

Literature Review: Examining Contextual Integrity within Human-Computer Interaction

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Nissenbaum’s Framework of Contextual Integrity (CI) provides a mechanism for understanding the negotiation of privacy between two or more parties. In this position paper, we present a preliminary review of recent Human-Computer Interaction (HCI) literature that uses Nissenbaum’s framework. For this initial analysis, we used a keyword search and examined peer-reviewed papers published between the years of 2008 and 2017 in the top 20 HCI venues according to Google Scholar and Microsoft Academic Research. Overall, we found that many of the studies do not implement CI within the design of their study nor do they provide summative evaluations. To close these gaps, we recommend HCI researchers to engage more thoroughly with the framework to inform their research designs and conduct studies that provide a deeper understanding of how the framework applies and can be extended in various contexts. We also recommend researchers pursue more summative evaluations based on CI for new technology solutions.

CCS Concepts:

KEYWORDS

Contextual Integrity, Literature Review, Human-Computer Interaction.

1 INTRODUCTION

Privacy can be a very dense and ambiguous concept. There are a wide range of theories that approach privacy in different ways and perspectives. Some classify information type by sensitivity [1, 26], others focus on privacy as awareness and control of information [14], and still others approach it from a state-based perspective where there are different privacy states (e.g. anonymity, intimacy) [28]. Despite these various approaches, there is still a widely recognized privacy paradox [25] where many measures of privacy do not necessarily predict behavior [27]. More recently, norm-based approaches have been used to explain privacy violations, a prominent one being Nissenbaum’s framework of Contextual Integrity (CI) [21]. This conceptual framework is based on two principles: 1) individuals interact within a “plurality of realms” (or contexts), and 2) each context has its own norms. Therefore, privacy is a negotiation, reliant on norms and assumptions, between two or more individuals [21]. The CI framework also provides researchers with a systematic approach, by means of heuristics, for designing technologies that take into consideration privacy. Three of the key dimensions of CI include: 1) *contexts* (e.g., social contexts), 2) *contextual informational norms* (privacy norms), and 3) *contextual ends, purposes, and values* (what embodies the context) [22]. Over the years, many researchers within the Computer Science (CS) field have drawn from Nissenbaum’s framework of CI and applied it to several different privacy related challenges; yet, a recent review of this literature [4] found that CS researchers often do not engage with the normative aspects of CI. This review focused on CS disciplines other than the Human-Computer Interaction (HCI) subfield of CS. Given that HCI is known for its engagement with social theories, human contexts, and norms [6], we are interested in understanding how contextual integrity has been applied within HCI, as well as uncovering areas for further exploration. Therefore, we posed the following questions:

RQ1: *Within which technology contexts do HCI researchers apply CI?*

RQ2: *How deeply do HCI researchers engage with CI?*

RQ3: *What types of studies do HCI researchers conduct when applying CI?*

We provide a preliminary synthesis of the 16 peer-reviewed HCI research articles published in top-tier HCI venues in the last 10 years that directly referenced Nissenbaum’s framework of Contextual Integrity. From our analysis, we found that HCI researchers have used CI when studying the Internet of Things (IoT), social media, and mobile smartphones. We also found that most of these studies did not deeply engage with CI beyond invoking it in the background or discussion sections of the paper to either motivate or explain their findings. Few studies used CI to inform the design of their study, system, or even their codebooks, when CI was presented as a theoretical lens for qualitative work. Finally, most of the HCI studies that used CI were conducted as formative evaluations to explore users’ perceptions and needs, as opposed to summative evaluations, where CI was instantiated and evaluated by users as part of an actual system. We conclude that, while most CS literature tends to engage with CI theoretically in terms of systems theory, HCI researchers have an untapped opportunity to translate CI into the design of real-world applications and evaluate these systems to determine if they meet users’ needs and normative expectations of privacy. To close these gaps, we recommend HCI researchers engage more critically with the framework of CI to inform their research design, design new sociotechnical systems, and evaluate whether CI can be used as an actionable framework for translating users’ privacy norms into usable systems.

2 BACKGROUND

There have been some reviews of privacy research in HCI and other social computing-related fields [9, 32], but the only one focused on CI was by Benthall et al. [4] who recently surveyed 20 computer science papers that used the framework of CI. They found several gaps within the literature, such as: 1) the application of CI is dependent on the architecture of the system of interest, 2) the concept of “context” is interpreted in numerous different ways within the literature, 3) CS researchers draw from their own disciplines instead of engaging with the standard form of CI. In addition, the researchers provided areas for expanding the CI literature in CS, for example moving beyond the interaction between users and an app provider to other third parties, as well as measuring social norms rather than user’s expectations. While this research provides insights for the field of CS and included occasional references to HCI literature, the studies that were cited mainly came from more technical subfields of CS. Privacy in itself is a social construct that cannot fully be address by technical solutions. Therefore, we focus our research specifically on understanding how CI is used within the HCI community where research addresses the social phenomenon.

3 METHODS

To begin to collect a representative sample of high-quality HCI articles, we performed a search using the following criteria: 1) published within the last 10 years (2008-2017), 2) must be peer-reviewed, and 3) published in the top HCI journal or conference venues based on Google Scholar [8] and Microsoft Academic Research rankings [18]. By gathering the union of these rankings, we identified a total of 32 top HCI venues (listed in **Table 1** in the Appendix). For our initial search, we performed a keyword search for the case-insensitive phrase “contextual integrity” in each of these 32 venues. A total of 24 papers were found. Eight of these articles were removed because they did not meet our search criteria, and one article was removed as a duplicate. Table 1 provides a summary of the final hits for each venue. We note that the HCI conferences and journals (e.g., *CSCW*, *CHI*, *Communications of the ACM*, *UbiComp*) that used CI tended to be more of the sociotechnical or social computing venues than the novel interaction modalities and systems-focused HCI venues (e.g., *Multimodal Interfaces*, *Intelligent User Interfaces*, *Computer Graphics*, and *Applications*).

For our preliminary analysis, the first author read through each article and coded for the following dimensions: 1) **technology context**: the type of technology being studied, 2) **CI engagement**: to what extent CI was used in the research, 3) **type of HCI research conducted**: whether the study was a formative or summative evaluation and the type of scholarly contribution made by the research (e.g., design implications, framework, new technology).

4 SYNTHESIZING THE LITERATURE

Based on our preliminary analysis, we uncovered three emergent themes based on the dimensions of our codebook. We provide further details on these findings in the following sections.

4.1 Technology Context in which CI is Used

We found that the articles centered around three main technology contexts: IoT, social media, and mobile devices. Half of the articles (7/15) focused on different types of IoT devices, such as sensor-based technologies, ubiquitous systems, and human-agent collectives. For example, Luger [13] focused on studying the concept of consent within ubiquitous computing systems. This researcher was interested in understanding if new forms of consent are necessary or if existing principles within systems design can be applied to ubiquitous computing systems. Another study by Jennings et al. [10] introduced a new class of socio-technical systems, that is Human-Agent Collectives, where the human and technology take turns in leading interactions. These systems can have unpredictable behaviors and flexible autonomy. Therefore, the authors suggest that these technologies should provide users with more awareness and control over their data to others.

Five articles focused on social media platforms, such as Facebook. Wang et al. [33] studied Facebook default privacy settings; Ayalon and Toch [2] studied impact of time on Facebook post sharing; and Shi et al. [29] examined interpersonal privacy concerns through a Facebook case study. These studies integrate contextual integrity by examining users' privacy perceptions, expectations, and norms as well as their willingness to share information.

Three remaining articles focused on mobile devices, such as smartphones. In Shilton's [30] article, participatory sensing is recommended as a tool for addressing privacy challenges within data collection on mobile phones. Similarly, Shklovski et al. [31] conducted two studies to understand users' reactions when exposed to potential privacy breaches. Moorthy and Vu [19] studied smartphone voice activated personal assistants (VAPA) to "inform design decisions of how to make the privacy use of the VAPA in public spaces more acceptable" to the user. Overall, these articles focused on studying design solutions for privacy concerns related to data leakage, surveillance, and bystander privacy invasions.

4.2 Level of Engagement with Contextual Integrity

More than half of the articles from our analysis (9/15) referenced Nissenbaum's Framework of Contextual Integrity primarily within their background literature. Of these articles, seven provided some explanation to the framework [2, 10, 13, 17, 19, 31, 35], but the other two were just in-text citations [12, 30] to help define the concept of privacy. For instance, Landwehr [12] explains that when information stays within a context such as health information with an individual's caregiver, privacy is preserved. Those that did provide an explanation of CI, however, did not seem to fully integrate the framework of CI throughout their research design or within results. For example, in Shklovski et al.'s [31] research about privacy and personal space within mobile app use, they explain the framework of CI to help the reader understand when there has been a "violation of contextual integrity," which can trigger a person to be "creeped out." Similarly, Moorthy and Vu [19], provide a short definition to Nissenbaum's framework of CI to introduce the concept of contextual integrity and provide an explanation for individuals' sharing preferences: "Nissenbaum's (2004) framework of contextual integrity argues that 'there are no such thing [sic] as universal privacy norms but that these are distinct to each situation, and assist in maintaining contextual integrity'..." Both of these studies [19, 31] use these definitions of CI as a way to situate their research problems, but the framework of CI is not further applied within other aspects of their research design or experiment, such as informing their study research hypotheses or construct measures.

Four papers explicitly used CI to inform their study's design and data analysis. For example, Wang et al. [33] used CI to inform the experimental design of their user study by using the CI dimensions of *context* and *attributes* when designing four variations of a privacy notice for

Facebook apps. Two papers also used CI for informing their qualitative codebooks. For example, to examine children's understanding of privacy, Kumar et al. [11] coded "contextual integrity components such as *context*, *attributes*, *actors*, and *transmission principles*." Bowser et al. [5] also created a codebook related to privacy norms based on CI to identify themes within their interview and focus group data.

Finally, only two articles used CI as a guiding framework for their entire research study [3, 7]. For example, Chen and Xu [7] draw upon CI to identify appropriate actors, information access, and information transmission principles and understand potential privacy management challenges created by group dynamics within clinical work practices. However, they use data from three different qualitative studies "originally designed and carried out for studying the use of EMR systems."

The overall common theme within the articles was that the framework of CI was used to motivate the research problem and not necessarily to design the research experiment or an actual system.

4.3 The Types of HCI Research that Apply Contextual Integrity

While about half (8/15) of the articles performed some kind of user study, seven were formative evaluations, where the researchers asked users about their perceptions through surveys and interviews. Even though CI was mentioned in various survey studies, we did not find any articles that operationalized measures to assess the multi-dimensional aspects of CI. Therefore, the framework primarily informed the design of new technologies rather than building and evaluating new systems. For example, Bowser et al. [5] provides suggestions for designing flexible data flows to build trust between individuals that may be sharing sensible data. Similarly, Shklovski [31] suggests that technologies should behave in manners that respect a user's privacy (e.g., telling the user directly that the app can "extend beyond [the user's] personal space and of allowing outside influences in"). Only one article [33] that implemented summative evaluation by having users test a prototype for a new privacy dialog for Facebook apps.

The other seven HCI research articles that did not include user studies often focused on providing design implications and avenues for future research. In general, these seemed to be theoretical or opinion papers [34]. For example, Wolf et al. [35] provide practical implications, such as implementing "Tool Clinics," a framework for being self-reflective when considering technological solutions; however, this is still to be implemented in the design stage of a technology. Other types of contributions were future avenues of research. Both Jennings [10] and Landwehr [12] provided questions and challenges for researchers to address in the future.

5 DISCUSSION AND CONCLUSION

In this paper, we summarize an initial dataset of HCI publications that use the framework of CI. Overall, we found several gaps within the literature. First, when many of the studies applied the framework of CI, they gave brief descriptions and did not fully engage with the framework. Future studies could benefit from operationalizing the framework of CI as a robust multi-dimensional construct. This could provide a mechanism for scholars to evaluate systems in terms of its contextual integrity. Additionally, many of the studies provide useful insights into the design of future technologies, however, there was no evaluation of new technology solutions. To address this gap, we recommend that future research focus on providing more summative evaluations of systems that instantiate CI in a meaningful way.

We would like to note that this is very preliminary work that has a number of limitations. First, we reviewed only a small sample of sixteen peer-reviewed articles in top HCI venues. We plan to expand our search to ensure a more representative sample of the HCI field. We have already conducted an additional forward-reference search to identify articles that cited Nissenbaum's foundational works [15, 16, 20, 21, 23, 24], which yielded an additional 79 articles. Our goal is to synthesize this larger data set to gain deeper insights as to the application of CI within HCI.

A APPENDIX

Table 1: Article Counts by HCI Venue

Conference/Journal	Total Hits
ACM Conference on Computer-Supported Cooperative Work & Social Computing (CSCW)	4
ACM Conference on Human Factors in Computing Systems (CHI)	3
Communications of The ACM Journal	3
ACM Conference on Pervasive and Ubiquitous Computing (UbiComp)	1
Human-Computer Interaction	1
Interacting with Computers Journal	1
International Journal of Human-Computer Interaction	1
Behaviour & Information Technology Journal	1
International Journal of Human-Computer Studies	1
ACM Symposium on User Interface Software and Technology (UIST), IEEE Transactions on Affective Computing Journal, ACM/IEEE International Conference on Human Robot Interaction (HRI), ACM Transactions on Computer-Human Interaction (TOCHI), ACM Conference on Designing Interactive Systems (DIS), ACM International Conference on Multimodal Interfaces (ICMI), International Conference on Human-Computer Interaction with Mobile Devices and Services (Mobile HCI), arXiv Human-Computer Interaction (cs.HC), ACM International Conference on Intelligent User Interfaces (IUI), IEEE International Symposium on Mixed and Augmented Reality (ISMAR), ACM Transactions on Interactive Intelligent Systems (TiiS), IEEE Transactions on Human-Machine Systems Journal, IEEE Transactions on Haptics Journal, ACM Eye Tracking Research & Application (ETRA), IEEE Pervasive Computing Journal, International Journal of Human-computer Studies ∨ International Journal of Man-machine Studies, ACM Interactions Magazine, IEEE Computer Magazine, IEEE Computer Graphics and Applications (CG&A), International Conference on Human-Computer Interaction (INTERACT), ACM International Conference on Tangible, Embedded and Embodied Interactions (TEI), International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS)	0
Grand Total	16

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