How Are Information Deserts Created? A Theory of Local Information Landscapes

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To understand information accessibility issues, research has examined human and technical factors by taking a socio-technical view. While this view provides a profound understanding of how people seek, use, and access information, it often overlooks the larger structure of the information landscapes that shape people's information access. However, theorizing the information landscape of a local community at the community level is challenging because of the diverse contexts and users. One way to minimize the complexity is to focus on the materiality of information. By highlighting the material aspects of information, it becomes possible to understand the community-level structure of local information. This paper develops a theory of local information landscapes (LIL theory) to conceptualize the material structure of local information. LIL theory adapts a concept of the virtual as an ontological view of the local information that is embedded in technical infrastructures, spaces, and people. By complementing existing theories, this paper provides a new perspective on how information deserts manifest as a material precondition of information inequality. Based on these theoretical models, a research agenda is presented for future studies of local communities.

Introduction

Information accessibility issues such as how libraries and other information institutions enable people to find desired information effectively have long been of interest to information science researchers (Burnett, Jaeger, & Thompson, 2008; Culnan, 1985). Disparities in information access have been characterized as the *digital divide* or *information inequality* because of people's high dependency on technology in finding information (Norris, 2001; Schiller, 2013; Van Dijk, 2005). Because many factors are associated with these problems, information accessibility has been studied from (a) a human-centered view based on the understanding of individual- or group-level characteristics such as physical impairment (Malu & Findlater, 2015), economic status (Smith & Hanisch, 2015), generational factors (Russell & Young, 2015), contextualized experience (Lloyd, 2005), and education level (Boer, 2015); and (b) a technology-focused view that focuses on system or material factors such as the information aggregation/filtering technique (Kavanaugh et al., 2014), information visibility (Struppek, 2006), and recommendation system performance (Lee & Brusilovsky, 2017). Of course, these issues are not solely about humans or technology; rather a tension exists between the two approaches, placing each study somewhere on a *socio-technical* spectrum (Langefors, 1978).

The socio-technical view provides valuable insight into the factors that affect people's information access in various contexts and situations. At the same time, studies taking the socio-technical approach assume that (a) information is socially-constructed, (b) contexts where information is created and used, that is, *information grounds* (Fisher & Naumer, 2006), shape the dynamics of people in accessing information along with individual and technological factors, (c) information is somewhere in the virtual or physical world, and (d) the distribution and structure of available information is determined by socio-technical strategies such as an efficient database design. These assumptions lead to the idea that understanding contexts and users, designing a proper information system for a particular context, and connecting users to the system through easy-to-use interfaces are the main concerns when addressing information accessibility problems. They provide an effective basis for identifying important aspects of individual- and organizational-level information accessibility issues such as information seeking, using, and sharing.

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In a local community or urban environment, human-centered and technology-focused approaches can still provide a useful basis for understanding different types of information and various groups' access challenges. However, studies that take a socio-technical view are more likely to focus on the information within particular systems that are used by specific groups of people. As a result, it is possible for information science researchers and system designers to overlook the larger systems of information in a community and their implications for both individuals and the community. In other words, socio-technical approaches risk underestimating the effects of the complex structures of available information and local information sources that constantly shape individuals' information behavior and access, regardless of new information systems. If a researcher studies a digital literacy problem of residents in a city by examining their use of particular online calendars and websites for seeking local event information, for example, this researcher may have to target only a part of the event information available in the entire city, maybe 20% at most, according to a study by López, Butler, and Brusilovsky (2014). It would be possible to understand residents' information behavior and barriers in using the target information sources, but the researcher may face difficulties in explaining their holistic capacity that stems from other existing infrastructures and information sources. Even if people have access to local event information through social media, there could be other important information that is available only on physical bulletin boards in a neighborhood, or that is not available at all in formal online and offline locations, but only disseminated through a limited number of people.

This suggests that understanding the structure and complexity of local information at the community level can provide useful perspectives on individuals' information access and behavior. However, theorizing the community-level information landscapes is challenging because there are many different users and contexts interacting with each other in a community. One way to minimize the effects of diverse users and contexts is to highlight the materiality of information (Dourish, 2017). An analogy for the materiality of information can be drawn from discussions on the materiality of technology. Technology can be understood as material by itself before it is understood as a socially-constructed entity where its roles depend on social contexts and people who use it (Leonardi, Nardi, & Kallinikos, 2012). Similarly, scholars conceptualized the materiality of information because information is presented as material forms such as a monitor display, flyers on a bulletin board, and magnetic tapes, which provide different capabilities for information users (Dourish, 2017; Dourish & Mazmanian, 2011). The materiality of information is a pre- or necessary condition of the social construction of information. Also, it allows us to understand the forms and structure of local information at the community level by mitigating its entanglements with diverse contexts and users.

This article presents a theory of local information landscapes (LIL theory) for studies of local information that considers the impact of the complexity and diversity of the overall local information that exists in diverse forms. To develop this theory, a conceptual model is constructed by viewing the local information landscape in a community as an entity that has structures and features and exists on top of various infrastructures and spaces. In other words, the structure and features of local information, or the local information landscapes, are suggested as important elements that will affect people's information behavior and accessibility. This material view provides opportunities to identify otherwise overlooked aspects of local information; specifically it leads us to think about (a) the creation of information landscapes that is closely related to the provision of information, (b) the relationships between local information landscapes and other community features such as civic engagement and economic well-being, (c) the conceptual differences between information behavior and provision, (d) the understanding of local spaces, people, and technical infrastructures as material entities that embed and provide local information, and (e) how the material pre-conditions of information inequality in a local community, that is, information deserts, look and how they can be conceptualized and assessed in a systematic way.

With the assistance of LIL theory, this article sheds light on the community-level characteristics of information that were rarely considered by previous studies. From a theoretical perspective, researchers who study local community-related subjects can benefit from this proposed theory, because it provides a new lens, vocabularies, and theoretical constructs to think about the relationships between information provision, community features, community outcomes, and information access. Practically, LIL theory can help local information system designers and policy-makers understand a holistic structure of local information in their planning stage by asking questions, such as "how will new information systems change the overall information availability in a community?"

To develop LIL theory, models and theories about information access and behaviors are reviewed for understanding the current scope of existing theories. After identifying the challenges of reviewed theories in the context of local community research, the concept of *the virtual* is adapted from communication theory (De Souza e Silva & Sutko, 2011). By incorporating the concept of the materiality of information, the adjusted model of the virtual helps to conceptualize the interplay between physical space, technology, people, and local information. Also, the proposed model is useful for identifying gaps that existing models of information access do not or cannot explain in detail. By reviewing empirical studies about local communities and information, a new framework of local information landscapes is assessed and theorized as LIL theory. Based on this theory, research opportunities regarding the emergence and implication of community-

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level information studies are presented for different disciplines. Finally, the implications and limitations of this work are discussed.

Theoretical Models for Information Access, Behavior, and Context

Some theories and models that explain information behavior, access, and contexts are relevant for describing the relationships between local information-related factors and other community factors. They include, but are not limited to, models developed in information science, human-computer interaction (HCI), and communication. Among many other theories about information behavior and access, this article focuses on five models that exhibit a reasonable variability in their coverage of theoretical components because they provide an initial understanding about current streams of local information research and help identify potential risks and challenges in the research programs.

The theory of information worlds, which integrates Chatman's small world concept and Habermas' notion of the public sphere, explains multi-level influences that affect people's information access and behaviors (Chatman, 2000; Habermas, 1991; Jaeger & Burnett, 2010). Social boundaries and influences around individuals that vary from small world influences, such as a family and friends, to life-world structures, such as institutions and technology, shape people's information behaviors and activities. According to this theory, small world and life-world influences are not two separate constructs, but two endpoints of a social influence spectrum, while still interacting with each other (Jaeger & Burnett, 2010). Also, the theory of information worlds explains different kinds of information access issues, that is, physical, intellectual, and social access (Burnett & Jaeger, 2008), that are affected by various environmental and contextual influences from the user perspective. For example, viewed from the information worlds lens, the *CiVicinity* project (Hoffman, Robinson, Han, & Carroll, 2012), a web-based local information portal that combines and filters local news and events from multiple information sources, can be explained using the "boundary" concept; that is, the new technology not only enhances individuals information access and use, but also expands technological and institutional boundaries by consolidating diverse information sources, that is, an element of normative information behavior (Burnett & Jaeger, 2008). Although this theoretical lens allows us to understand information technology as part of the social and environmental influences that shape individuals information behavior, it marginally conceptualizes how information is created, accessed, and acquired by an individual, which is an essential part in describing the community-level structure of information.

Contextualizing and focusing more on people's interactions with the environment, Lloyd (2010) suggested the concept of the information landscapes to describe the settings in which information literacy is understood and manifested. According to her, information landscapes is a socially constructed, intersubjectively-created space that stems from people's interactions, collective experiences, and information practices, which in turn shape shared knowledge among them (Lloyd, 2010). Given this conceptual space, information literacy is understood as people's activities and skills that are required to process and deal with the shared knowledge and situated information (Lloyd, 2006, 2010). At a workplace, for example, an information landscape is formed through the interactions between an individual's literacy and other employees' actions; in an educational environment, it is created mostly based on students' literacy and textual information in books (Lloyd, 2006). In these examples, information is a socially-constructed entity and a result or medium of the interaction between the information user and provider. Accordingly, the information landscapes of individuals change rapidly with regard to contexts and their contextualized experiences, shaping different landscapes for one another. Also, this conceptualization leads us to understand information inequality as a phenomenon that is closely related to peoples literacy and their interactions with the diverse contexts in which they are embedded. It provides an insightful understanding of the interactions between information providers and receivers. However, at the same time, analysis becomes intractable when it comes to the community level because of the complex entanglements between diverse users, providers, and contexts.

Compared to the theories of information worlds and information literacy landscapes, the model of information grounds highlights the situational aspect, that is, grand contexts where information is generated (Fisher, Durrance, & Hinton, 2004; Fisher & Naumer, 2006). In an empirical study of information grounds (Pettigrew, 1999), community health nurses' information behavior was examined during their services for elderly people. This study found that nurses' information giving behavior, that is, information provision, was affected by four elements of information grounds that collectively created a grand context: environmental factors (e.g., type of building, weather), activities (e.g., treatment processes), factors associated with nurses (e.g., knowledge of local resources and senior's situations), and factors associated with patients. These elements partially overlap with those from the theory of information worlds (e.g., the layout of a building can be explained by the "explicit boundary" idea in information worlds). Savolainen (2009) compared these two models regarding spatial and social factors and concluded that they complemented each other by emphasizing different aspects. Spatial and social factors are normative constraints in a small world, while they are opportunities that enable serendipitous information seeking and sharing from the information grounds perspective. As such, the model of information grounds systematically explains factors and contexts that shape the information provision process by individuals. However, this model is still limited in

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conceptualizing diverse forms of local information in a holistic manner, thus providing marginal implications on the community-level structure of local information.

A study from HCI also conceptualized the creation and flow of local information in neighborhoods as data-in-place, as a result of implementing location-based technology (Taylor et al., 2015). Unlike information grounds, local data was intentionally created by installing physical devices (e.g., PosterVote) to develop the notion of data technology in a local community as an ecosystem of devices and services. Specifically, they characterized local information as a thing that matters by interacting with residents, shapes contours by being transferred, reflects spatial/temporal/social structures, and forms small worlds where each has its own internal logic (Chatman, 2000). By elaborating on the characteristics of data in a material form in a neighborhood (as opposed to an abstract form of it in the cloud servers), this model effectively rationalizes how data interacts with people and places, and thus how data technology can be designed in ways that enhance community engagement. Although limited in including other forms of data such as social media data in the model and in explaining people's information seeking behavior because of the intentional creation of data, it combines the concept of small worlds with materialized data to better describe the impact of local technologies on people's lives.

Some studies in the field of communication also suggested a useful model for describing local information systems. As the communication research field has mainly viewed information technology as media for enhancing communications, technical infrastructures in a local community were seen as communication channels and conceptualized as *communication infrastructure* (Ball-Rokeach, Kim, & Matei, 2001; Kim & Ball-Rokeach, 2006). Because this approach is useful in interpreting and characterizing communications among local residents, it can be beneficial in explaining people's interactions that are a basis for civic engagement. Taking this view, the CiVicinity example can be understood as one of many communication infrastructures that facilitates information exchange among people in a neighborhood (Hoffman et al., 2012). However, the focus of this model is limited to the flow and dissemination of information, that is, communication, rather than forms and availability of information in a static manner. As a result, the dynamics and effects of local information itself are not well characterized by the communication infrastructure view.

Together, these theoretical models explain different aspects of individuals' information seeking, sharing, and using behaviors in community settings, as well as the impact of local information on residents' dynamics. Viewed at the community level, based on the coverage of these models, it is possible to construct a conceptual diagram that summarizes the relationships between community factors that affect information behavior/access/provision and community outcomes that are affected by peoples information behavior/access/provision (Figure 1). Each theory or model is mapped to the corresponding arrows that show causalities or effects explained by it. Also, information behavior and provision are not distinctive concepts in this model because information provision is one of the information sharing behaviors of an individual, so they are attached together in the diagram.

However, this preliminary model for local information research provides limited understanding for local information when it comes to the level of community, as it presents two major challenges: an ontological challenge, where none of the theoretical models in Figure 1 conceptualizes how provided information exists in a local community, and a causality challenge, where it is hard to explain how information provision affects individuals' information behavior and how provided information itself is related to other community factors.

To understand the complexity and diversity of local information, its sources, and their interactions with each other, it is necessary to have a new model that leverages and articulates the structure and features of information available in a local community. This new conceptualization needs to be capable of (a) explaining different kinds of information available in a community in an abstract way, (b) providing an understanding of how complex relationships

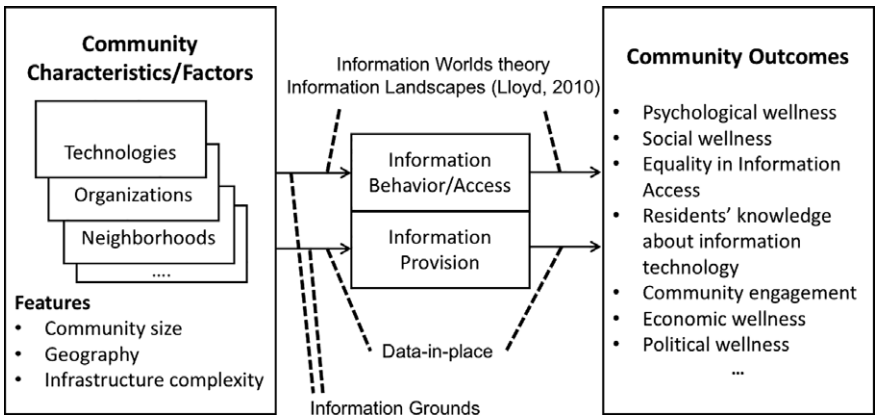

FIG. 1. A preliminary model for the relationships between information behavior/access, local community factors, and outcomes based on the existing models and theories.

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between diverse entities that contain information manifest, and (c) suggesting ways to describe different kinds of local information sources at the community level (rather than at the individual- or organization-level).

Toward a Theory of Local Information Landscapes

The ontological challenge of the preliminary model (Figure 1) can be resolved through a new model that explains a community-level, material structure of local information. Among many other models and frameworks, the notion of *the virtual* is adapted to conceptualize how local information looks at the community level (De Souza e Silva & Sutko, 2011).

The Virtual: An Ontological View of Local Information Landscapes

De Souza e Silva and Sutko (2011) conceptualized the interplay between people, space, technology, and information to understand the location-based technologies that people use in an urban environment based on the philosophy of the virtual. Unlike other communication theories, this model focuses less on technology as a communication medium, but rather recognizes location-based technologies as entities in the space of the virtual where one component limits or extends the capability of another among people, technology, space, and information. The characterization of the interplay between components of the virtual, that is," limiting or extending the capability," aligns well with the concept of materiality, because materials (e.g., a computer) come with capacity and ability before they are used in a meaningful way (Leonardi & Barley, 2008). Although not particularly developed as a material model of location-based technologies, the concept of the virtual can be adapted by incorporating the discussion of materialities of information (Dourish, 2017).

Because people, space, and technology are material entities that contain local information and, at the same time, provide representations of information, local information at the community level can be understood as being embedded in these entities while each component extends or limits the capacity of another (Figure 2). This new model explains a material state of how local information exists in a community and connotes the pre-condition of socially-constructed information (i.e., the condition of information before it becomes meaningful to people). Also, the adjusted model of the virtual denotes a material instantiation of context, because a combination of its components (e.g., nurses as people and buildings as spaces) is a necessary condition for a particular context before it is realized as socially-constructed elements (e.g., nurses as service providers and buildings as medical places[1]).

[1] The concepts of place and space follow the distinction made by Harrison and Dourish (1996), where space denotes the three-dimensional, physical structures while place includes cultural and social meanings attached to it.

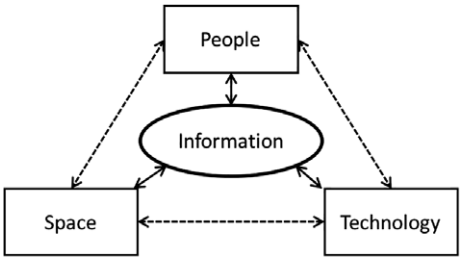

FIG. 2. An adapted model of the virtual. Information can be embedded in either people, space, or technology in a material form, whereas each component extends or limits the capability of another.

The embeddedness of information in material entities can be supported by previous studies about information behavior and access. The model of information grounds explains how information is created and provided to people. In the example of nurses in a community-based clinic (Pettigrew, 1999), information is given to elderly people by the influences of the environment (i.e., medical place), activity, and individual factors. From a material perspective, this sharing behavior is a provision of information to a social system. Meanwhile, other examples such as international students' wandering around behavior (Oh, Butler, & Lee, 2014) and the fragmentation of local information sources (López et al., 2014) indicate that local information can be provided directly to physical spaces and technical infrastructures, respectively. These studies together, with the adapted model of the virtual, suggest that the process of local information provision can be described in any of three ways:

- Provided to a technological infrastructure (e.g., posting a story on social media)
- Provided to a physical space (e.g., posting a flyer on a bulletin board)
- Provided to a social system (e.g., notifying students about homework in a class)

In addition to the information provision process, the components of the virtual also have features such as scale, complexity, and persistency; it can be about space (small/homogeneous vs. large/heterogeneous), technology (small/simple vs. large/complex), and people (small group vs. complex social system). The material characteristics of a component might determine the persistency/transience of local information as well (e.g., a small group of people forgot about particular information; or data before saving it in a computer was gone because of a power outage). An example of the relationship between the scales of some components and the characteristic of information is shown in Figure 3.

The scale, complexity, and persistence of components, in turn, create a multi-dimensional model that better explains the material aspects of local information at the community level. In other words, the interplay between the components of the virtual comprises a local information

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landscape. We define this adjusted concept of the virtual as the model of local information landscapes (LIL model). Based on this model, it is possible to refine the preliminary model of local community research (Figure 1). The new theoretical framework, that is, *LIL framework*, is presented in Figure 4. By inserting the model of local information landscapes in the preliminary model, it is possible to flesh out how information is provided to the community and the roles it plays in shaping individuals' information behavior and other community outcomes. LIL framework not only resolves the ontological challenge of the preliminary model, but also makes distinctions between information provision and behavior by viewing information in a material way.

LIL framework allows us to focus on the roles of the technical and material systems in shaping other sociotechnical dynamics of how people use, seek, and share information. Also, it implies that information availability in a community depends not only on individual or organizational actions to provide information to a community's spaces, digital fora, and/or social groups, but also how the interplay between the components of the virtual shapes their capabilities to embed and provide local information.

Empirical Studies About Local Communities and Local Information

LIL framework integrates diverse studies about local communities, partially resolving the causality challenge of the preliminary model. To provide an initial assessment of the proposed framework's face validity, it is necessary to synthesize a broader spectrum of studies that deals with local communities and information. Throughout several academic disciplines, studies on this spectrum can be roughly categorized into three themes: (a) deployment of information and communication technologies (ICTs) to solve community problems, (b) correlation and causation between community features, LIL features, and community outcomes, and (c) examination of peoples information behavior in local community settings.

Deployment of ICTs. Many studies from HCI and community informatics (CI) have focused on the psychological and human factors of residents and other community outcomes as dependent variables, and have designed and deployed technology as a means to solve local community problems. A representative work in this paradigm is Carroll's notions that characterize important community outcomes (Carroll, 2014). He conceptualized local community qualifications with three facets: (a) community identity (attachment), (b) participation and awareness (engagement), and (c) social support network, which as a whole represents people's connectedness to the community. Having these kinds of community outcomes as main objects, community informatics and HCI researchers studied how various ICTs affected community outcomes such as people's community engagement and sense of connectedness to the community (Han, Shih, Rosson, & Carroll, 2014; Humphreys, 2010; LeDantec, Watkins, Clark, & Mynatt, 2015; López & Farzan, 2015; Pasek, More, & Romer, 2009).

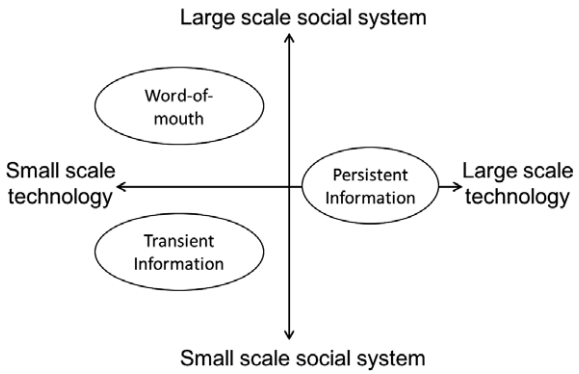

FIG. 3. An example of the relationship between the scales of LIL components and the persistence of information.

This trend has been predominant in the field of information and communication technologies for development (ICT4D), a sub-field of HCI and CI. Many studies implemented ICTs in local communities of developing countries and examined how technology influenced community outcomes. Examples include, but are not limited to, how increasing internet access through a community information center affected rural people's lives in Bangladesh (Hossain, 2015), wheather mobile phones eliminated noncommercial farmers' poverty (Smith & Hanisch, 2015), and how a technology literacy program sustained and enhanced local culture, beliefs, and traditions (Abd Aziz, Fitri, & Soubakeavathi, 2015).

In this stream of studies, issues about people's information access, intermediary processes in achieving study goals, are not explicitly discussed and are often assumed as being resolved through the deployment of technological solutions. The presumption behind this might be the fact that community outcomes such as socioeconomic level, inequality, or civic engagement can be enhanced by either facilitating people's exchange of information or increasing their access to information that exists on the internet (without this assumption, for example, a technology's influence on civic engagement is hardly explained). From the LIL perspective, these studies can be mapped onto the arrow between community features (i.e., technology) and outcomes (e.g., civic engagement) in LIL framework (Figure 5a).

Other studies in CI did not directly focus on community outcomes, but instead studied information access, provision, and dissemination. For example, Muthiah (2015) studied how a voice message service enhanced farmers' information dissemination in India and tried to understand if information dissemination actually helped reduce the poverty level in a community. Also, Schuler (2015) explored how academia could make community ICTs more relevant in the realm of civic intelligence. These research studies provide a methodological approach to generating information in a local community and imply that

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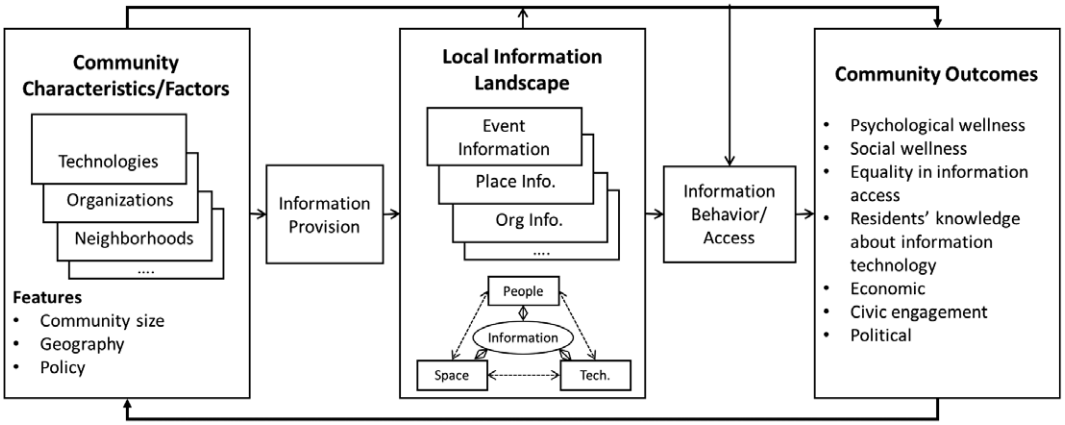

FIG. 4. LIL Framework: the key elements of the local information landscapes.

community-wide strategies are necessary for facilitating information provision. These types of studies can be mapped onto the arrow between community characteristics and information provision (Figure 5b).

Design studies that focus on crowdsourcing platforms for local communities are another stream of research in the category of technology deployment. Volunteered geographic information (VGI)-based systems are representative work for solving information provision problems by implementing a specific platform (Hara, Le, & Froehlich, 2013; Masli, Bouma, Owen, & Terveen, 2013). Figure 5c shows the positions of these types of HCI and CI studies. Because these studies do not further examine the impact of the new technology on the local information landscape of a community, there are opportunities to create a new problem space regarding the deployment of ICTs in communities.

Correlation and Causation Between Community Features, LIL, and Community Outcomes. Although the other categories of local community research have studied causations between community-related features, they usually focus on a small group of demographics or particular technologies. Unlike this kind of research, many studies from computational social science, political science, and sociology explicitly target community-level characteristics in understanding the dynamics of local communities. Their focus has been mainly to predict community features such as socioeconomic status using computational techniques (e.g., machine learning) to provide low-cost, real-time indicators for various urban characteristics (Figure 6a), and to understand the effects of community characteristics such as ethnic heterogeneity on other community outcomes (e.g., civic engagement; Figure 6b).

Community features predicted based on large-scale datasets include, but are not limited to, the socioeconomic level in a city based on cellphone detail records (CDR; Blumenstock, Cadamuro, & On, 2015; Lee et al., 2017; Soto, Frias-Martinez, Virseda, & Frias-Martinez, 2011), recognizability of urban places and socioeconomic level using user-generated data from a web-based game (Quercia, Pesce, Almeida, & Crowcroft, 2013), land uses and points of interests (POIs) in a city using CDR and geo-tagged tweets (Frias-Martinez, Soto, Hohwald, &

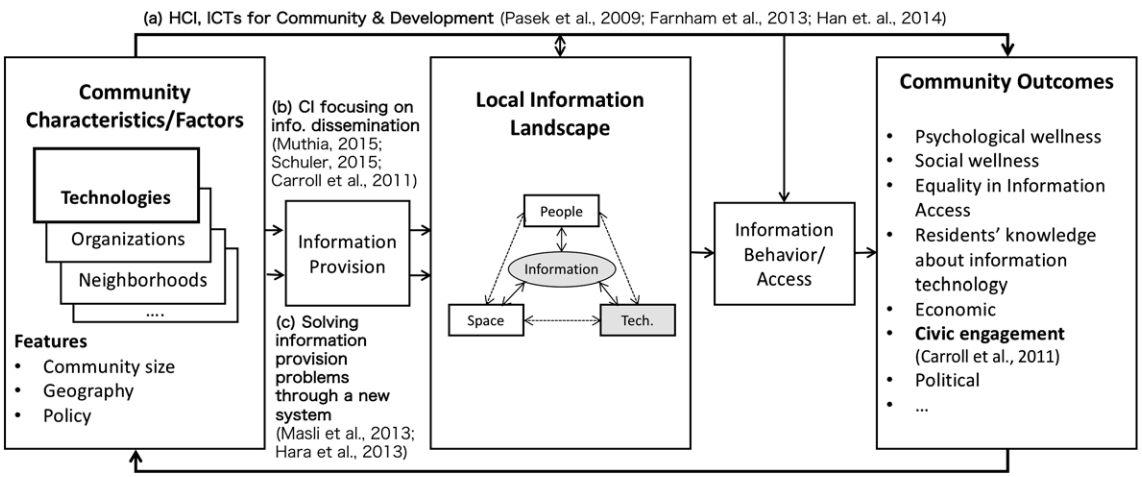

FIG. 5. Mapping HCI and CI studies onto LIL framework.

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Frias-Martinez, 2012), human mobility patterns using Foursquare and GPS trajectories (Noulas, Scellato, Lambiotte, Pontil, & Mascolo, 2012), and local friendships depending on physical distance using geo-tagged Facebook data (Backstrom, Sun, & Marlow, 2010). Often, these studies needed to conceptualize and model digitized local information (i.e., raw data) for describing their fundamental characteristics as a baseline to computationally find meaningful patterns. In other words, this kind of prediction study usually assumed that local information was geographically and demographically biased because of the irregular distribution of geo-tagged data in a city and the technology users' inconsistent demographics (Quercia et al., 2013; Venerandi, Quattrone, Capra, Quercia, & Saez-Trumper, 2015). Although some studies suggest that demographic biases are not wide-spread in particular domains (Quattrone, Capra, & De Meo, 2015), it is a common understanding and challenge for urban computing researchers that geographical biases in geo-tagged data need to be adjusted using mathematical techniques and richer datasets (Wang, Schoenebeck, Zheng, & Zhao, 2016).

These studies, if viewed from the LIL perspective, develop prediction models that identify correlations between local information that exists in technical infrastructure (e.g., social media and cellphone vendors' databases) and community features such as socioeconomic status. This research stream is not only methodologically useful because of the cost-effectiveness and mathematical novelty, but also theoretically meaningful in the LIL aspect due to the implications of local information itself. Because urban data is a type of local information available in a city, the efforts taken to use different types of data to predict community features can help understand the sources, distributions, qualities, and characteristics of various kinds of local information. Identifying biases in the data can reflect researchers' value on data quality (e.g., eliminating modeling errors; Wang et al., 2016); but, it also could be the case that the geographical biases themselves may represent the characteristics of existing local information and have theoretical implications in their own right.

Meanwhile, studies that focus on causalities between community features and outcomes have contributed to social science theories (Head, 2007). For example, civic engagement, a major community outcome, is a function of public interventions for connecting government and citizens (Brown & Keast, 2003) and of broader community features such as community heterogeneity (Costa & Kahn, 2003; Laurence, 2009; Putnam, 2007). Although similar to the studies that implemented ICTs in local communities for increasing civic engagement, these studies examined direct causal effects of community-level characteristics on civic engagement, which explains community-level dynamics rather than illustrating correlations between urban features.

Examination of Information Behavior in a Local Community. In library and information science, local information has often been studied from an information behavior perspective in research focusing on library uses. Because public and school libraries are known as important local information sources for diverse populations, studies about library use can be seen, to some degree, as being related to local communities. For example, important factors that shape individuals' library use and information behavior include cultural backgrounds (Baron & Strout-Dapaz, 2001; Bordonaro, 2006; Liu & Redfern, 1997), public libraries' efforts in technology education and assistance (i.e., digital literacy program; Bertot, Real, & Jaeger, 2016), and the use of online community networks (Pettigrew, Durrance, & Unruh, 2002). Library-focused studies provide insight into the importance of institutional efforts to increase the accessibility (e.g., IT training), but also have limitations in the geographical coverage of information sources by constraining their locations.

Other studies focused on immigrants' information seeking and use that were closely related to their adjustment and settlement in a city. Particular contexts and information sources were found as critical factors that affected

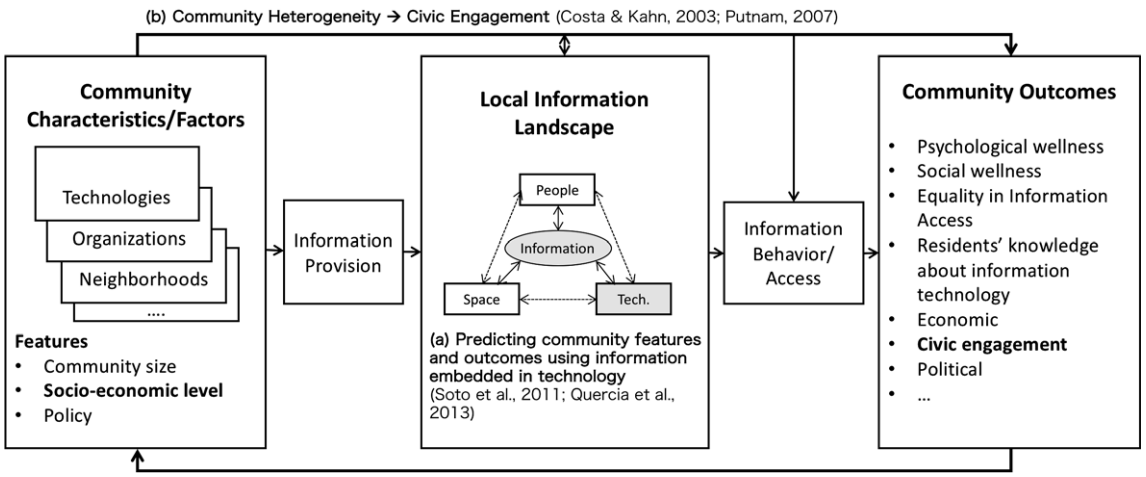

FIG. 6. Mapping computational social science, political science, and sociology studies about local communities on LIL framework.

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immigrants' information behavior. These factors include close relationships (Quirke, 2012), the internet and online/offline social networks (Khoir, Du, & Koronios, 2014; Komito & Bates, 2011), and word-of-mouth (Shoham & Kaufman, 2007). Studies in everyday life information seeking (ELIS) further highlighted the exploration of what information practices (e.g., social media use) became part of particular populations' daily lives (Lingel, 2011; Sin & Kim, 2013). These studies about information behavior regarding library use and daily life, if viewed through the LIL lens, deal mostly with the relationships between community features (e.g., librarys programs, infrastructures, and cultural traits) and people's information behavior (Figure 7a). Since information provision is a form of information behaviors from the conventional perspective, studies that focused on information provision could also be understood as a similar type of research to those mapped onto Figure 7a. From the LIL perspective, however, information provision research can be mapped onto LIL framework differently because the new conceptualization distinguishes the materiality of information from the use of it (e.g., nurses' information sharing with seniors in a community clinic), thus is mapped to Figure 7b.

Similar to the studies on the ELIS of immigrants, Oh et al. (2014) studied international students' information behavior when they first came to the United States. Oh and colleagues found that newcomers' information seeking behavior, particularly their geospatial information seeking behavior, was unique in that people not only made use of technology and institutional information, but also depended on their social capital, ethnic groups, and the "wandering-around without any purpose" strategy to find information. The position of this study in LIL framework is similar to the aforementioned ones (i.e., Figure 7a: the relationship between community features and information behavior). However, the wandering-around behavior in a city for acquiring information is noticeable, because this behavior exemplifies people's access and use of information directly through interactions with physical spaces. Along with the example of people's interactions with data-in-place such as posting on PosterVote (Taylor et al., 2015) that was intentionally installed for facilitating people's information sharing, the wandering-around behavior implies that local information embedded on physical spaces actually shapes people's information behavior in local communities (Figure 7c). Also, these studies show that the information people seek and use is not limited to that from information providers but exist pervasively in a community with *and* without respect to actors' intentions as LIL framework indicates.

A Theory of Local Information Landscapes

As reviewed with research from different disciplines, LIL framework (Figure 4) can explain various relationships between factors and characteristics of local communities. Particularly, it was possible to understand information provision as a process in the formation of local information landscapes by distinguishing it from other information behaviors with the assistance of the LIL lens. This initial assessment partially resolves the causality challenge of the preliminary model (Figure 1). The mapping of empirical studies together suggests that LIL framework is a meta-theoretical framework that explains diverse relationships between community characteristics, community outcomes, and local information landscapes. Therefore, it is possible to theorize these relationships found from LIL framework as a theory of local information landscapes (LIL theory).

Although many empirical studies implicitly demonstrate some parts of LIL framework, no research explicitly studied local information landscapes as a variable that affects or is affected by other community characteristics and outcomes. Thus, the causality challenge remains, and new problem spaces can be created to better understand the causal relationships between the components of LIL framework. At the same time, this new model provides theoretical implications for understanding information inequality and information poverty from a material perspective.

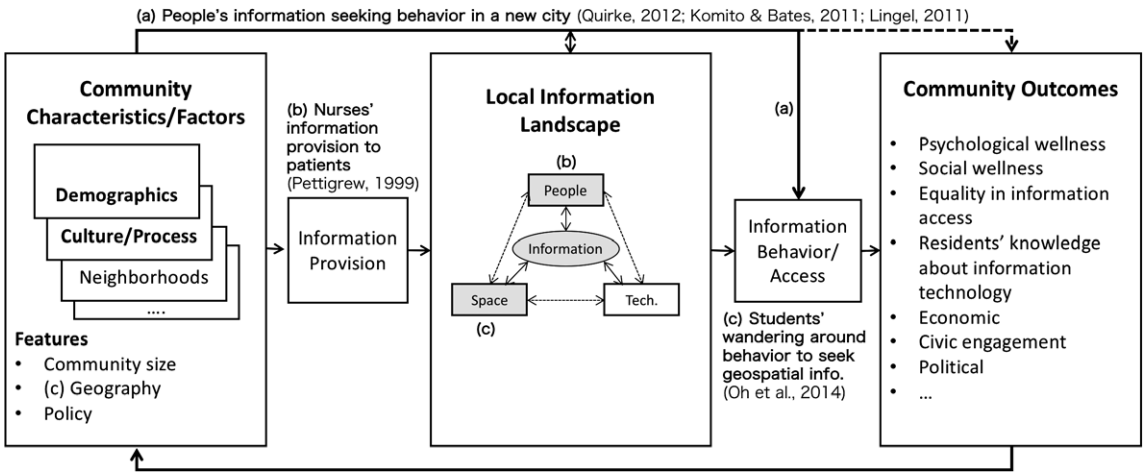

FIG. 7. Mapping library and information science studies targeting local information on LIL framework.

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Theoretical Implication: Information Deserts

Similar to the studies that take a socio-technical approach to solving information access issues, the notions of information inequality and information poverty, while having different nuances, conceptualize people's disparities in accessing information as socially-constructed phenomena (Norris, 2001; Schiller, 2013). Information inequality has often highlighted social inequality imposed by such things as the power- and economy-driven provision of information in mass media (Schiller, 2013), uneven possessions of information by individuals in different social classes (Van Dijk, 2000), and the general ICT capacity of households (Hilbert, 2014). Focusing more on the deprived side of the digital divide, information poverty often considers individuals' situational aspects such as discrepancies in peoples' digital literacy (Eshet-Alkalai, 2004) and their broader information processing incapability (i.e., information illiteracy) beyond the digital skills (Eisenberg, 2008). Also, information poverty was understood as a result of the economic and technological deficiency (Haider & Bawden, 2007). Although the nuances and focus of this phenomenon are different across research communities, as Yu (2006) noted, it is an implicit assumption that most research studies on the topic of information inequality and poverty perceive information as a socially constructed entity. By taking the LIL lens, it becomes possible to understand information inequality and information poverty from a material perspective.

Some notions that discuss some material characteristics of information can be found in previous studies. Particularly, if digitized data on the internet is conceptualized, material aspects of the data could surface. For example, the concept of *data deserts* has been explored as a societal or disciplinary characteristic that is affected by the recent explosion in digitized data. In computational and human geography, researchers suggested that data deserts exist in technical systems where data is scarce because data availability and continuity differed before and after the big-data era (Kitchin, 2014). In a similar vein, HCI researchers in the domain of volunteered geographic information (VGI) have studied the data creation process by volunteers and articulated the notion of localness that explains the origins of data and data providers (Sen et al., 2015). This stream of research found that there were discrepancies between the locations of editors who contributed to geographically-specific Wikipedia pages and the regions that these pages referenced, providing evidence of geographical inequalities in data creation. Rural areas were not only more likely to have data created by outsiders, but also found to have lower quality data than urban areas on Wikipedia and OpenStreetMap because of the high portion of data created by automated agents (Johnson et al., 2016).

Although these studies have limitations in understanding information inequality in general in a community due to their focus on digital data (leaving other forms of information behind), the term *deserts* in data deserts illustrates the meaning of materiality well. The use of the term, *deserts*, has been prevalent in the discussion of *food deserts* that signifies people's disparities in accessing food resources such as grocery stores and restaurants (Walker, Keane, & Burke, 2010). Because food and the locations of food providers are material entities that have physical distances from each household, the concept of food deserts has been studied as a necessary condition of its manifestations in people's lives and food accessibility. A takeaway from the food deserts studies is that the materiality of food matters as a factor that affects people's lives. Conversely, the social construction of food was also studied: a study that took a socio-technical approach in understanding food deserts examined the impact of families' socioeconomic status on food's symbolic values (Fielding-Singh, 2017).

These two different understandings of food accessibility issues are consistent with the two views on information accessibility issues suggested in this article: socio-technical and material views. This observation and analogy justify the use of the term *deserts* for conceptualizing the material aspects of information inequality or information poverty, thus as *information deserts.* Based on LIL theory, information deserts can be defined as structural and material states of local information landscapes that are pre- or necessary conditions of community-level information inequality (but not a sufficient condition). As López et al. (2014) suggested, there can be some material/structural forms of local information landscapes that could potentially affect people's information inequality. Some examples of information deserts are as follows:

- When local information is fragmented across different information sources (López et al., 2014).
- When local information is transient because of the material characteristics of embedding entities (e.g., word-of-mouth in a small group of people).
- When there is a lack of components of local information landscapes (e.g., lack of local bulletin boards in a neighborhood).

The Fragmentation of Local Information Across Different Sources

When a certain type of local information is provided only to a part of the components of the LIL model, the distribution of information would be inconsistent across different information sources, and this might negatively affect people's information accessibility. López et al. (2014)'s work is a representative example that demonstrates information fragmentation with respect to technical infrastructure owners. This structural characteristic is distinguishable from the concept of fractured information landscapes, suggested by Lloyd (2017), which takes a socio-cultural view on the fracture of information landscapes where an individual's familiarity with information sources and contexts is a key in understanding the overall landscape.

The uneven distribution of local event information embedded in different technical infrastructures (e.g., nei-

DOI: 10.1002/asi

ghborhood blogs and city-wide newspaper websites) shows that certain types of event information (e.g., museum-initiated events) are not available from neighborhood-based websites; instead, they are available in a city-wide information source. This implies that information deserts can be unintentionally created as a byproduct of organizational strategies or because of the nature of particular information types. From a user perspective, it is possible that an individual would not be able to access every information available in the community unless he or she looks into all the information sources. Thus, the high fragmentation of local information could be potentially detrimental to people's information access at the community level (c.f., it does not represent information inequality by itself; rather, it is a necessary condition of information inequality).

Transience of Local Information

Even if information were provided evenly to the information sources in a community (so there is no fragmentation), the transient characteristic of the entity that embeds information could create another form of information deserts. For example, if a piece of information was provided to a couple of people through word-of-mouth and they forgot about that information, it is understood from the LIL view that information deserts are created due to the transient characteristic of information (because this information is no longer accessible). Another example can be found in a case where information is in a volatile memory of a computing system. If, for some reason, pieces of local information are stored only in a Random-Access Memory (RAM) that stores data while power is on and there was a sudden power outage for a few seconds, then that information disappears because of the characteristics of RAM.

The transience of information that stems from the material characteristics of the embedding components has a different meaning from that of the information that is available at the moment of practices, that is, contingent information, such as medical information acquired at the moment when a nurse examines a patient's body (Bonner & Lloyd, 2011) or that is informal/contextualized, that is, vernacular information (Trace, 2008). This type of information emerges from collective group activities, cultural experiences, and an internal view on information, thus, is called local knowledge as well (Lloyd, 2014). Contingent or vernacular information is available and sought depending on people's understanding of situated practices and is perceived differently by time, space, and individual. Unlike this type of information, information deserts created based on the transience of information conceptualize any material states with a lack of information that stems from the characteristics of embedding entities.

Lack of Components of the Local Information Landscape Model

If there are not enough infrastructures, people, or spaces that can contain and provide local information, information deserts can be created as well. For example, physical bulletin boards are spatial entities that embed local information. People would have a hard time finding certain types of local information from locations where bulletin boards are scarce or absent (e.g., neighborhoods with few numbers of coffee shops and public libraries) by eliminating the capability of information creation/provision in the local community. Similarly, a lack of neighborhood gatherings or technical infrastructures is another form of information deserts created by limiting the possibility of information provision.

Research Agenda

Given the forms of information deserts and LIL framework with respect to the scale, complexity, and persistence of the LIL components, research studies that can be designed in several academic fields are presented by identifying gaps using LIL framework (Figure 4).

Human-Computer Interaction (HCI) and Community Informatics (CI)

A few local community studies from HCI and CI highlighted information provision by focusing on the amount of information disseminated through infrastructures and people (Carroll et al., 2011; Foth, Forlano, Satchell, Gibbs, & Donath, 2011). However, the effect of the information provision is still unexplored thoroughly for the three types of provisions (i.e., provisions to technical infrastructures, people, and physical spaces). In addition, HCI and CI tend to focus on one or a few particular systems when considering information provision. Mapping empirical studies onto LIL framework (Figure 5) suggests that the impact of implementing new technology can be further explored by considering new categories of dependent variables: the characteristics of local information landscape and peoples information behavior regarding them.

In most cases, some information systems, either technical or social, already exist when an ICT is implemented. Even for a developing country, for example, social systems such as a word-of-mouth network or local communication structures exist for exchanging information within a community. Designing and implementing a new ICT might help residents communicate better with each other regardless of the existing structure of local information landscapes, but it is also possible that adding one more system may lead to the high complexity of residents' information access practices. Conducting user studies using only a new system may not capture the effects of adding new technology. Accordingly, new categories of research studies can be designed by considering these effects:

- Comparing people's information behavior before and after deploying a new system given conventional information sources (by focusing on their daily experiences, rather than their behavior regarding a new system).

DOI: 10.1002/asi

- Identifying the amount and types of information that can be complemented in a city by implementing a new system.
- Designing and developing visual analytics tools that show how information deserts in a city change over time before and after implementing a system (e.g., how does the degree of fragmentation in LIL change?).
- Identifying and justifying the position and role of a new system within the existing local information landscape of a city - whether it is an implementation of a complementary system that provides an easy access structure (e.g., Hu, Farnham, & Monroy-Hernández, 2013) or a completely new system that provides new information that was hardly provided before.

Computational Social Science and Political Science

Many researchers have focused on identifying and adjusting geographical biases from datasets (Wang et al., 2016), because it was essential to verify the characteristics of geospatial data and their findings in justifying prediction models. If we think of the geospatial data as a form of local information that is embedded in technical infrastructure, it is possible to say that biases in the data may actually represent the structure of local information landscapes (or potentially information deserts) by themselves. In this sense, quantifying and explaining diverse aspects of information deserts using geo-tagged data would be possible for future studies. Also, studies that examined relationships between community features and outcomes (e.g., the effects of community heterogeneity on civic engagement) can be re-visited by taking LIL framework into account. Examples are as follows:

- Constructing mathematical models that quantify:
  –The degree of fragmentation of local information in a city.
  –The availability of each component of the LIL model.
- Predicting the effect of adding an information source in a city (e.g., how can we measure the impact of adding a Twitter-based local information application on a city's information deserts?)
- Studying causal relationships between information deserts (e.g., the complexity of local information infrastructures) and community outcomes (e.g., socioeconomic status).
- Studying how the LIL features (e.g., the fragmentation of local information) mediate or moderate the relationships between community features and outcomes.

Library and Information Science

Existing theories about information access and behavior can be extended by making use of LIL theory. Also, based on the library and information science studies mapped in Figure 7, it is possible to identify some hidden patterns of information behavior regarding the complexity, scale, and persistence of the LIL components. For example, because some studies about geospatial information embedded in physical spaces and social systems focus on particular contexts and scales of LIL components (e.g., space as a city environment; Oh et al., 2014; Pettigrew, 1999), LIL theory can help systematically find other features of the LIL components by diversifying the complexity, scale, and persistence of each component. Some examples of such opportunities are as follows:

- Exploring people's information seeking behavior where the scale of spatial entities is small and transient (e.g., customer's information seeking behavior in a coffee shop where the turnover rate of flyers on the bulletin board is fast).
- Studying how the interplay between multiple sources that contain the same information manifests in different contexts (e.g., when the same information is available both from a bulletin board and librarians in a public library, how each affects people's information seeking behavior; how each of these components extends or limits the capability of another; and how the information redundancy plays a role for library visitors in accessing it).
- Exploring how and why information is provided to a physical space (e.g., how information about local events, such as farmers markets, becomes embedded on physical spaces, and why? What are the implications of actors' information provision behavior?).

Discussions and Limitations

Despite the advantages of the proposed theory and new research opportunities derived from it, some issues remain. First of all, the complexity of each component is still largely encapsulated in an abstract form. The component of *people*, even from a material perspective, cannot be completely separated from human factors because some characteristics such as memorizing ability and their attentions are important in keeping information. The interactions and dynamics of groups and organizations themselves are very complicated processes that can affect the form of local information substantially. Although existing theories and models in HCI and Psychology explain diverse aspects of information users well, the *people* component needs to be further explored from the material perspective to characterize the local information landscape better. Articulating the scopes and priorities of the characteristics of the LIL components would make this model more useful for local community scholars.

In addition, more empirical studies from diverse academic disciplines need to be explored to better understand and refine LIL theory. In this article, only some of the major academic fields that study local communities and cities were reviewed to construct LIL theory. However, there are many other empirical studies and academic fields that can complement and assess this theory (e.g., urban and transportation studies were not reviewed in this article). More efforts are needed by scholars from diverse academic fields to fill the potential gaps between studies that examine community-level characteristics.

Lastly, the LIL model has limitations with regard to explaining the emergence of highly-situated information in the local community context. As Lloyd (2010) noted, information and knowledge often arise from people's collective understanding of physical environments and practices. By focusing on the materiality of information,

DOI: 10.1002/asi

however, the LIL model is more useful for explaining the features of standardized/legitimized public information than those of nuanced, situation-dependent information. This focus could be seen as a trade-off between the scalability and scope of the ontological model. Further research and case studies are needed to understand these tensions and trade-offs better and to refine LIL framework.

Despite these limitations, this work is meaningful in several aspects. Although assessing LIL framework, it was possible to review a wide spectrum of local community research across disciplines beyond the scope of LIS. It is our hope that scholars from different fields communicate with each other more by using and developing LIL theory with studies that fill in the empirical gaps. Distinguishing information provision and behavior/access is another contribution of this article. Although information creation is not a new concept in the LIS field (Trace, 2007), information provision to three material components of LIL has rarely been modeled as a theoretical framework in the context of local communities. Through LIL theory, scholars who study information creation can benefit from systematic approaches to thinking about the ways that information is provided. Also, information behavior studies can benefit from the ecological forces of local information landscapes that shape individuals' information behavior and accessibility (beyond the discussion of how created information exists).

Conclusion

Separating an information layer from the physical and technological systems have been explored to some degree among information and social science scholars, conceptualizing it as information layers (Weng et al., 2013). LIL theory not only separates information layers from the local community, but also characterizes how information is embedded in different entities and how each component limits or extends the capability of another depending on their scales and complexity. It was also possible to conceptualize a community-level, material structure of local information landscapes as a construct that provides capacity and ability for individuals' information behavior, access, and other community-level qualities. Through this theorizing process, it was possible to examine the opportunities that are suggested in the introduction:

1. Local information can be provided to physical spaces, technical infrastructures, and social systems.
2. By constructing the LIL model that describes the material structure and distribution of local information at the community level, it becomes possible to understand people's information access issues as a result of a community-level complexity in the local information landscape.
3. LIL theory can complement existing theories about information behavior, access, and contexts such as the information worlds theory and information grounds by distinguishing information provision, the results of provision, and their effects on information behavior/access.
4. Physical spaces, technical infrastructures, and social systems can be in different forms with varying scales and complexities that together shape the characteristics of local information while embedding it.
5. Diverse manifestations of information inequality and information poverty have necessary conditions, that is, the material states of local information landscapes; these structural forms can be conceptualized as information deserts.

Because there are still some components and aspects that need to be further refined and articulated, this article should be seen as an initial effort to conceptualize and construct a theory of local information landscapes. Despite its abstractness, it was possible to explore research opportunities that were rarely considered before. Based on this work, researchers in local community-related disciplines can use LIL theory as a baseline tool to discover gaps between various kinds of literature. If the constructs of LIL framework can be developed with concrete measures, urban planners, policy-makers, and local information system designers would further benefit from its metrics, guidelines, and assessment frameworks.

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References

Abd Aziz, N., Fitri, S.M., & Soubakeavathi, R. (2015). Constructing sustainable digital learning environments for remote rural children of Sarawak. The Journal of Community Informatics, 11(1). Retrieved from http://ci-journal.org/index.php/ciej/article/view/865

Backstrom, L., Sun, E., & Marlow, C. (2010). Find me if you can: Improving geographical prediction with social and spatial proximity. In Proceedings of the 19th International Conference on World Wide Web (pp. 61–70). New York, NY: ACM.

Ball-Rokeach, S.J., Kim, Y.-C., & Matei, S. (2001). Storytelling neighborhood: Paths to belonging in diverse urban environments. Communication Research, 28(4), 392–428.

Baron, S., & Strout-Dapaz, A. (2001). Communicating with and empowering international students with a library skills set. Reference Services Review, 29(4), 314–326.

Bertot, J.C., Real, B., & Jaeger, P.T. (2016). Public libraries building digital inclusive communities: Data and findings from the 2013 digital inclusion survey. The Library Quarterly, 86(3), 270–289.

Blumenstock, J., Cadamuro, G., & On, R. (2015). Predicting poverty and wealth from mobile phone metadata. Science, 350(6264), 1073–1076.

Boer, P.J. (2015). Community meeting the namibian education technology policy with olpcs xo laptops: Is it a viable approach? The Journal of Community Informatics, 11(1). Retrieved from http://ci-journal.org/index.php/ciej/article/view/1121

Bonner, A., & Lloyd, A. (2011). What information counts at the moment of practice? Information practices of renal nurses. Journal of Advanced Nursing, 67(6), 1213–1221.

Bordonaro, K. (2006). Language learning in the library: An exploratory study of ESL students. The Journal of Academic Librarianship, 32(5), 518–526.

Brown, K., & Keast, R. (2003). Citizen-government engagement: Community connection through networked arrangements. Asian Journal of Public Administration, 25(1), 107–131.

Burnett, G., & Jaeger, P.T. (2008). Small worlds, lifeworlds, and information: The ramifications of the information behaviour of social groups in public policy and the public sphere. Information Research: An International Electronic Journal, 13(2). Retrieved from http://InformationR.net/ir/13-2/paper346.html

Burnett, G., Jaeger, P.T., & Thompson, K.M. (2008). Normative behavior and information: The social aspects of information access. Library & Information Science Research, 30(1), 56–66.

Carroll, J.M. (2014). The neighborhood in the internet: Design research projects in community informatics. London: Routledge.

Carroll, J.M., Horning, M., Hoffman, B., Ganoe, C., Robinson, H., & Rosson, M.B. (2011). Community network 2.0: Visions, participation, and engagement in new information infrastructures. In International Symposium on End User Development (pp. 270–275). Berlin, Heidelberg: Springer.

Chatman, E.A. (2000). Framing social life in theory and research. The New Review of Information Behaviour Research, 1, 3–17.

Costa, D.L., & Kahn, M.E. (2003). Civic engagement and community heterogeneity: An economist's perspective. Perspectives on Politics, 1(1), 103–111.

Culnan, M.J. (1985). The dimensions of perceived accessibility to information: Implications for the delivery of information systems and services. Journal of the Association for Information Science and Technology, 36(5), 302–308.

De Souza e Silva, A., & Sutko, D.M. (2011). Theorizing locative technologies through philosophies of the virtual. Communication Theory, 21(1), 23–42.

Dourish, P. (2017). The stuff of bits: An essay on the materialities of information. Cambridge, MA: MIT Press.

Dourish, P., & Mazmanian, M. (2011). Media as material: Information representations as material foundations for organizational practice. In Third International Symposium on Process Organization Studies (p. 92). Corfu, Greece.

Eisenberg, M.B. (2008). Information literacy: Essential skills for the information age. DESIDOC Journal of Library & Information Technology, 28(2), 39.

Eshet-Alkalai, Y. (2004). Digital literacy: A conceptual framework for survival skills in the digital era. Journal of Educational Multimedia and Hypermedia, 13(1), 93.

Fielding-Singh, P. (2017). A taste of inequality: Food's symbolic value across the socioeconomic spectrum. Sociological Science, 4, 424–448.

Fisher, K.E., Durrance, J.C., & Hinton, M.B. (2004). Information grounds and the use of need-based services by immigrants in queens, new york: A context-based, outcome evaluation approach. Journal of the American Society for Information Science and Technology, 55(8), 754–766.

Fisher, K.E., & Naumer, C.M. (2006). Information grounds: Theoretical basis and empirical findings on information flow in social settings. In New directions in human information behavior (pp. 93–111). Dordrecht: Springer.

Foth, M., Forlano, L., Satchell, C., Gibbs, M., & Donath, J. (2011). From social butterfly to engaged citizen: Urban informatics, social media, ubiquitous computing, and mobile technology to support citizen engagement. Cambridge, MA: MIT Press.

Frias-Martinez, V., Soto, V., Hohwald, H., & Frias-Martinez, E. (2012). Characterizing urban landscapes using geolocated tweets. In International Conference on Privacy, Security, Risk and Trust and International Confernece on Social Computing (pp. 239–248). Washington D. C.: IEEE.

Habermas, J. (1991). The structural transformation of the public sphere: An inquiry into a category of bourgeois society. Cambridge, MA: MIT Press.

Haider, J., & Bawden, D. (2007). Conceptions of "information poverty" in LIS: A discourse analysis. Journal of Documentation, 63(4), 534–557.

Han, K., Shih, P.C., Rosson, M.B., & Carroll, J.M. (2014). Understanding local community attachment, engagement and social support networks mediated by mobile technology. Interacting with Computers, 28(3), 220–273.

Hara, K., Le, V., & Froehlich, J. (2013). Combining crowdsourcing and Google street view to identify street-level accessibility problems. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 631–640). New York, NY: ACM.

Harrison, S., & Dourish, P. (1996). Re-place-ing space: The roles of place and space in collaborative systems. In Proceedings of the ACM conference on Computer Supported Cooperative Work (pp. 67–76). New York, NY: ACM.

Head, B.W. (2007). Community engagement: Participation on whose terms? Australian Journal of Political Science, 42(3), 441–454.

Hilbert, M. (2014). Technological information inequality as an incessantly moving target: The redistribution of information and communication capacities between 1986 and 2010. Journal of the Association for Information Science and Technology, 65(4), 821–835.

Hoffman, B., Robinson, H., Han, K., & Carroll, J. (2012). Civicinity events: Pairing geolocation tools with a community calendar. In Proceedings of the Third International Conference on Computing for Geospatial Research and Applications (p. 14). New York, NY: ACM.

Hossain, M.D. (2015). Users and uses of internet access points in Bangladesh: A case study of community information centers (CICs). The Journal of Community Informatics, 11(1). Retrieved from http://ci-journal.org/index.php/ciej/article/view/1043

Hu, Y., Farnham, S.D., & Monroy-Hernández, A. (2013). Whoo. ly: Facilitating information seeking for hyperlocal communities using social media. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 3481–3490). New York, NY: ACM.

Humphreys, L. (2010). Mobile social networks and urban public space. New Media & Society, 12(5), 763–778.

Jaeger, P.T., & Burnett, G. (2010). Information worlds: Behavior, technology, and social context in the age of the internet. New York, NY: Routledge.

Johnson, I.L., Lin, Y., Li, T.J.-J., Hall, A., Halfaker, A., Schöning, J., & Hecht, B. (2016). Not at home on the range: Peer production and the urban/rural divide. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (pp. 13–25). New York, NY: ACM.

Kavanaugh, A., Krishnan, S., Pérez-Quiñones, M., Tedesco, J., Madondo, K., & Ahuja, A. (2014). Encouraging civic participation through local news aggregation. Information Polity, 19(1, 2), 35–56.

Khoir, S., Du, J.T., & Koronios, A. (2014). Study of Asian immigrants' information behaviour in South Australia: Preliminary results. In Proceedings of the iConference 2014.

Kim, Y.-C., & Ball-Rokeach, S.J. (2006). Civic engagement from a communication infrastructure perspective. Communication Theory, 16(2), 173–197.

Kitchin, R. (2014). The data revolution: Big data, open data, data infrastructures and their consequences. London: Sage.

Komito, L., & Bates, J. (2011). Migrants' information practices and use of social media in Ireland: Networks and community. In Proceedings of the 2011 iConference (pp. 289–295). New York, NY: ACM.

Langefors, B. (1978). Discussion of the article by Bostrom and Heinen: MIS problems and failures: A socio-technical perspective. Part I: The causes. MIS Quarterly, 2(2), 55–62.

Laurence, J. (2009). The effect of ethnic diversity and community disadvantage on social cohesion: A multi-level analysis of social capital and interethnic relations in UKcommunities. European Sociological Review, 27(1), 70–89.

LeDantec, C.A., Watkins, K.E., Clark, R., & Mynatt, E. (2015). Cycle Atlanta and OneBusAway: Driving innovation through the data ecosystems of civic computing. In International Conference on Human-Computer Interaction (pp. 327–338). Cham: Springer.

Lee, D.H., & Brusilovsky, P. (2017). Improving personalized recommendations using community membership information. Information Processing & Management, 53(5), 1201–1214.

Lee, M., Dottle, R., Espino, C., Subkhan, I., Rokem, A., & Mashhadi, A. (2017). A tool for estimating and visualizing poverty maps. In NetMob 2017. Retrieved from http://netmob.org/assets/img/bookofabstract_oral_2017.pdf

Leonardi, P.M., & Barley, S.R. (2008). Materiality and change: Challenges to building better theory about technology and organizing. Information and Organization, 18(3), 159–176.

Leonardi, P.M., Nardi, B.A., & Kallinikos, J. (2012). Materiality and organizing: Social interaction in a technological world. Oxford: Oxford University Press.

Lingel, J. (2011). Information tactics of immigrants in urban environments. Information Research, 16(4). Retrieved from http://InformationR.net/ir/16-4/paper500.html

Liu, M., & Redfern, B. (1997). Information-seeking behavior of multicultural students: A case study at San Jose State University. College & Research Libraries, 58(4), 348–354.

Lloyd, A. (2005). Information literacy: Different contexts, different concepts, different truths? Journal of Librarianship and Information Science, 37(2), 82–88.

Lloyd, A. (2006). Information literacy landscapes: An emerging picture. Journal of Documentation, 62(5), 570–583.

Lloyd, A. (2010). Information literacy landscapes: Information literacy in education, workplace and everyday contexts. Oxford: Chandos Publishing.

Lloyd, A. (2014). Following the red thread of information in information literacy research: Recovering local knowledge through interview to the double. Library & Information Science Research, 36(2), 99–105.

Lloyd, A. (2017). Researching fractured (information) landscapes: Implications for library and information science researchers undertaking research with refugees and forced migration studies. Journal of Documentation, 73(1), 35–47.

López, C., Butler, B., & Brusilovsky, P. (2014). Does anything ever happen around here? assessing the online information landscape for local events. Journal of Urban Technology, 21(4), 95–123.

López, C., & Farzan, R. (2015). Lend me sugar, I am your neighbor!: A content analysis of online forums for local communities. In Proceedings of the Seventh International Conference on Communities and Technologies (pp. 59–67). New York, NY: ACM.

Malu, M., & Findlater, L. (2015). Personalized, wearable control of a head-mounted display for users with upper body motor impairments. In Proceedings of the 33rd ACM Conference on Human Factors in Computing Systems (pp. 221–230). New York, NY: ACM.

Masli, M., Bouma, L., Owen, A., & Terveen, L. (2013). Geowiki + route analysis = improved transportation planning. In Proceedings of the 2013 Conference on Computer Supported Cooperative Work Companion (pp. 213–218). New York, NY: ACM.

Muthiah, G. (2015). Assessment of mobile voice agricultural messages given to farmers of Cauvery delta zone of Tamil Nadu, India. The Journal of Community Informatics, 11(1). Retrieved from http://ci-journal.org/index.php/ciej/article/view/1067

Norris, P. (2001). Digital divide: Civic engagement, information poverty, and the internet worldwide. Cambridge: Cambridge University Press.

Noulas, A., Scellato, S., Lambiotte, R., Pontil, M., & Mascolo, C. (2012). A tale of many cities: Universal patterns in human urban mobility. PLoS One, 7(5), e37027.

Oh, C.Y., Butler, B.S., & Lee, M. (2014). Information behavior of international students settling in an unfamiliar geo-spatial environment. Proceedings of the American Society for Information Science and Technology, 51(1), 1–11.

Pasek, J., More, E., & Romer, D. (2009). Realizing the social internet? Online social networking meets offline civic engagement. Journal of Information Technology & Politics, 6(3–4), 197–215.

Pettigrew, K.E. (1999). Waiting for chiropody: Contextual results from an ethnographic study of the information behaviour among attendees at community clinics. Information Processing & Management, 35(6), 801–817.

Pettigrew, K.E., Durrance, J.C., & Unruh, K.T. (2002). Facilitating community information seeking using the internet: Findings from three public library–community network systems. Journal of the American Society for Information Science and Technology, 53(11), 894–903.

Putnam, R.D. (2007). E Pluribus Unum: Diversity and community in the twenty-first century the 2006 Johan Skytte Prize Lecture. Scandinavian Political Studies, 30(2), 137–174.

Quattrone, G., Capra, L., & De Meo, P. (2015). There's no such thing as the perfect map: Quantifying bias in spatial crowd-sourcing datasets. In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work (pp. 1021–1032). New York, NY: ACM.

Quercia, D., Pesce, J.P., Almeida, V., & Crowcroft, J. (2013). Psychological maps 2.0: A web engagement enterprise starting in London. In Proceedings of the 22nd International Conference on World Wide Web (pp. 1065–1076). New York, NY: ACM.

Quirke, L. (2012). Information practices in newcomer settlement: A study of Afghan immigrant and refugee youth in Toronto. In Proceedings of the 2012 iConference (pp. 535–537). New York, NY: ACM.

Russell, H., & Young, K. (2015). Influences and experiences of using digital devices in laterlife. The Journal of Community Informatics, 11(1). Retrieved from http://ci-journal.org/index.php/ciej/article/view/1008

Savolainen, R. (2009). Small world and information grounds as contexts of information seeking and sharing. Library & Information Science Research, 31(1), 38–45.

Schiller, H. (2013). Information inequality. New York, NY: Routledge.

Schuler, D. (2015). Engaging academia: Strengthening the link between community and technology. The Journal of Community Informatics, 11(2) Retrieved from http://ci-journal.org/index.php/ciej/article/view/1215.

Sen, S.W., Ford, H., Musicant, D.R., Graham, M., Keyes, O.S., & Hecht, B. (2015). Barriers to the localness of volunteered geographic information. In Proceedings of the 33rd ACM Conference on Human Factors in Computing Systems (pp. 197–206). New York, NY: ACM.

Shoham, S., & Kaufman, S. (2007). Information needs of north american immigrants to Israel. Journal of Information, Communication and Ethics in Society, 5(2/3), 185–205.

Sin, S.-C.J., & Kim, K.-S. (2013). International students' everyday life information seeking: The informational value of social networking sites. Library & Information Science Research, 35(2), 107–116.

Smith, M.D., & Hanisch, J. (2015). Impacts of mobile phone use on poverty reduction for non-commercial farmers in rural North Ghana. The Journal of Community Informatics, 11(1). Retrieved from http://ci-journal.org/index.php/ciej/article/view/652

Soto, V., Frias-Martinez, V., Virseda, J., & Frias-Martinez, E. (2011). Prediction of socioeconomic levels using cell phone records. In International Conference on User Modeling, Adaptation, and Personalization (pp. 377–388). Berlin, Heidelberg: Springer.

Struppek, M. (2006). The social potential of urban screens. Visual Communication, 5(2), 173–188.

Taylor, A.S., Lindley, S., Regan, T., Sweeney, D., Vlachokyriakos, V., Grainger, L., & Lingel, J. (2015). Data-in-place: Thinking through the relations between data and community. In Proceedings of the 33rd ACM Conference on Human Factors in Computing Systems (pp. 2863–2872). New York, NY: ACM.

Trace, C.B. (2007). Information creation and the notion of membership. Journal of Documentation, 63(1), 142–164.

Trace, C.B. (2008). Resistance and the underlife: Informal written literacies and their relationship to human information behavior. Journal of the Association for Information Science and Technology, 59(10), 1540–1554.

Van Dijk, J. (2000). Widening information gaps and policies of prevention. In Digital democracy: Issues of theory and practice (pp. 166–183). London: Sage.

Van Dijk, J. (2005). The deepening divide: Inequality in the information society. London: Sage.

Venerandi, A., Quattrone, G., Capra, L., Quercia, D., & Saez-Trumper, D. (2015). Measuring urban deprivation from user generated content. In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (pp. 254–264). New York, NY: ACM.

Walker, R.E., Keane, C.R., & Burke, J.G. (2010). Disparities and access to healthy food in the United States: A review of food deserts literature. Health & Place, 16(5), 876–884.

Wang, G., Schoenebeck, S.Y., Zheng, H., & Zhao, B.Y. (2016).“Will Check-in for Badges”: Understanding bias and misbehavior on location-based social networks. In International AAAI Conference on Web and Social Media (pp. 417–426). Cologne, Germany.

Weng, L., Ratkiewicz, J., Perra, N., Gonçalves, B., Castillo, C., Bonchi, F.,... Flammini, A. (2013). The role of information diffusion in the evolution of social networks. In Proceedings of the 19th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (pp. 356–364). New York, NY: ACM.

Yu, L. (2006). Understanding information inequality: Making sense of the literature of the information and digital divides. Journal of Librarianship and Information Science, 38(4), 229–252. New York, NY: ACM.