

Conceptualising Digital Materiality and its Socio-Technical Implications through the Phenomenon of Crowdsourcing

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Abstract: *Digital materiality is a relatively new concept in the information systems literature that attempts to give “substance” to, or explain the material properties of, digital artefacts. These artefacts, such as software programs, are challenging our traditional assumptions of what is “materiality”. Crowdsourcing or the aggregation of publicly-reported data for a variety of purposes – from tracking instances of violence within a geographic area, to coordinating information for aid agencies working in humanitarian emergency situations – is an example technology that transcends the line of a purely physical or digital object. This paper will briefly touch on the definition of digital materiality within IS thought, followed by a discussion of how crowdsourcing fits into its conceptualisation, namely in terms of its characteristics and organisational consequences. The purpose is to instantiate the more theoretical notion of digital materiality through a tangible technology with far-reaching socio-technical implications.*

Keywords: Digital materiality; crowdsourcing; ICTD; Innovation; Socio-technicality

1. Introduction

Digital materiality is a relatively new concept in the information systems (IS) literature that attempts to give “substance” to, or explain the material properties of, digital artefacts. These artefacts, such as software programs, are challenging our traditional assumptions of what is “materiality”. Crowdsourcing or the aggregation of publicly-reported data for a variety of purposes – from tracking instances of violence within a geographic area, to coordinating information for aid agencies working in humanitarian emergency situations – is an example technology that transcends the line of a purely physical or digital object. This paper will briefly touch on the definition of digital materiality within IS thought, followed by a discussion of how crowdsourcing fits into its conceptualisation, namely in terms of its characteristics and organisational consequences. The purpose is to instantiate the more theoretical notion of digital materiality through a tangible technology (e.g., the crowdsourcing application, PowerLife) with far-reaching socio-technical implications. Academic articles relating to digital materiality and crowdsourcing from the European Journal of Information Systems, Information Systems Research, MIS Quarterly, the Academy of Management Annals, and more¹ were reviewed to form the theoretical basis of this paper, while first-hand design decisions made in the case study application were explained in light of these theoretical concepts.

2. Literature review

2.1 Digital Materiality

Digital artefacts such as software programs, operating systems, and other “intangible” information technologies are neither physical goods – in the sense that they can be physically touched or interacted with – nor incorporeal abstractions, which have long been perceived as the two fundamentally different ontologies of things (Latour 2005, Orlikowski & Scott 2008, Suchman 2007). They, therefore, require a new lens through which to view their unique properties – that of digital materiality. Leonardi (2010) defines “material” partially as the “instantiation of theoretical ideas”, which

¹ First Monday, IEEE Intelligent Systems, Industrial Management & Data Systems, International Journal of Health Geographics, International Review of the Red Cross, Journal of Internet Law, SAIS Review, and State Crime (via JSTOR and Summon)

he illustrates through examples such as women's suffrage policies externalising the concept that sexes are equal.

Kallinikos et al. (2013) define digital material as having the following characteristics:

1. Editability
2. Interactivity
3. Openness and reprogrammability (to other digital objects)
4. Distributedness
5. Modularity
6. Granularity

Digital artefacts' interoperability by way of their modular and multi-layered architecture – in which services and content are independent from devices and underlying networks, respectively – is an important condition of the digital ecosystem (Yoo et al. 2010). Combined with the granularity of these artefacts, it, additionally, makes them “generative” i.e., allowing users to realise affordances that, perhaps, the designers did or could not envision (Kallinikos et al. 2013). The reproducibility and recombining of these generative objects, paired with the non-rival nature of the ecosystem, paves the way for limitless innovation (Kallinikos et al. 2013). Kallinikos et al. (2013) argue that digital artefacts are inherently “intentionally incomplete”, which is both a problem and an opportunity; an opportunity in the sense that it does not confine the possible links to other artefacts and array of resultant services, and a problem insofar as it threatens control and stability in its ultimate direction and use.

Kallinikos et al. (2013) point to the potential disruption for traditional archiving of material due to digital artefacts' constant state of flux and, thereby, difficulty of preservation over time, specifically in terms of “provenance” and “authority”. As the authors note, “provenance refers to the documentation of the origins and history of an archived item, authenticity denotes the preservation of the original object rather than the truth or accuracy of its content” (Kallinikos et al. 2013). For example, modern web pages are dynamic in the sense that they display current, sometimes momentary, information drawn from a multitude of sources at each individual page load. Each potentially different rendering is not stored. At best, there exists software that takes snapshots of screens at random intervals - capturing rudimentary HTML, such as text, layout, and styling (Kallinikos et al. 2013). This can be useful for different reasons, namely legal e.g., courtroom evidence (Howell 2006). However, this “frozen” content cannot capture the full range of user-experience, search functionality (if applicable), or interactive components historically. Therefore, archiving, if done at all, can represent only a “partial replication” of the original site (Kallinikos et al. 2013). In essence, individually-rendered internet experiences become lost in cyberspace with neither formal nor exact archives of their existence.

Theories relating to the socio-technical construction of technology have long been used in information systems to assess technological implementations in different organisational contexts (Luna-Reyes et al. 2005, Lee et al. 2008). In this vein, Orlikowski & Scott (2008) call attention to digital materiality's relation to the field of organisational theory and challenge the belief that organisations, actors, work, and technology should be viewed individually, arguing instead for the “inherent inseparability between the technical and the social.” The authors posit that expanding our understanding of the emergent “sociomaterial configurations” that characterise modern organisational routines will lead to the useful conclusion for managers and scholars that digital material and its after-effects are formed and enacted through interaction, and not of one (e.g., the actor or the artefact) influencing the other (Leonardi 2010, Orlikowski & Scott 2008).

In the following section, I will outline some basic crowdsourcing literature to define the phenomenon and frame the subsequent analysis of its relation to digital materiality.

2.2 Crowdsourcing

Most simply, crowdsourcing is the collection and organisation of data or resources from dispersed, individual contributors. Williams (2013) defines it as a tool for “an... entity that outsources. tasks, which that entity could not achieve alone, to large groups of self-selected people (lay and expert).” Although contemporary notions of crowdsourcing seem to be possible only with the advent of the internet and advanced mobile and digital technologies, there are countless instances of early, pre-digital crowdsourcing, from the original Oxford English Dictionary – built upon the efforts of 800 volunteers beginning in 1859 – to The Golden Bough (1890) – a novel documenting global violence

compiled by questionnaires sent to and returned by officers, doctors, and missionaries across four continents (Williams 2013, Gupta & Sharma 2013).

Boulos et al. (2011) argue that, as social creatures, people have always used the sharing of information to help one another in situations of need. Crowdsourcing is an extension of this innate human tendency and enables it on a more widespread level with the ability to aggregate larger sets of data over longer intervals of time. Digital crowdsourcing allows for data to be shared more rapidly, more completely, and with higher quality (Boulos et al. 2011). Boulos et al. (2011) define higher quality in terms of *sensitivity* – or local people knowing their own communities most intimately and perceiving details about them that outsiders might not – and *specificity* – or the ability for locals to verify or dismiss information quickly. According to the authors, these technologies need to be *horizontal* (allowing cross-sharing to and by citizens); *semi-structured* (not restricting users to tightly-coupled interfaces or inputs); *real-time* (creating a “dialogue” among users); *open* (encouraging contributions by all relevant users and creating a “community” sentiment infused with a meritocracy system that factors “credentials, reputation and trust” into the experience); *geo-aware* (proximity to reported events is necessary for interpretation and contextualisation of data); and *accessible* i.e., with the simplest technology possible (Boulos et al. 2011). Despite the power and uniqueness of digital crowdsourcing, however, there are significant challenges, including potential for information overload and noise (large-scale data-management issues); report verification; information integrity concerns by users (whether warranted or not); misinformation; safety issues; and reporting bias (Boulos et al. 2011, Gao et al. 2001).

In terms of using this power for humanitarian crises, which has become a popular affordance of digital crowdsourcing, there are additional, if nuanced, challenges that present themselves when these technologies are enacted. As Meier & Munro (2010) point out, the exponential increase in the use of mobile phones and open source mapping technologies results in a unique convergence of platforms that can be useful in pinpointing crises, supplies or people needed, and supplies or people available to help during humanitarian emergencies. However, they also warn that non-local humanitarian staff can crowd out well-intentioned efforts of ordinary, local citizens who certainly have better local knowledge in terms of both geography and populations affected. In addition, the issue of information overload is heightened in humanitarian contexts, as local organisations are often working above full capacity during emergency situations. The additional “noise” they receive from crowdsourcing applications could very well be more of a burden than an asset (Meier 2011, Meier & Munro 2010, Pettit et al. 2011).

I will next illustrate how crowdsourcing typifies some fundamental characteristics of digital material using the example application, PowerLife, as well as briefly discuss the social, technical, and organisational consequences of digital materiality, in general, and crowdsourcing, in particular.

3. Analysis

PowerLife is a crowdsourcing application idea designed by five postgraduate students within the Information Systems and Innovation Group at the London School of Economics. It is designed to be a collaborative, mobile and web-based application for citizens to come together and report energy-related issues in their communities on a crowdsourced map. It seeks to bring attention to energy issues such as power outages, gas leaks, gas shortages, and so on by collecting first-hand information and engaging citizens to be proactive in this data collection and subsequent lobbying of relevant authorities to take action. It can, additionally, be used to assist NGOs in their existing work campaigning for the resolution of these issues. The platform is meant to empower citizens by giving them a collective voice as well as a space to promote favourable, energy-saving behaviours through a special “Go Green” functionality. Civil infrastructure – of which energy is just one component – should be a basic right for citizens of all countries, and PowerLife intends to help fill the gaps that the public, private, and third sectors can leave behind. The application also aims to be used as a reporting tool for greater advocacy, legal, or research reasons by providing historical data on geographic distributions of outages and trends in times when power is most vulnerable. It will be mainly focused on regions where these issues are commonplace and disrupt daily life. It differs from other similar applications, such as FixMyStreet and Iris Venezia, in several senses, namely its adaptability to different cities and issues; welcomed [but non-contractual] participation from government, third, and private sectors; encouragement of energy-saving habits and actions; event mobilisation; privacy preferences, and more.

The notion of digital materiality has several notable parallels with crowdsourcing. First, the digitisation of crowdsourcing has helped give a name to the phenomenon. Although we have seen examples of it for centuries prior, the term “crowdsourcing” itself, coined by Jeff Howe and Mark Robinson, had not existed before 2006 (Gupta & Sharma 2013). Second, crowdsourcing can be described as a quintessential example of digital materiality (as defined by Kallinikos et al. 2013). Using PowerLife to demonstrate this link, we can see that it is:

(1) Editable - PowerLife, as a crowdsourced mapping application, is constantly updating content i.e., data reported by and displayed to users. Even when no new information is submitted, issues that are associated with time, as in power outages which track how *long* an outage has existed, are accumulating time and, thereby, importance (represented by “urgency” within the application) with each passing second that the issue remains unresolved.

(2) Interactive - The application allows users to not only report issues but, in an interactive manner – defined by Kallinikos et al. (2013) as the “offering [of] alternative pathways along which human agents can activate functions embedded in the object” – to filter displayed issues or events (by type, location, or status) by way of the application’s loose coupling and modular architecture. Interactivity is not the “editability” of a digital object in that it modifies the artefact itself, but instead allows users to experience some sense of freedom in exploiting its affordances.

(3) Open - Based off the open source Ushahidi platform, PowerLife is open and interoperable by nature. Users can leverage the data made available by the application within their specific personal or organisational contexts. PowerLife provides developer-friendly APIs so that external systems can easily invoke its functionalities or raw data (e.g. information about locations with the highest number of reported issues or those reported over a certain time-frame in a certain location, etc.).

(4) Distributed - As a mobile and internet application, PowerLife cannot be compared to “single media” objects like books bounded by definite, physical borders (Kallinikos et al. 2013). Its borders are, instead, transient and distributed across multiple infrastructures (e.g., Ushahidi, the Internet, telecommunication networks, hardware) and an unlimited number of devices, which exponentially expands the affordances that can be achieved through use.

(5) Modular and (6) Granular - Modularity concerns the organisation of loosely-coupled, “distinct and relatively self-sufficient blocks” within an artefact that can be assembled in different ways with other “blocks” through standard interfaces to result in a variety of functions (Kallinikos et al. 2013). The potential for modularity, though possible with physical objects, is expanded in digital technologies. Granularity is conceptualised as the opposite of analogue (or physical) objects which are, generally, not able to be broken down into rudimentary parts (Kallinikos et al. 2013). Because of the digital nature of technological objects, they can, theoretically, be broken as far down as their binary, numerical core. This feature enables what Kallinikos et al. (2013) call “minute and piecemeal interventions” such as can be seen through PowerLife’s digital content editing on a variety of levels – from the macro, or decentralised mechanism to new cities and issue types by proactive users – to the micro, or ability for all users to create, update, or suggest new content. Although still an open design decision, the expansion of the application to new cities and issue types could very likely be made possible in an organic fashion, decentralising the administrative and technical support aspects of the roll-out to a self-organising community, like Wikipedia’s model, by utilising crowdsourced work and monitoring or cross-checking for quality. By delegating this control, users would be able to choose how and where to expand the application and which issue types beyond energy to include, such as water (e.g. sewage blockages, water shortages, water pollution, water waste, drinking water supply), roads (e.g., potholes, traffic lights, street lights, sidewalks/footpaths, road blocks), and beyond. As Williams (2013) notes, the central attribute of crowdsourced information is its generativity, in that it should inherently expand participation. The combination of modularity and granularity contributes to an overarching generativity or “generative matrix” of the other characteristics which results in not only new affordances, but “continuously shifting relationships” that can also have potentially problematic consequences in terms of control and management of digital material (Kallinikos et al. 2013).

Another parallel of digital materiality and crowdsourcing is archiving. As mentioned earlier, archiving is a persistent issue for digital material. The characteristics just touched upon (i.e., editability, interactivity, openness, etc.) can lead to constant fluctuations in an artefact’s content, if not its underlying technical structure. In crowdsourcing applications used within humanitarian contexts, like for the collection of evidence of possible injustice or violence by state and non-state actors (e.g., Ushahidi’s monitoring of 2008 post-election violence in Kenya), archiving becomes important, especially from a legal standpoint. As the application data updates frequently, it is the responsibility of

the system designers to facilitate users' ability to look back at specific points in time for particular, momentary data. Because of the characteristic of granularity, crowdsourcing applications can provide this level of detail if, and only if, designers have the forethought to build systems with this consideration in mind. PowerLife provides this affordance through its statistics and reporting tool, which allows users to view data historically for a designated geographical radius, issue type, and resolution status.

Within the humanitarian application lens – as it can feasibly be used in energy-crisis situations – PowerLife shares the problems of other similar technologies, including information overload and added noise for local organisations that are already operating at full capacity to address power outages and related issues. In this respect, PowerLife does not currently offer an easy solution, if one can exist at all.

Crowdsourcing also fits well within Orlikowski & Scott's (2008) notion of sociomateriality, which describes how digital material and its organisational implications are formed concurrently through interaction and not through a *post hoc ergo propter hoc*, "consequential" relationship. Crowdsourcing is not only a representation of publicly-sourced data, it *is* the data itself. In other words, there would be no data, no forum for people to aggregate their individual experiences, if it were not for the provided platform. The interplay between the application, users' local knowledge, and generated information to be used by others for their individual purposes are "inherently inseparable", both from social and technical standpoints (Orlikowski & Scott's 2008). For example, PowerLife would not exist without the local, aggregated knowledge and perceived value of the information. Comparably, aggregated data would not exist without the application's technical affordances and perceived public value (social affordances), nor would there be much of a public demand without the application demonstrating the possibility or tangibility of community-aggregated data and its potential use cases. Viewing crowdsourcing in light of its sociomaterial construction can help to expand our understanding of sociomateriality and how information and people are organised.

4. Conclusion

The purpose of the correlation with crowdsourcing, specifically within the context of the PowerLife application, is to make tangible some of the socio-technical implications of digital materiality, a notion that is just starting to enter our conceptual frameworks due to recent technological advancements. As Williams (2013) notes, we must first critically analyse and understand what technology can do better than people, crowds better than individual experts, several technologies better than one, and vice versa; in other words, digital forms are not always the best means to a desired end. These solutions should, instead, account for the "synergy" between technology and humans and what can be achieved more effectively by their *interaction* (Williams 2013). Crowdsourcing is just one of these possible solutions and one abstraction of the theory of digital materiality. Highlighting this link can help to concretise this novel idea and some of its widespread ramifications.

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