipulation	17782	63
	Information pooling	12655	35
Person characteristics	Information power	12083	87
	Information processing	20370	342
Attitudes	Information processing	40016	188
	Information complexity	17016	59
	Information satisfaction	11106	187
	Information accuracy	17779	165
	Information vs control	11107	49
	Information overload	30950	46
	Informational trust	11110	37

Table 9

Exploratory Meta-Analysis Search Taxonomy for Decision-Making

Initial node	Final node	Taxonomy code	Records
Behaviors	Decision making	17839	932
	Participation in decision making	10122	1122
	Decision making activities	20208	1473
	Group team decision quality	30661	158
	Team decision accuracy	12500	78
Attitudes	Decision making autonomy	17407	707

Table 10

Exploratory Meta-Analysis Search Taxonomy for Communication

Initial node	Final node	Taxonomy code	Records
Contextual characteristics	Communications general work activities	17409	49
	Communication frequency	11112	84
Organizational characteristics	Access to communication enhancing technology	10923	56
	Climate of communication	11413	439
	Information sharing	40119	1997
Behaviors	Communication	17842	234
Attitudes	Quality of communication experience	20038	482
	Communication processes	17480	939
Person characteristics	Communication ability	20663	435
	Work communication network	20171	684

Table 11

Exploratory Meta-Analysis Search Taxonomy for Knowledge

Initial node	Final node	Taxonomy code	Records
Behaviors	Elaboration of information (knowledge sharing)	11101	373
	Using knowledge	17633	127
Attitudes	Knowledge characteristics	40014	6433
Person characteristics	Knowledge	20378	6433

Table 12

Exploratory Meta-Analysis of Variables Related to Information Experiences

Variable	*n*	*k*	*r*	*SD*	95% CI
Decision making	4251	24,14,13	.544	.29	.673, .383
Communication	8218	35,16,15	.418	.21	.477, .355
Knowledge	11637	58,21,20	.354	.25	.486, .208

Note. n=Total Sample Size. K=Total number of effect size, samples, articles. r = sample size weighted mean observed correlation. SD = Standard Deviation of the observed correlation. 90%CI = Lower and upper values of the 95% Confidence Interval.

Table 13

Subject Matter Expert Item Ratings for Information Elements Dimension

	Items for Information Elements:	M	rwg	CVR
1	I found this information useful	4.4	0.89	0.9
2	I was able to access the necessary information with relative ease	4.6	0.89	0.9
3	I felt that I had the information I needed within a useful timeframe	4.1	0.78	0.8
4	Most of the information sees useless or trivial	4.1	0.78	0.8
5	I feel responsible for acting on this information	3.7	0.75	0.5
6	I have trouble figuring out what to do with this information	4.5	0.89	0.9
7	I believe most people would find this information meaningful	4.3	0.85	0.8
8	This information is frustrating to deal with	4.4	0.89	0.9
9	I feel this information is important to me	4.6	0.94	1.0
10	The meaning or intent of the information is clear	4.5	0.89	0.9
11	The information did not have a clear meaning	4.3	0.85	0.8
12	The information I receive appears to be accurate	4.1	0.83	0.7
13	I do not trust information from this source	4.5	0.89	0.9
14	This information is immediately relevant	4.5	0.89	0.9
15	The information is important to accomplishing a goal or objective	4.6	0.89	0.9
16	The information is relevant to my work role	4.7	0.95	1.0
17	The information is useful for my responsibilities in my role	4.6	0.89	0.9
18	This information is mostly redundant	4	0.75	0.7
19	I have already received this information through other means	4.7	0.95	1.0
20	The information is presented in a manner that makes it easy to interpret	4.7	0.95	1.0
21	The information is interesting to me	4.6	0.94	1.0
22	This information is something that I can use	4.5	0.94	1.0
23	I find myself enjoying this information experience	4.1	0.83	0.7
24	I am able to transform the information into something useful for myself	4.3	0.85	0.8
25	I went to great lengths to find the information I needed	4.2	0.66	0.8

Note. The reported mean is the mean rated representativeness of the item. rwg = rater agreement. CVR includes only items rated as “Extremely Effective” and “Substantially Effective.”

Table 14

Subject Matter Expert Item Ratings for Information States Dimension

	Items for Information States:	M	rwg	CVR
1	I received an appropriate amount of information	4	0.65	0.8
2	I am concerned about how the information I send is being used	4	0.70	0.6
3	I am concerned about the security of the information being delivered	4.5	0.89	0.9
4	I feel I am able to use the information I have in a timely manner	4.2	0.81	0.7
5	Information is available from appropriate sources	4.4	0.89	0.9
6	Information is freely shared among personnel	4.2	0.81	0.7
7	The information I receive is pertinent to my role	4.1	0.73	0.7
8	Most of the information I experience is useful for my responsibilities	4.3	0.90	0.9
9	I receive important information in a timely manner	4.4	0.89	0.9
10	Information passes through multiple layers before it gets to me	4.3	0.90	0.9
11	I am encouraged to share relevant information with others	4.6	0.94	1.0
12	Other co-workers freely share work related information with me	4.4	0.84	0.8
13	I must often obtain permission before sharing specialized information with others	4.3	0.75	0.8
14	Important information for my role is easily accessible when needed	4.4	0.84	0.8
15	Most of the information that comes my way is useful for my role	4	0.80	0.6
16	I find myself routinely dealing with unnecessary information	4.1	0.73	0.7
17	I am able to maintain adequate communication with persons relevant to my role in the organization	4.3	0.75	0.8
18	I find it takes a lot of effort to understand the information I receive	4.4	0.89	0.9
19	I feel that I receive too much information about trivial things	4.4	0.79	0.9
20	I feel I do not receive enough information about important things	4.1	0.78	0.8
21	I feel constantly bombarded by information in my current role	4.6	0.94	1.0

	Items for Information States:	M	rwg	CVR
22	I feel overwhelmed by the amount of information I regularly experience in my role	4.6	0.94	1.0
23	I generally receive an adequate amount of information to perform my work	4.3	0.85	0.8
24	The information I receive does not generally have a purpose	3.9	0.73	0.6
25	I find the information I receive does not always appear accurate	3.9	0.78	0.5
26	I feel that I receive more information than I can effectively use	4.4	0.89	0.9
27	My organization encourages sharing of information	4.3	0.85	0.8
28	I feel like I need to protect work-related information at all costs	4.3	0.75	0.8
29	A lot of information shared in this environment is not work-related	4.1	0.78	0.8
30	I spend a great deal of time having to search for useful information	4.5	0.94	1.0
31	It is difficult to filter the information I need from the amount I am experiencing	4.4	0.89	0.9
32	I feel it is rather easy to access the required information	4.5	0.89	0.9
33	People find it difficult to access the information they need	4	0.70	0.8

Note. The reported mean is the mean rated representativeness of the item. rwg = rater agreement. CVR includes only items rated as “Extremely Effective” and “Substantially Effective.”

Table 15

Subject Matter Expert Item Ratings for Information Related Outcomes Dimension

	Items for Information Related Outcomes:	M	rwg	CVR
1	This information is useful for increasing my role-related knowledge	4.3	0.75	0.8
2	I am able to make better decisions using this information	4.6	0.94	1.0
3	Using this information will help me perform better in my work role	4.6	0.89	0.9
4	I can apply this information to current role responsibilities	4.6	0.89	0.9
5	I am able to use this information for my own development	4.5	0.94	1.0
6	This information will help me accomplish tasks in my current role	4.5	0.89	0.9
7	Access to this information makes me more productive	4.7	0.95	1.0
8	I am thankful to have this information for use in my role	4.1	0.68	0.8
9	I would appreciate more information like this	4	0.65	0.7
10	This information helps me make better decisions	4.7	0.95	1.0
11	This information helps me perform better in my current role	4.4	0.84	0.8

Note. The reported mean is the mean rated representativeness of the item. rwg = rater agreement. CVR includes only items rated as “Extremely Effective” and “Substantially Effective.”

Table 16

Subject Matter Expert Item Ratings for User Context Dimension

	Items for User Context:	M	rwg	CVR
1	Please rate your current bandwidth for dealing with additional information.	4.2	0.86	0.8
2	Please rate your level of expertise in your work or student role	4	0.65	0.7
3	Please rate your familiarity with this type of information	4.5	0.89	0.9
4	Please rate the level of experience you have had with the task related to this information	4.1	0.78	0.6
5	Please rate your information experience across different levels of the organization:	4.3	0.90	0.9

Note. The reported mean is the mean rated representativeness of the item. rwg = rater agreement. CVR includes only items rated as "Extremely Effective" and "Substantially Effective."

Table 17

Subject Matter Expert Item Ratings for Information Design Dimension

	Items for Information Design:	M	rwg	CVR
1	The information is easy to categorize for use or saving.	4.4	0.89	0.9
2	I find the information compelling	4.2	0.91	0.9
3	The information captures my attention	3.9	0.78	0.7
4	The information is presented in a manner consistent with my typical use	3.9	0.73	0.6
5	I am able to easily apply the information as needed	4.3	0.75	0.8
6	The information must be transformed into a more useful format before application	4.6	0.94	1.0
7	This information is consistent with current guidance or direction	4	0.70	0.8
8	I feel like this information is not providing the full picture of what is going on	3.6	0.74	0.6
9	I feel that those who are sharing this information are hiding something	3.9	0.83	0.8

Note. The reported mean is the mean rated representativeness of the item. rwg = rater agreement. CVR includes only items rated as "Extremely Effective" and "Substantially Effective."

Table 18

Subject Matter Expert Item Ratings for Human Processing Dimension

	Items for Human Processing:	M	rwg	CVR
1	The information presented creates a sense of overload	4.5	0.94	1.0
2	This information is immediately relevant to my work responsibilities	4.3	0.80	0.9
3	I find myself dealing with excess information that does not seem necessary	4.5	0.94	1.0
4	I can easily identify the useful pieces of the information provided	4.5	0.94	1.0
5	The information has been personalized for a specific audience	4	0.80	0.8
6	This information helps convey the importance of our work to others	3.8	0.71	0.7
7	I feel like I have a say, or a voice, in how to process this information	4	0.85	0.7

Note. The reported mean is the mean rated representativeness of the item. rwg = rater agreement. CVR includes only items rated as "Extremely Effective" and "Substantially Effective."

Table 19

Subject Matter Expert Item Ratings for Environment/Context Dimension

	Items for Environment/Context:	M	rwg	CVR
1	This information is not flexible enough for the current work environment	4.1	0.88	0.8
2	The information is responsive to the dynamic information environment	4	0.85	0.7
3	I feel like the information I receive is in conflict with other information sources	4.2	0.66	0.8
4	It feels like there are constraints on how to utilize this information	4.5	0.89	0.9
5	It is easy to share information with others in this environment	4.2	0.86	0.8
6	I feel that the information sharing structure is useful	4.4	0.94	1.0
7	I am constantly searching for more information than what has been provided	4.3	0.85	0.8
8	I feel like I never have enough information to do my job appropriately	4.1	0.83	0.7

Note. The reported mean is the mean rated representativeness of the item. rwg = rater agreement. CVR includes only items rated as "Extremely Effective" and "Substantially Effective."

Table 20

Subject Matter Expert Item Ratings for Information Utility Dimension

	Items for Information Utility:	M	rwg	CVR
1	I can easily engage with the information provided	4.2	0.91	0.9
2	I feel like the information makes sense	4.1	0.88	0.8
3	The information provided fits with other information I have about my job	4.2	0.76	0.8
4	I completely understand what I need to do with this information	4.1	0.78	0.8
5	This information is helpful for other people in my organization	4.1	0.88	0.8
6	I wish I had a better system for managing this information	3.7	0.60	0.6
7	I am limited by the tools available to manage this information	3.9	0.75	0.7
8	I feel like I have more questions than answers after seeing this information	4.4	0.79	0.9
9	I don't understand the purpose of this information	4.4	0.79	0.9
10	This information seems important enough to protect	4.3	0.85	0.8
11	I can easily apply this information to my work role	4.4	0.89	0.9
12	This information was tailored for my use	4.1	0.83	0.7
13	I would consider this information to be valuable	4.3	0.80	0.9

Note: The reported mean is the mean rated representativeness of the item. rwg = rater agreement. CVR includes only items rated as “Extremely Effective” and “Substantially Effective.”

Table 21

Exploratory Factor Loadings for Information Characteristics

Item	*M*	*SD*	Factor 1	Factor 2	Factor 3	Factor 4
1	5.77	1.45	**0.78**	**0.65**	**0.71**	0.27
2	5.35	1.46	0.33	**0.44**	**0.55**	0.18
3	5.85	1.23	**0.47**	**0.41**	0.31	0.16
4	5.03	1.75	0.35	0.33	**0.64**	**0.47**
5	5.71	1.42	**0.61**	**0.47**	**0.50**	0.24
6	4.42	2.07	**0.46**	0.40	**0.65**	0.35
7	5.89	1.30	**0.83**	**0.49**	0.37	0.11
8	5.69	1.36	0.39	0.37	**0.56**	0.35
9	5.32	1.63	**0.44**	0.40	**0.61**	**0.52**
10	6.09	1.14	**0.56**	**0.57**	**0.42**	0.29
11	5.93	1.30	**0.65**	**0.52**	**0.43**	0.20
12	5.56	1.47	**0.40**	**0.61**	**0.56**	0.22
13	5.86	1.40	**0.59**	**0.66**	**0.57**	0.27
14	4.90	1.66	**0.50**	0.28	0.28	**0.44**
15	4.47	1.77	0.08	0.04	0.00	0.27
16	5.50	1.46	**0.42**	0.39	**0.72**	0.29
17	5.63	1.46	**0.72**	**0.57**	**0.47**	0.15
18	5.97	1.27	**0.68**	**0.57**	**0.53**	0.16
19	4.69	1.91	**0.56**	**0.50**	**0.63**	0.09
20	5.69	1.34	**0.65**	**0.52**	**0.52**	0.11
21	5.49	1.43	**0.51**	**0.76**	**0.53**	0.11
22	5.69	1.32	**0.65**	**0.68**	**0.52**	0.09
23	5.62	1.36	**0.61**	**0.88**	**0.56**	0.13
24	5.66	1.31	**0.52**	**0.83**	**0.52**	0.16
25	5.32	1.50	**0.50**	**0.53**	**0.48**	-0.02
26	5.66	1.37	**0.58**	**0.89**	**0.55**	0.13
27	5.53	1.45	**0.54**	**0.74**	**0.54**	0.00
28	5.73	1.36	**0.70**	**0.76**	**0.64**	0.18
29	5.40	1.55	**0.67**	**0.67**	**0.54**	0.07
30	5.59	1.35	**0.66**	**0.71**	**0.52**	0.09
31	5.52	1.43	**0.64**	**0.86**	**0.52**	0.13
32	5.51	1.28	**0.41**	**0.47**	**0.67**	0.10
33	5.17	1.46	**0.64**	**0.51**	**0.59**	0.02
34	5.50	1.42	**0.65**	**0.45**	**0.46**	0.02
35	5.36	1.41	**0.49**	**0.62**	**0.70**	0.13
36	5.56	1.27	**0.43**	**0.57**	**0.79**	0.31
37	3.90	1.85	0.07	0.10	0.19	**0.49**

Item	*M*	*SD*	Factor 1	Factor 2	Factor 3	Factor 4
38	5.44	1.30	**0.44**	**0.60**	**0.70**	0.21
39	4.58	1.81	0.30	0.38	**0.57**	**0.64**
40	5.08	1.77	0.22	0.33	0.34	**0.59**
41	4.73	1.86	0.02	0.01	0.12	**0.55**
42	4.20	1.73	0.21	0.19	**0.42**	**0.57**
43	5.56	1.49	**0.42**	**0.69**	**0.50**	0.26
44	5.65	1.10	**0.42**	**0.49**	**0.57**	0.31
45	5.04	1.60	0.20	0.26	0.19	0.01
46	5.05	1.41	0.26	0.22	0.31	-0.03
47	4.70	1.63	0.35	**0.44**	**0.46**	**0.61**
48	4.90	1.40	0.17	0.34	**0.45**	-0.02
49	4.90	1.70	0.23	0.31	0.39	**0.62**
50	3.97	1.69	0.15	0.24	0.32	**0.42**
51	5.66	1.19	**0.45**	**0.58**	**0.71**	0.21
52	5.73	1.35	**0.44**	**0.56**	**0.78**	0.31
53	5.59	1.30	0.39	**0.54**	**0.66**	0.18
54	5.68	1.32	**0.42**	**0.54**	**0.76**	0.32
55	5.43	1.41	0.32	0.40	**0.48**	0.11

Note. Item = Original Item Number. Bolded Numbers are Factor Loadings above .4.

Table 22

Exploratory Factor Loadings for Information Environment

Item	*M*	*SD*	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
1	5.55	1.44	**0.51**	**0.52**	0.21	0.14	-0.01	0.16	0.02
2	5.31	1.64	0.33	**0.62**	**0.52**	0.05	0.02	0.26	0.09
3	5.86	1.28	**0.42**	**0.63**	**0.43**	0.13	-0.05	0.14	0.01
4	5.84	1.47	0.39	**0.73**	**0.52**	0.15	0.15	0.15	0.10
5	3.92	1.79	0.09	0.18	0.08	0.02	**0.43**	0.15	0.10
6	5.28	1.31	**0.68**	**0.44**	0.38	0.28	-0.06	0.29	0.07
7	4.51	1.69	0.18	0.26	**0.43**	0.28	0.39	**0.44**	0.18
8	4.88	1.70	0.18	0.22	**0.44**	0.29	**0.48**	0.32	0.15
9	5.50	1.11	**0.52**	**0.41**	0.32	0.21	-0.11	0.21	0.13
10	5.65	1.09	**0.68**	**0.42**	0.30	0.30	0.02	0.16	0.00
11	5.02	1.47	0.32	0.23	0.12	**0.64**	-0.05	0.07	0.14
12	5.66	1.13	**0.41**	0.35	**0.43**	0.20	-0.15	0.09	0.01
13	5.58	1.10	**0.53**	**0.44**	**0.47**	0.23	-0.14	0.21	0.13
14	5.25	1.26	**0.73**	**0.41**	0.24	0.25	-0.01	0.20	0.20
15	3.70	1.60	0.20	0.09	0.14	-0.03	0.10	0.29	**0.60**
16	5.37	1.39	0.23	0.16	0.10	**0.64**	-0.07	0.15	0.02
17	5.43	1.36	0.39	0.24	0.17	**0.54**	-0.14	0.09	-0.04
18	3.89	1.83	0.03	0.11	0.10	0.35	0.29	0.20	0.34
19	5.30	1.23	**0.77**	0.37	0.24	0.17	0.05	0.18	0.14
20	5.52	1.14	**0.60**	**0.43**	**0.56**	0.22	-0.22	0.22	0.06
21	4.32	1.67	**0.40**	0.39	**0.73**	0.16	0.04	**0.48**	0.28
22	5.58	1.15	**0.69**	0.40	0.28	0.39	-0.10	0.24	0.03
23	4.40	1.62	0.26	**0.44**	0.23	0.05	0.27	**0.61**	0.20
24	4.27	1.69	0.29	0.36	**0.69**	0.17	0.07	**0.41**	0.27
25	4.55	1.69	**0.58**	**0.44**	**0.46**	0.16	0.20	**0.41**	0.36
26	4.06	1.72	0.19	0.22	0.26	-0.01	0.11	**0.71**	0.27
27	4.04	1.72	0.22	0.22	0.25	0.12	0.17	**0.74**	0.17
28	5.34	1.29	**0.70**	**0.41**	0.28	0.28	-0.02	0.19	0.09
29	5.14	1.42	**0.41**	**0.45**	**0.70**	0.15	0.01	0.26	0.11
30	4.61	1.59	**0.40**	**0.50**	**0.59**	0.09	0.23	0.30	0.11
31	3.94	1.74	0.09	0.23	0.34	0.07	0.17	**0.54**	0.14
32	5.16	1.52	0.39	0.16	0.19	**0.73**	0.07	0.12	0.10
33	3.18	1.71	-0.08	0.02	0.06	0.22	**0.52**	0.12	0.24
34	4.47	1.69	0.21	0.22	**0.55**	-0.03	0.01	0.17	0.15
35	4.08	1.75	0.30	0.31	0.18	0.05	**0.53**	**0.50**	0.19
36	4.34	1.58	0.30	0.34	0.37	0.18	0.17	**0.70**	0.21
37	5.21	1.31	**0.69**	0.32	0.24	0.21	0.02	0.20	0.07

Item	*M*	*SD*	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
38	4.87	1.51	**0.61**	0.38	0.34	0.15	0.33	**0.50**	0.20
39	3.56	1.53	-0.03	0.04	0.12	0.06	0.11	0.12	**0.65**
40	4.76	1.61	0.31	0.34	**0.47**	0.15	0.22	0.32	0.33
41	4.35	1.67	0.28	**0.50**	**0.51**	0.13	0.16	**0.55**	0.30
42	4.84	1.71	0.30	0.16	0.04	0.07	-0.41	0.01	0.11
43	5.23	1.41	0.40	**0.42**	-0.01	**0.44**	-0.08	0.12	-0.03
44	5.26	1.35	**0.61**	**0.57**	0.23	**0.41**	-0.11	0.29	0.08
45	3.73	1.74	0.25	0.39	0.20	0.07	**0.41**	0.36	0.23
46	4.61	1.71	**0.43**	**0.51**	0.31	0.09	0.38	0.40	0.28
47	3.82	1.75	0.38	**0.55**	0.28	0.20	0.34	**0.51**	0.30
48	4.29	1.73	0.36	**0.51**	**0.40**	0.17	0.26	**0.43**	0.22
49	4.47	1.90	0.37	**0.61**	0.32	0.14	0.20	0.38	0.21
50	5.55	1.61	0.33	**0.76**	**0.48**	0.10	0.04	0.24	0.11
51	4.42	1.58	0.24	0.16	0.10	-0.10	-0.38	0.00	-0.05
52	5.57	1.36	0.39	**0.66**	0.35	0.22	-0.26	0.27	0.11
53	4.65	1.66	0.31	0.37	0.16	0.16	-0.17	0.11	0.09
54	5.65	1.38	0.38	**0.69**	0.37	0.22	-0.26	0.16	-0.01
55	5.22	1.40	0.33	**0.45**	0.27	0.18	-0.34	0.09	0.07

Note. Item = Original Item Number. Bolded Numbers are Factor Loadings above .40.

Table 23

Fit Indices for Confirmatory Factor Analysis of Information Interaction dimensions

Structure	χ^2	*df*	RMSEA	CFI	TLI	SRMR	$\Delta\chi^{2\dagger}$ (Δdf)
Higher order construct of Information Interaction	240.09	*98*	0.067	0.945	0.937	0.046	
Information Characteristics							
2-factor, 6-item	15.49 *p*=.05	8	0.054	0.994	0.988	0.018	
2-factor, 8-item	104.39	19	0.114	0.961	0.945	0.030	88.6 (11)
Information Environment							
3-factor, 10-item	70.51	32	0.061	0.975	0.965	0.037	
3-factor, 12-item	136.39	51	0.072	0.956	0.943	0.041	65.88 (16)

Note. N=331. χ2 = Chi-Square Statistic. *df* = Degrees of Freedom for the Chi-Square Statistic. RMSEA = Root Mean Square Error of Approximation. CI = Confidence Interval. CFI = Comparative Fit Index. TLI = Tucker-Lewis Index. SRMR = Standardized Root Mean Square Residual.

* = $p < .001$. † $p < .01$ unless noted otherwise.

Table 24

Final 2-dimension, 5-factor, 16-item measure of Information Interaction

	Information Interaction Items	*M*	*SD*	Loading
	Information Characteristics - Utility			
1	I found this information useful	5.71	1.76	0.88
2	Using this information will help me perform better in my work role	5.37	1.77	0.84
3	This information helps me make better decisions	5.46	1.63	0.79
	Information Characteristics - Engagement			
4	I am able to easily apply the information as needed	5.42	1.57	0.84
5	I can easily engage with the information provided	5.58	1.56	0.84
6	I completely understand what I need to do with this information	5.72	1.55	0.70
	Information Environment - Access			
7	Information is available from appropriate sources	5.61	1.21	0.77
8	I receive important information in a timely manner	4.92	1.56	0.77
9	Important information for my role is easily accessible when needed	5.30	1.42	0.79
	Information Environment - Purpose			
10	The information I receive is pertinent to my role	5.63	1.19	0.75
11	Most of the information I experience applies to my work responsibilities	5.48	1.24	0.77
12	Most of the information that comes my way is useful for my role	5.36	1.33	0.86
13	I find myself routinely dealing with unnecessary information	3.70	1.71	0.50
	Information Environment - Sharing			
14	I am encouraged to share relevant information with others	5.79	1.29	0.70
15	Information is freely shared among personnel	5.30	1.46	0.79
16	My organization encourages sharing of information	5.53	1.45	0.88

Table 25

Means, Standard Deviations, Scale Reliabilities, and Correlations

Variable	*M*	*SD*	1	2	3	4
1. Information interaction	5.33	0.95	*.90*			
2. Organizational structure	3.83	1.18	0.18*	*.81*		
3. Empowerment	5.27	0.96	0.37*	0.25*	*.88*	
4. Leadership behaviors	5.11	1.35	0.47*	0.29*	0.29*	*.92*

Note. Cronbach's alpha appears along the diagonal in italics.
* $p < .001$.

Table 26

Fit Indices for Each Individual Construct in the Structural Equation Model

Model	χ^2 †	*df*	CFI	TLI	RMSEA	90% CI for RMSEA	SRMR	$\Delta\chi^2$ (Δdf)†
Organizational Structure two item correlated errors	38.11	12	0.974	0.955	0.064	.042, .087	0.032	
Organizational Structure no modifications	106.21	14	0.909	0.864	0.111	.092, .131	0.050	68.1 (2)
Psychological Empowerment as higher order construct	108.47	50	0.986	0.982	0.047	.035, .059	0.037	
Leadership behaviors two items correlated errors	89.67	23	0.982	0.972	0.074	.058, .090	0.025	
Leadership behavior no modifications	183.25	26	0.958	0.941	0.107	.092, .121	0.032	93.58 (3)
Information characteristics	12.68 *p*=.12	8	0.998	0.996	0.033	.000, .066	0.012	
Information environment two item correlated errors	60.15	31	0.988	0.983	0.042	.026, .058	0.029	
Information environment no modifications	98.04	32	0.973	0.962	0.062	.048, .076	0.039	37.89 (1)
Information Interaction as higher order construct	185.66	97	0.981	0.977	0.041	.032, .050	0.042	

Note. N=532. χ2 = Chi-Square Statistic. *df* = Degrees of Freedom for the Chi-Square Statistic. RMSEA = Root Mean Square Error of Approximation. CI = Confidence Interval. CFI = Comparative Fit Index. TLI = Tucker-Lewis Index. SRMR = Standardized Root Mean Square Residual.

* = $p < .001$. † $p < .01$ unless noted otherwise.

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APPENDIX A

List of propositions from literature review

From organizational systems theory, information interaction (II) is characterized by:
- Systems perspective – a "whole of organization" approach
- II is a key enabler of the organizational feedback process
- Shared information processing concepts of input, process, and output

From cognitive psychology/human factors, information interaction (II) is characterized by:
- Humans as processors in a system
- Reliability of human processing in problem solving, decision making, task engagement
- Bandwidth given the presence of noise and information loss
- Context – quantity, quality, timeliness, and efficiency – all vs relevance
- Proportionality vs content of information
- Uncertainty, time, pressure, and expertise for using information
- Ability to filter information (function of value)
- Micro information exchanges – must be short, dynamic, and unobtrusive

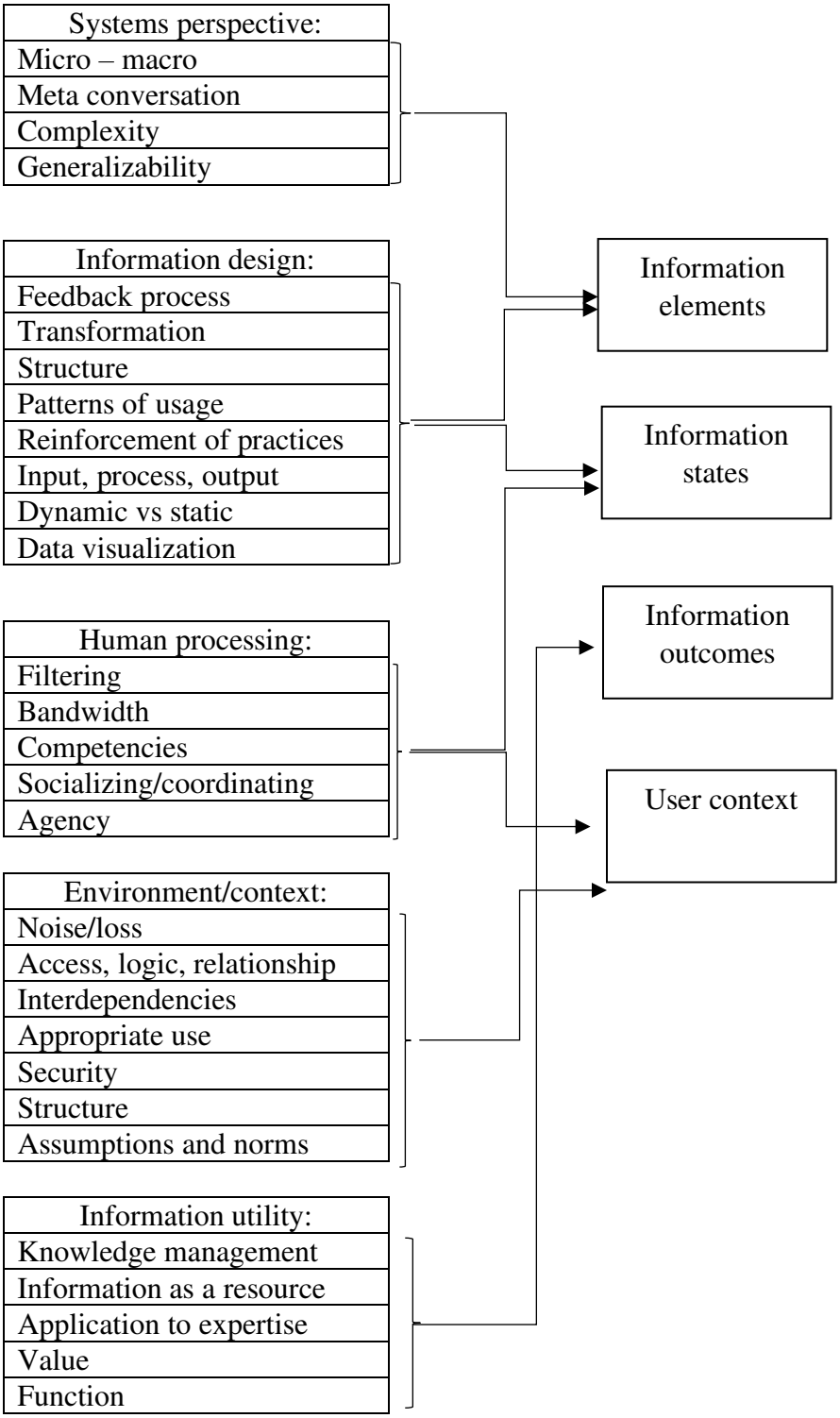
From computer science, information interaction (II) is characterized by:
- Transformation to increase usefulness
- Responsibility for transformation
- Interconnections of 1) data access, 2) semantic web, 3) ontologies
- Association with organizational knowledge management processes
- Information as a resource – can be created, read, updated, or deleted
- Information processing – utility, access, control, and time
- Information competencies – generalizable or context specific?
- Accessibility of information (function of value)
- Value towards task accomplishment
- Appropriate use
- Balancing accessibility with information security
- Learning mechanisms (function of accessibility)
- Structure governing information interaction
- Data visualization (function of usability, value)

From organizational communication, information interaction (II) is characterized by:
- Socializing, structuring, and coordinating activities
- Micro-Marco dimension perspective
- Patterns of information usage
- Meta-conversation of an organization
- Reinforces/changes organizational structure for communication practices

- Interpersonal interactions and organizational interactions – creates patterns of interaction with structure
- Complexity and agency of organizational structure/system
- Agency of individuals toward information
- Links, nodes, and assigned configuration (dictated by structure)
- Utility of application for decision-making, knowledge management (usability, value)
- Communication functions – role, organizational processes, medium, quality
- Communication network/information environment (structural and interpersonal)
- Generalizability of definition, application, and relationships
- Social network structure (interpersonal links/nodes)
- Core communication processes: 1) command, control, coordination, 2) socialization, 3) decision making, 4) participation and empowerment, 5) culture, community, 6) interorganizational communication

APPENDIX B

Thematic elements from propositions linked to anticipated dimensions



APPENDIX C

Item and measure concept development based on theoretical propositions

Information experience form

Think of an interaction you have had with information **related to your work role** in which you felt the experience was especially effective or ineffective in making the information useful and valuable to you. Please provide your answers in the space provided.

- Where did the information come from?
- How did you access it?
- What did you do with the information you had? (e.g. was it used to help make a decision?)
- Was this experience typical of interactions you've had with this kind of information, or with the originator of the information?

Visualize your experience interacting with the information you've just described. Picture yourself in the moment of engaging with that information. As you reflect on your reaction to the information, please respond to the following prompts:

No, I strongly disagree	No, I disagree quite a lot	No, I disagree just a little	I'm not sure	Yes, I agree just a little	Yes, I agree quite a lot	Yes, I strongly agree
1	2	3	4	5	6	7

1. I found this information useful
2. I was able to access the necessary information with relative ease
3. I felt that I had the information I needed within a useful timeframe
4. Most of the information seems useless or trivial (R)
5. I feel responsible for acting on this information
6. I have trouble figuring out what to do with this information (R)
7. I believe most people would find this information meaningful
8. This information is frustrating to deal with (R)
9. I feel this information is important to me
10. The meaning or intent of the information is clear
11. The information did not have a clear meaning (R)
12. The information I appears to be accurate
13. I do not trust information from this source (R)
14. This information is immediately relevant
15. The information is important to accomplishing a goal or objective
16. The information is relevant to my work role
17. The information is useful for my responsibilities at work
18. This information is mostly redundant (R)
19. I have already received this information through other means (R)

20. The information is presented in a manner that makes it easy to interpret
21. The information is interesting to me
22. This information is something that I can use
23. I find myself enjoying this information experience
24. I am able to transform the information into something useful for myself
25. I went to great lengths to find the information I needed (R)

Now visualize yourself in the work environment in which you had this information experience. Think about the setting, about your workload and other organizational goals and outcomes. Reflect on amount of information present in the environment in comparison to the information you need to accomplish your tasks.

Please answer the following questions about your general experiences of interacting with information in your work environment:

No, I strongly disagree	No, I disagree quite a lot	No, I disagree just a little	I'm not sure	Yes, I agree just a little	Yes, I agree quite a lot	Yes, I strongly agree
1	2	3	4	5	6	7

1. People find it difficult to access the information they need (R)
2. I receive an appropriate amount of information
3. I am concerned about how the information I send is being used (R)
4. I am concerned about the security of the information being delivered (R)
5. I feel I am able to use the information I have in a timely manner
6. Information is available from appropriate sources
7. Information is freely shared among personnel
8. The information I receive is pertinent to my role
9. Most of the information I experience is useful for my responsibilities
10. I receive important information in a timely manner
11. Information passes through multiple layers before it gets to me (R)
12. I am encouraged to share relevant information with others
13. Other co-workers freely share work related information with me.
14. I must often obtain permission before sharing work-related information with others.
15. Important information for my role is easily accessible when needed.
16. Most of the information that comes my way is useful for my job.
17. I find myself routinely dealing with unnecessary information (R)
18. I am able to maintain adequate communication with persons relevant to my role in the organization.
19. I find it takes a lot of effort to understand the information I receive (R)
20. I feel that I receive too much information about trivial things (R)
21. I feel I do not receive enough information about important things (R)
22. I feel constantly bombarded by information in my work role (R)
23. I feel overwhelmed by the amount of information I regularly experience (R)
24. I generally receive an adequate amount of information to perform my job
25. The information I receive does not generally have a purpose (R)
26. I find the information I receive does not always appear accurate (R)

27. I feel that I receive more information than I can effectively use. (R)
28. My organization encourages sharing of information
29. I feel like I need to protect work-related information at all costs
30. A lot of information shared at work is not work-related (R)
31. I spend a great deal of time having to search for useful information (R)
32. It is difficult to filter the information I need from the amount I am experiencing (R)
33. I feel it is rather easy to access the required information.

Please answer the following questions about your general experiences of interacting with information in your work role:

No, I strongly disagree	No, I disagree quite a lot	No, I disagree just a little	I'm not sure	Yes, I agree just a little	Yes, I agree quite a lot	Yes, I strongly agree
1	2	3	4	5	6	7

Information related outcomes:

1. This information is useful for increasing my work-related knowledge
2. I am able to make better decisions using this information
3. Using this information will help me perform better in my work role
4. I can apply this information to current tasks/responsibilities
5. I am able to use this information for my own development
6. This information will help me accomplish work tasks
7. Access to this information makes me more productive
8. I am thankful to have this information for use in my work
9. I would appreciate more information like this
10. This information helps me make better decisions
11. This information helps me perform better in my work role.

Modalities:

Please rate the following communication mechanisms/roles in the workplace by which you receive information. Rate each modality based on the average experience of receiving work-related information. That is, only rate the modality on information interaction experiences related to work.

1. Co-worker
2. Immediate supervisor
3. Administrator (front office, HR, or other admin function)
4. Strategic positions (company head, president, chief executive officers)
5. E-mail
6. Formal company meetings (includes teleconferences)
7. Face-to-face (in-person) communication
8. Phone calls
9. Written (physical hard copy) communication

Timeline:

1. Is this information best applied now, in the future, or is the application part of an ongoing process?
    a. Now
    b. Future
    c. Ongoing process

User context:

1. Please rate your level of expertise in your work role (1-7 Likert, extremely bad to extremely good)
2. Please rate your familiarity with this type of information (1-7 Likert, completely unfamiliar to completely familiar)
3. Please rate the level of experience you have had with the task related to this information (1-7 Likert, far below average experience to far above average experience)
4. Please rate the level of impact you anticipate this information has across organizational levels (1-7 Likert, No impact at all to Highest possible impact):
    a. Personal
    b. Interpersonal
    c. Groups/teams
    d. Strategic

APPENDIX D

Construct measures for nomological network

Organizational structure scale (Khandwalla, 1977)
In general, the operating management philosophy in my unit favors:

Highly structured channels of communication and a highly restricted access to important operating information	1 2 3 4 5 6 7	Open channels of communication with important operating information flowing freely
A strong insistence on a uniform managerial style throughout the unit	1 2 3 4 5 6 7	Managers' operating styles allow flexibility between formal and informal styles
A strong emphasis on giving the most say in decision making to formal managers	1 2 3 4 5 6 7	A strong tendency to let the expert in a given situation have more say in decision making even if its means bypassing formal authority
A strong emphasis on continuing "tried and true" management principles despite any changes in business conditions	1 2 3 4 5 6 7	A strong emphasis on adapting freely to changing circumstances
A strong emphasis on always getting personnel to follow formal procedures	1 2 3 4 5 6 7	A strong emphasis on getting things done even if it means disregarding formal procedures
Tight formal control of most operations by means of sophisticated control information systems	1 2 3 4 5 6 7	Loose, informal control; heavy dependence on informal relationships and cooperation for getting things done
A strong emphasis on maintaining compliance to formal job descriptions	1 2 3 4 5 6 7	A strong tendency to let the requirements of the situation and the individual's personality define proper "on-the-job" behavior

Please respond to the following statements based on your experience with your immediate supervisor for your work role:

No, I strongly disagree	No, I disagree quite a lot	No, I disagree just a little	I'm not sure	Yes, I agree just a little	Yes, I agree quite a lot	Yes, I strongly agree
1	2	3	4	5	6	7

Perception of supervisor – Leadership behaviors/qualities

- Please rate your perceptions of each potential supervisor based on the following questions (using the provided Likert scale): This supervisor seems as though they would:
    - Lead by example
    - Foster collaboration among the team and other work groups
    - Develop a team attitude and spirit among employees
    - Encourage innovation by protecting the team when they take necessary risks
    - Care about the personal development/growth of team members
    - Only care about performance that makes them look good (-)
    - Care only about their own interests (-)
    - Exert a lot of control or micro-management of the team (-)
    - Care more about their authority than the team (-)

Psychological Empowerment (Spreitzer, 1995)
Please respond to the following statements which seek how empowered you felt to accomplish tasks within your work role.

No, I strongly disagree	No, I disagree quite a lot	No, I disagree just a little	I'm not sure	Yes, I agree just a little	Yes, I agree quite a lot	Yes, I strongly agree
1	2	3	4	5	6	7

Meaning:
1. I believe this work will be very important to me.
2. My new job activities seem personally meaningful to me.
3. The work I expect to do seems meaningful to me.

Competence:
4. I feel confident about my ability to do my job.
5. I have self-assurance about my capabilities to perform my work activities.
6. I feel that I would have the expertise necessary for my new role.

Self-determination:
7. I feel like I will have significant autonomy in determining how I do my job.
8. I feel the freedom to decide how to go about doing my work.
9. It appears there is considerable opportunity for independence and freedom in how I do my job.

Impact:
10. My impact on the team and its success seems large.
11. I feel a great deal of control over the impact I'll have on my team.
12. It appears that I can have significant influence on the impact my team will have on the organization.

Demographics

1. What is your age (in years)? ___
2. Please select your sex.
    - Male
    - Female

3. Please select your ethnicity.
    - American Indian or Alaskan native
    - Asian
    - Black, or African American
    - Caucasian, or white
    - Hispanic, or Latino
    - Native Hawaiian, or other Pacific Islander
    - Multi-racial
    - Other
4. How many years of work experience do you have? ___
    a. Less than 1 year
    b. 1 – 2 years
    c. 2 – 4 years
    d. 5 – 7 years
    e. 7 – 10 years
    f. 10+ years
5. Please indicate how long you have been in your current job:
    a. Less than 1 year
    b. 1 – 2 years
    c. 2 – 4 years
    d. 5 – 7 years
    e. 7 – 10 years
    f. 10+ years
6. Please select your highest level of education:
    a. Less than high school diploma
    b. High school diploma or equivalent
    c. Some college
    d. Bachelor's degree
    e. Master's degree
    f. Doctorate

APPENDIX E

Interview questions

Questions about you:

- Overall, how many years of work experience do you have?
- How many years of experience do you have dealing specifically with communication, or related information operations roles?

Questions about your experiences:

1. Please describe some common experiences in which you interact with information in your organization at the following levels in order to achieve some goal or outcome:
    a. Organizational (highest) level – this can represent mass communication events or large-scale knowledge management platforms used or seen by most or all of the members of the organization.
    b. Group/team – how is information shared or used to accomplish team/group goals?
    c. Interpersonal – What are typical examples of information being shared or used between one or two individuals?
    d. Personal – How do you personally interact with information to accomplish your daily roles and responsibilities?
2. Tell me about an information-related organizational level effort you were involved in within the last year or two that you believe was meaningful to organizational outcomes.
    a. What made it especially meaningful or impactful?
    b. What was your primary role in the effort?
    c. How did you create, transform, or use information to accomplish your objectives?
    d. What was the reaction from those involved in this effort (if any were helping)?
    e. What was the reaction from those who received the information and had to act on it in some way?
3. I'd like to know more about how you use information, and what you believe makes for a positive information experience. Reflecting on your experience with using information for some outcome (such as a decision), what is the most important thing that someone or something else can do to improve your information experience?
    a. How do you determine the relevance of information to your work role?
    b. How do you assess your information load?
        i. Are you able to give feedback on the load to make it better?
        ii. Do you assess/manage information load of others? If so, how?
    c. What makes information easier to engage with?
        i. How do you increase potential information engagement for others?
    d. How does accessibility affect your ability to engage with information?
        i. How much control do you have over the accessibility?
4. If you were to summarize the various factors or elements that you believe are important for managing an information experience, what would those be?

APPENDIX F

Case Studies

Study 1 – Humanitarian Operations

To maintain confidentiality, the organization in this case study will be referred to as CS1 (case study 1). The case study on humanitarian operations involves a small organization with a very large reach and impact. With 25 staff members and thousands of volunteers, CS1 has worked with 138 countries since 1987, providing life-saving medical equipment, training, and support to bridge health resource gaps in areas of need. For CS1, their information story revolves around resourcing, and has two major components. The first information component is related to gaining access to resources through information. The second component relates to moving resources, the importance of information flow in logistics, and how information related to logistics drives a reciprocal relationship between partnerships and resourcing.

CS1 relies entirely on donations for their operations. This includes funding for staff, management and storage of their inventory, systems, and maintenance of large distribution warehouses. Additionally, all of the supplies that CS1 provides for medical needs are donated through other medical organizations. In order for CS1 to acquire needed medical supplies, and to receive donations and logistical support to run the organization, they must maintain a dialogue with supporters to continually demonstrate the value behind the weight of effort being applied. Specifically, CS1 must maintain constant and effective communication with resource partners in order to maintain their operations. To support their communication efforts CS1 makes use of a specialized knowledge management tool for tracking both logistics and relationships, including sources, gifts, shipping, and status of communication and contact.

The use of a knowledge management tool for CS1 provides workers with a sense of control in a chaotic environment. The tool provides a hub that centralizes information, captures work done in a dynamic environment, and is meant to help teams stay on track by knowing where to focus efforts while preventing silos from lack of communication. However, like any tool, there are limitations noted by the users. First, the workers do not like utilizing the tool, as it is not user-friendly and creates frustrations with data entry and visualization. Additionally, workers do not appreciate its redundancy, as most of the work they perform is interpersonal, and inputting information in the knowledge management tool feels, for them, like an unnecessary extra step. As one worker stated, “I could manage a project from beginning to end through emails and phone calls, ensuring it’s completion without once actually needing to touch the knowledge management tool.” Another complaint of the tool is the inability to capture all of the information pertinent to one’s role. One worker who had just been promoted into a new role noted how the tool “does not capture enough information to help with turnover,” noting the difficulty of combining information needs for both tracking relationships and logistics in an environment of constant change.

One of the biggest information challenges for CS1 is also one of their greatest assets; the dependency on partnerships. CS1 benefits from its small but connected model by being able to maneuver in a complicated information environment. The maneuverability meets needs for both partners looking to donate, and for partners who are in need of support.

For medical organizations looking to donate, CS1 provides an easy avenue for accepting and using donations of medical equipment. For example, hospitals that open, but do not use, a device

can no longer use that device for any other purposes. Rather than wasting the equipment, hospitals may demonstrate goodwill through donation to CS1. CS1 prominently displays partnerships in an effort to promote further goodwill and encourage participation in meeting the humanitarian needs. Maintaining partnerships requires constant communication with existing partners, and the careful crafting of narratives that tell a positive story about the efforts of CS1, and how the partnerships it has enable the positive efforts.

For aid recipients, CS1 provides a responsiveness with access to resources unburdened by similar processes that struggle under bureaucratic processes of government-run programs. As an example, the National Institute of Health (NIH) was working with African countries dealing with Ebola, and were having difficulty understanding how to encourage people to receive the medical help they needed. CS1 was able to immediately conduct a needs assessment and establish logistical support for Ebola workers in country. Two major needs were discovered. One, people were not seeking help due to ostracism about Ebola. Two, personal protective equipment (PPE) was not adequate, with the biggest limiting factor being duct tape. CS1 was able to provide a rapid response by 1) immediately sending two cargo containers full of duct tape, and 2) creating an education campaign to help local people understand Ebola and reduce ostracism associated with seeking medical care. This example demonstrates the ability of CS1 to maneuver in the information environment for identifying what information is most useful, in this case the immediate need and the reason for not seeking care, and how to turn information into action.

The challenge of communicating for both relationships and logistics can be highlighted through two examples of how CS1 conducts operations:

Example 1. This example focuses on how CS1 responds to needs and communicates in normal operating circumstances. Typically, CS1 will be made aware of a need through the ongoing communications it has with other medical relief partners such as governments or other aid-based non-governmental organizations. Once a need has been presented CS1 sends a team to conduct a needs assessment, which is compared against previous assessments, logistical requirements, and current capacity to fulfill requirements. The logistical requirements developed from needs assessments then drive a feedback mechanism for 1) ensuring the correct partnerships are in place to meet the need, and 2) engaging the supply chain and decision making necessary to ensure supplies reach their final destination. A dedicated operations team oversees efforts that include how things are packed, who receives it, order of reception, passage through customs, and how those receiving the resources know what to do with them.

Example 2. This example highlights the flexibility of CS1 to respond to a dynamic information environment, specifically related to the COVID-19 pandemic. CS1 had always focused on international needs, but the COVID-19 pandemic spurred the US to initially forbid shipping of PPE overseas, creating concerns that CS1 would have to close down. Instead, FEMA began contacting CS1 about potential domestic support. Soon, CS1 began to re-supply PPE back into the very systems that had donated them originally. This created opportunities to engage with new partners such as domestic firefighters and EMTs, providing a level of visibility that didn't exist prior to the pandemic.

Study 2 – Medical workers

To maintain confidentiality, the organization in this case study will be referred to as CS2 (case study 2). This study examines information processes in a medical organization. Specifically, I will explore how information is communicated within the organization to help workers maintain awareness of information pertinent to their roles and to the organization as a

whole. For information pertinent to one's role, the organization uses tools and processes intended to increase the empowerment of the individual. For information about the organization as a whole the organization uses a top-down structure to strategically align multiple levels of information and organizational processes.

CS2 was noted for a forward-leaning stance on providing information experiences for its workers that create a sense of transparency, ownership, and accountability. As one worker stated, "[CS2] actually cares about the communication experience," explaining that the emphasis on good communication is "engrained in the culture, empowered by the structure, and drive by the mission." They go on to characterize the organization's communication as being "fully invested in the people," being driven by a desire to produce information that is "functional, accountable, and transparent." The positive outlook purported by workers at CS2 toward communication is indicative of the deliberate efforts to maintain an information environment that keeps workers informed and aware, without creating information overload or inundating workers with non-usable information. Part of the responsibility for maintaining a health information environment was suggested as a key leadership issue.

The quality of the information experience is noted as being a foundational piece of the leadership process at CS2. When reflecting on the culture of communication, one worker stated the "tone was set by leaders years ago, and has been maintained through home grown leadership." Another worker shared that "leadership ownership is expected in the information flow process. Leaders act as information filters, tailoring communication to help team members avoid overload." Leaders are seen as key in protecting and enabling the experts engaged in expert-work, while also aligning objectives of stakeholders across different areas of the organization. Leaders at CS2 are expected to outline important pieces of information, sharing information in a broad enough manner to keep the experience useful to everyone, and acting as strategic node for linking pieces of information in the organizational system.

The importance of leader-driven information sharing is exemplified in an example of the strategic communications process at CS2. Strategic communication here follows a specialized flow through a chain of stakeholders to concurrently provide information to internal and external stakeholders. A staggered approach is used to share information at the most senior levels first, followed by sharing with team leaders, then team members, then key external stakeholders, all at previously determined time intervals. One worker responsible for this communication process noted that it is "always done with the same process, same order of operations from top down," with the only adjustments being made for the information mediums used to communicate. One noteworthy function of the interval release system is that it allows flexibility for creating "exit ramps," or points at which the communication process needs to stop, and backtrack, or a point at which it can be fully shared without further control. The staggered approach also highlights the use of structure and consistency, so that all workers know where the information will be coming from and are aware of the process for it to move through the system. It also emphasizes the role of leaders in focusing of crafting worthwhile information content, while the role of the structure/system in place is responsible for dissemination of strategic information. Specifically, information is not just "hung" somewhere for workers or external stakeholders to go find, rather it is actively pushed out to ensure workers and other stakeholders are made aware. Additionally, the strategic communication process is not over-used, so that it does not become so routine that it becomes a part of the normal information flow in the workplace. The importance of adequate communication channels highlights another emphasis of CS2, the recognition of information as aligning tool.

CS2 recognizes that they are responsible for creating an information environment and providing information that attracts and maintains partnerships in a shared health network. This includes efforts to promote access to information (through systems), and sharing of information that develops mutual trust and work toward shared health outcomes. One example was an effort by CS2 to strategically align multiple physicians with similar interest toward a health outcomes model that promoted better self-care of patients. Working with multiple potential partners, CS2 had to act as an information manager to properly network, integrate shared health file systems, and to build trust and relationships among providers. Additionally, CS2 had to engage in internal campaigning to gain buy-in and support from its in-house health teams. CS2 recognized and utilized the power of their brand, and the power of their organizational mission as key sources of power for projecting information and overcoming uncertainties.

Study 3 – Large scale government ops - Command and control – strategy to task planning – Information operations

To maintain confidentiality, the organization in this case study will be referred to as CS3 (case study 3). This study examines information processes in a large government organization. CS3 is heavily bureaucratic due to its size and resource scope. Given the enormity of the organization and its mission, I will focus this case study on the information experiences associated with how the joint operational planning process supports command and control. The main themes from this study include the importance of information management, structure, flexibility, and the use of guidance, direction, and intent with information products that guide decision making.

The joint operational planning process (JOPP) is the primary tool for providing guidance and direction to achieve objectives set at the national level of government. In order to meet broad goals and objectives at the national level, JOPP creates a method for reducing broad objectives into more narrow and direct objectives, and creates a system accounting for the various domains of effort that need to be considered for meeting objectives. The process of creating executable objectives while planning for synchronizing desired effects across multiple domains helps establish a common operating picture (COP); a desirable information environment for carrying out joint operations. The utility of the COP, as enabled by the JOPP, drives command and control decisions for executing a mission, and can dictate the level of flexibility and authority given to forces in carrying out mission requirements.

To illustrate the JOPP in action, I will describe the key action steps, how they guide the information experience, and ultimately lead to outcomes that enable execution. The process begins when an issue is identified and a mission is determined for acting on the issue. Guidance is then established at the most senior level of leadership in order to establish mission intent. A directive is then issued, which details the situation, the mission, the intended execution, and the administration and logistics considerations for operations. This directive is then passed through a large command and control mechanism (an operations center), with various teams responsible for providing inputs and acting on the guidance.

Each team within the operations center has a unique role in translating strategic objectives into tasks carried out as part of the daily flow of operations. For example, the operations division is responsible for over-seeing the execution of daily operations, ensuring that tasks are being accomplished within a give-timeframe, and providing guidance to operators for any dynamic adjustments required in the operating cycle. Prior to the operations division receiving tasking order, the plan would have been informed by assessments and intelligence, a

strategic division, plans division, and a team responsible for aligning objectives with effects, and assigning resources responsible for creating desired effects. The passing of planning responsibilities through various teams represents the strategy-to-task planning approach.

The strategy-to-task planning cycle allows for reduction of strategic plans into manageable pieces inside the command and control structure. Planning undergoes an important transformation in the strategy division of the operations center; the commander's guidance is broken into strategic objectives, which are prioritized for mission planning. Each strategic objective is broken into operational objectives, which are then broken into tactical objectives. Each tactical objective then contains several tasks that must be executed to accomplish the objective. Every task is assigned possible effects needed to complete the task, with potential capabilities assigned to create the desired effects. Each set of capabilities is matched with requirements to execute the capabilities which, when scoped, generates a set of responsibilities to the forces/resourcing units who are provide the desired capabilities. This reduction process establishes alignment between goals and actions by ensuring that every capability used is linked to a desired effect, tied to a tactical task, supporting a tactical objective, part of an operational objective, nested under a strategic objective, all tied to meeting the commander's intent for mission accomplishment. Therefore, every action built into the tasking daily tasking cycle should be able to easily trace its purpose to the highest level of objectives and mission imperatives. Once the formal planning is set, with objectives tied to tasks, the planning responsibilities are then passed to the plans division, where the effects and master planning team are responsible for operationalizing the document.

The plans division is ultimately responsible for alignment between individual actions and the strategic objectives of a mission. The effects team link desired effects with the resources required to generate the action that creates the effect. Specifically, they incorporate and prioritize all actions, from all organizational components, for a given day of execution. Once all desired effects are accounted for on a given day, the master operational planning team allocates tasks to match capabilities to objectives through a detailed, minute-by-minute execution task matrix for daily operations. A message is then distributed to all components of the organization who are responsible for assigning/utilizing the appropriate asset for execution on the planned date/time group. Of note, assessment of daily operations feeds an important part of this cycle by potentially re-prioritizing asset allocation based on target objectives, and whether or not objectives were met on a previous day. The master operational planners also allocate assets and planning space for dealing with dynamic issues in the operating environment. Once the tasking plan and matrix are finalized the plans are passed to the operations division for execution of the mission.

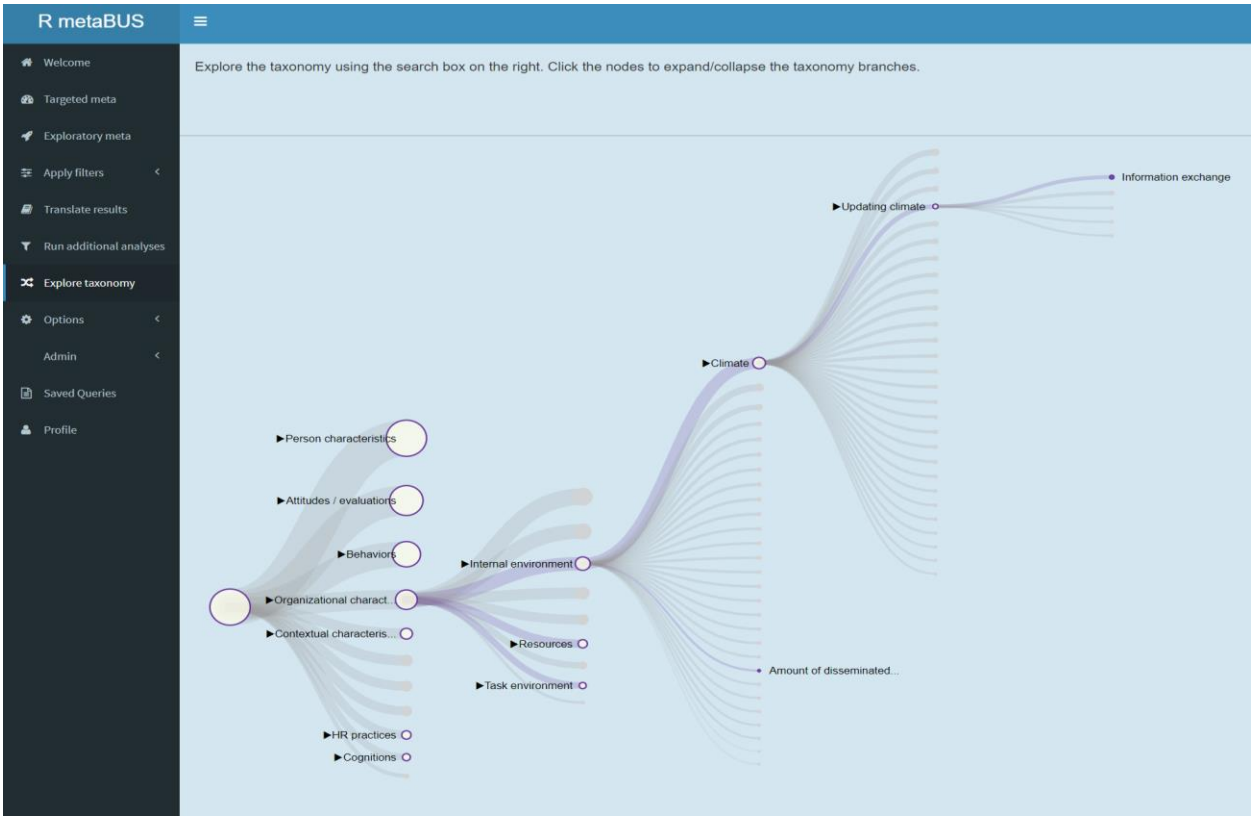
The operations division is dedicated to daily execution of operations, maintaining awareness of and monitoring the operational environment. While tasked units are engaging in each of their individual responsibilities, the operations divisions act as a common point of communication, collaboration, and real time updates for any operators in the field. Additionally, the operations division uses large screens throughout an operations floor to display the most current and important information of the environment, priority objectives, and the units carrying out the mission. The use of constant, up-to-date information on large displays helps maintain a common operating picture and provides a strategic visual of tactical execution in real time. As daily operations unfold, all assessment data and feedback from operations is fed back into the planning cycle to inform and influence ongoing and future planning work. The combination of each team working on both deliberate and dynamic planning tasks produces a daily operations cycle.

The daily operations cycle drives the command and control of the operations center, from events and meetings to briefings and reporting requirements. The output is the efficient accessibility of resources and employment of forces and capabilities to meet objectives. The effectiveness of this operations center is part of a larger joint planning process intended to develop and maintain a common operating picture of all forces and capabilities worldwide, at any given moment. This allows the highest levels of the organization to engage in a continuous planning process that consistently drives operations for the immediate future while allowing for responsiveness to a dynamic operating environment.

The effort to maintain responsiveness during the planning and execution process is due to the need for de-conflicting and synchronizing effects across multiple domains, and matching available forces and capabilities to objectives, all on a worldwide scale. Additionally, CS3 must coordinate with other agencies, components, and partners to integrate effects across multiple lines of effort. The planning process must also have the flexibility to support long-term planning efforts, contingency planning, and crisis action planning, which all have differing associated timeframes and potential weight of effort. The process must also allow for flexibility to account for operations in different regions of the world, where partnerships, access, and actions may have different meanings. The guiding doctrine therefore is considered a “starting point” for all plans, or a “point to deviate from” as necessary. The idea is that all units should be able to follow their planning efforts back up the chain to the same initial guiding doctrine.

APPENDIX G

Example of metaBUS taxonomic structure



APPENDIX H

Survey for review by Subject Matter Experts

Item development information interaction measure – SME review

Information interaction definition: An individual's manifestation of utility for information as it is experienced.

Importantly, the concept of interaction in this theory implies that an individual perceives and attends to a signal, or piece of information, and thus experiences the information in that present moment. The interaction being captured is relative to that individual's information experience in that particular moment of space and time.

Information is an all-encompassing term for the details, figures, facts, data, or general particulars of life conveyed or represented to individuals. I expect the information experience can be measured by identifiable properties, which in combination will form multiple dimensions reflective of a general information interaction experience.

Based on the review and thematic analysis of related theoretical literature, I am proposing four major dimensions of information interaction: 1) information elements, 2) information states, 3) information outcomes, and 4) user context.

Information experience primer

"Think of an interaction you have had with information **related to your work role** in which you felt the experience was especially effective or ineffective in making the information useful and valuable to you. Please provide your answers in the space provided."

- Where did the information come from?
- How did you access it?
- What did you do with the information you had? (e.g. was it used to help make a decision?)
- Was this experience typical of interactions you've had with this kind of information, or with the originator of the information?

This next section covers items related to **information elements**. The information elements, it's characteristics and creation context, are a potential indication of how information design is associated with potential usefulness of the information.

"Visualize your experience interacting with the information you've just described. Picture yourself in the moment of engaging with that information. As you reflect on your reaction to the information, please respond to the following prompts:"

Not at all effective	Slightly effective	Moderately effective	Very effective	Extremely effective
1	2	3	4	5

26. I found this information useful
27. I was able to access the necessary information with relative ease
28. I felt that I had the information I needed within a useful timeframe
29. Most of the information seems useless or trivial (R)
30. I feel responsible for acting on this information
31. I have trouble figuring out what to do with this information (R)
32. I believe most people would find this information meaningful
33. This information is frustrating to deal with (R)
34. I feel this information is important to me
35. The meaning or intent of the information is clear
36. The information did not have a clear meaning (R)
37. The information I appears to be accurate
38. I do not trust information from this source (R)
39. This information is immediately relevant
40. The information is important to accomplishing a goal or objective
41. The information is relevant to my work role
42. The information is useful for my responsibilities at work
43. This information is mostly redundant (R)
44. I have already received this information through other means (R)
45. The information is presented in a manner that makes it easy to interpret
46. The information is interesting to me
47. This information is something that I can use
48. I find myself enjoying this information experience
49. I am able to transform the information into something useful for myself
50. I went to great lengths to find the information I needed (R)

This section covers items related to **information states**. This encompasses the information experience itself. Regardless of original intent or crafting of the information, the user experience may be altered by the state at which the interaction occurs. This dimension seeks to capture the context or environment of the information experience.

“Now visualize yourself in the work environment in which you had this information experience. Think about the setting, about your workload and other organizational goals and outcomes. Reflect on amount of information present in the environment in comparison to the information you need to accomplish your tasks.

Please answer the following questions about your general experiences of interacting with information in your work environment:”

Not at all effective	Slightly effective	Moderately effective	Very effective	Extremely effective
1	2	3	4	5

34. People find it difficult to access the information they need (R)
35. I receive an appropriate amount of information
36. I am concerned about how the information I send is being used (R)
37. I am concerned about the security of the information being delivered (R)
38. I feel I am able to use the information I have in a timely manner
39. Information is available from appropriate sources
40. Information is freely shared among personnel
41. The information I receive is pertinent to my role
42. Most of the information I experience is useful for my responsibilities
43. I receive important information in a timely manner
44. Information passes through multiple layers before it gets to me (R)
45. I am encouraged to share relevant information with others
46. Other co-workers freely share work related information with me.
47. I must often obtain permission before sharing work-related information with others.
48. Important information for my role is easily accessible when needed.
49. Most of the information that comes my way is useful for my job.
50. I find myself routinely dealing with unnecessary information (R)
51. I am able to maintain adequate communication with persons relevant to my role in the organization.
52. I find it takes a lot of effort to understand the information I receive (R)
53. I feel that I receive too much information about trivial things (R)
54. I feel I do not receive enough information about important things (R)
55. I feel constantly bombarded by information in my work role (R)
56. I feel overwhelmed by the amount of information I regularly experience (R)
57. I generally receive an adequate amount of information to perform my job
58. The information I receive does not generally have a purpose (R)
59. I find the information I receive does not always appear accurate (R)
60. I feel that I receive more information than I can effectively use. (R)
61. My organization encourages sharing of information
62. I feel like I need to protect work-related information at all costs
63. A lot of information shared at work is not work-related (R)
64. I spend a great deal of time having to search for useful information (R)
65. It is difficult to filter the information I need from the amount I am experiencing (R)
66. I feel it is rather easy to access the required information.

This section covers items related to **information related outcomes**. Information related outcomes represent the purpose for information being sought, used, and shared in an organization. Information is generally considered as a means for advancing an individual's knowledge, decision-making ability, or feedback for the purpose of development.

"Please answer the following questions about your general experiences of interacting with information in your work role:"

Not at all effective	Slightly effective	Moderately effective	Very effective	Extremely effective
1	2	3	4	5

Information related outcomes:

12. This information is useful for increasing my work-related knowledge
13. I am able to make better decisions using this information
14. Using this information will help me perform better in my work role
15. I can apply this information to current tasks/responsibilities
16. I am able to use this information for my own development
17. This information will help me accomplish work tasks
18. Access to this information makes me more productive
19. I am thankful to have this information for use in my work
20. I would appreciate more information like this
21. This information helps me make better decisions
22. This information helps me perform better in my work role.

This separate section for modalities and timeline are meant to help establish more context surrounding the information experience, while being slightly formats for gathering the information than the standard questions participants will have seen thus far.

"Modalities:

Please rate the following communication mechanisms/roles in the workplace by which you receive information. Rate each modality based on the average experience of receiving work-related information. That is, only rate the modality on information interaction experiences related to work."

10. Co-worker
11. Immediate supervisor
12. Administrator (front office, HR, or other admin function)
13. Strategic positions (company head, president, chief executive officers)
14. E-mail
15. Formal company meetings (includes teleconferences)
16. Face-to-face (in-person) communication
17. Phone calls
18. Written (physical hard copy) communication

Timeline:

2. Is this information best applied now, in the future, or is the application part of an ongoing process?
    a. Now
    b. Future
    c. Ongoing process

This section covers items related to the **user context**. This is meant to capture elements of the individual related to how they may process, manage, or use information.

"User context:

5. Rate your current bandwidth for dealing with additional information
6. Please rate your level of expertise in your work role
7. Please rate your familiarity with this type of information
8. Please rate the level of experience you have had with the task related to this information
9. Please rate the level of impact you anticipate this information has across organizational levels:
    a. Personal
    b. Interpersonal
    c. Groups/teams
    d. Strategic"

This section contains items developed following interviews performed to learn more about individual experiences with information in the workplace. There are similarities to the items and dimensions already displayed in thus far, but I wanted to review them distinctly before combining them with the rest of the assessment.

Information design – the intentionality of planned efficacy during the information creation, modification, or transformation process:

1. The information is easy to categorize for use or saving
2. I find the information compelling
3. The information captures my attention
4. The information is presented in a manner consistent with my typical use
5. I am able to easily apply the information as needed
6. The information must be transformed into a more useful format before further usage
7. This information is consistent with current guidance or direction
8. I feel like this information is not providing the full picture of what is going on (R)
9. I feel that those who are sharing this information are hiding something (R)

Human processing – the perception of an individual of their own ability to handle, use, or manage information at the point of experience:

1. The information presented creates a sense of overload (R)
2. This information is immediately relevant to my work responsibilities
3. I find myself dealing with excess information that does not seem necessary
4. I can easily identify the useful pieces of the information
5. The information has been personalized for a specific audience
6. This information helps convey the importance of our work to others
7. I feel like I have a say, or a voice, in how to process this information

Environment/context – the surrounding contextual factors related to the information transmission, reception, and ability to use as information is experienced by the user:

1. This information is not flexible enough for the current work environment (R)

2. The information is responsive to the dynamic information environment
3. I feel like the information I receive is in conflict with other information sources
4. It feels like there are constraints on how to utilize this information
5. It is easy to share information with others in this environment
6. I feel that the information sharing structure is useful
7. I am constantly searching for more information than what has been provided (R)
8. I feel like I never have enough information to do my job appropriately (R)

Information utility – the perceived value or usefulness of information by the user:

1. I can easily engage with the information provided
2. I feel like the information makes sense
3. The information provided fits with other information I have about my job
4. I completely understand what I need to do with this information
5. This information is helpful for other people in my organization
6. I wish I had a better system for managing this information (R)
7. I am limited by the tools available to manage this information (R)
8. I feel like I have more questions than answers after seeing this information (R)
9. I don't understand the purpose of this information (R)
10. This information seems important enough to protect
11. I can easily apply this information to my work role
12. This information was tailored for my use
13. I would consider this information to be valuable