Defining Smart Community in the Context of Healthcare Efficiency in the UK: Mapping the Evolution of a Concept

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Defining Smart Community in the Context of Healthcare Efficiency in the UK:
Mapping the Evolution of a Concept

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ABSTRACT

This literature review article creates a new definition for the concept of smart community and applies the concept to the issue of improving healthcare efficiency in the UK. The definition emerges by mapping the evolution of the smart community concept from the mid-1990s up to 2020. The emergent concept is then applied to healthcare efficiency through discussion about related concepts including smart cities, coproduction, social capital, social computing, and cyber physical systems. The review takes a qualitative approach to exploring literature about concepts, an approach that recognises and engages with the complex interconnectedness of terminology in the digital sphere. Smart community was selected because it originated in response to financial crisis. The relevance to theory is creating a context-specific definition of smart community. By defining smart community in the context of healthcare, insights have emerged that could be useful to practice as well as theory.

KEYWORDS

Artificial Intelligence, Coproduction, Cyber Physical, Digital, Efficiency, Health, Healthcare, Internet of Things, Smart City, Smart Community, Social Capital, Social Computing, Symbiotic Computing

INTRODUCTION

Over recent years, there has been a lot of interest in the potential impact of ideas contained within digital concepts including smart community. A utopian discourse has emerged that outline digital technology solutions to a host of twenty first century economic and social challenges (Tapscott and Williams 2008; Broy, Cengarle and Geisberger, 2012; Mesko 2013). Tapscott and Williams claim that mass collaboration changes how we do everything. Broy et al focus their optimism on cyber physical systems stating that they could be as revolutionary as the internet. Mesko's utopian stance is specifically about healthcare, he describes a future where patients will soon be able to measure any health parameter at home, something he argues will disrupt healthcare.

This literature review article engages with one corner of this wider discourse, the potential contribution of the smart community concept to improving healthcare efficiency. The paper has two aims. The first is to create a current definition for the concept of smart community in the context of healthcare efficiency. The second is to apply this definition to discourse about improving healthcare efficiency.

By efficiency I mean costs in relation to the quality of service provision. This definition is informed by healthcare research (Palmer and Torgerson, 1999). Palmer and Torgersen state that efficiency is concerned with the relation between resource inputs and outputs, with outputs including both quality of life and life expectancy. The criteria is similar to the notion of QALY (quality, adjusted, life year)

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often used in health economics research. In terms of healthcare, I am looking at the wider system that includes prevention and mental health as well as treatment in hospitals. Specific technologies considered in this paper are artificial intelligence, monitoring devices and internet forums. The core focus of this article is however not on technologies but how changes related to smart community might be able to improve efficiency by changing the relationship between patients, other community members and healthcare professionals. In later sections I will explain how smart community ideas may change these relationships and what impact these changes might have.

Contribution to Theory

The academic contribution of this article is to map the evolution of the concept of smart community and by doing so to create a contemporary definition for it in the context of healthcare efficiency. This is needed due the paucity of academic smart community literature applied to healthcare efficiency, there is no clear current definition of the smart community concept in this context. By creating a new definition based on the evolution of the smart community concept I have made a contribution to theory.

My assertion that there is a paucity of smart community literature is supported by research (Xia & Ma, 2011; Granier &Kudo 2016; Michelucci & De Marco 2016; Grotherr et al 2020). Xia and Ma make this point directly when they state that further research is needed into the lifecycle of a smart community. Grotherr et al connect this to practice when they argue that knowledge of how to build smart communities is scarce.

One of the complications of mapping the evolution of smart communities is that it is a concept that is intertwined with similar terms that all have inconsistent definitions. Smart city for example is a term often associated with smart community. Like the concept of smart community, smart city is nebulous and has undefined theory (Harrison & Donnelly, 2011; Chourabi et al, 2012; Goodspeed, 2014; Tok et al, 2014; Albino et al 2015).

Goodspeed (2014, p89) argues that:

scholarly literature on smart cities contains a confusing jumble of theory and a lack of historical perspective.

Because of the interconnectedness of concepts, this review goes beyond simply looking at literature that uses the term smart community. For clarity, most of the discussion about connected terminology is given in the related concepts section, due to the porous nature of digital terms however it was not possible to confine all references to them in that section. As smart cities is the most directly connected concept it is the one that emerges most frequently. Zhang et al (2019) state that studying smart communities will enrich our understanding of smart city projects, their assertion implies the two concepts cannot be studied entirely in isolation.

Contribution to Practice

The second aim of this paper is addressed by connecting the smart community concept to practice. The concept will be connected to practice, in the related concepts section, after a new definition has been outlined.

Practical value for this research stems from the emerging consensus that current models of healthcare are not sustainable (Horne, Khan, & Corrigan, 2013; Penny, 2014; Ham, 2014; NHS England, 2014; Popejoy 2016). If the current model is unsustainable then it stands to reason that there is value in considering if alternative approaches contain insights about what a more efficient future might look like.

The smart community concept was selected as it originally emerged in the early nineties in Silicon Valley in response to financial crisis (Lindskog, 2004). As smart community originated as a response to financial crisis then it may contain insights that could be applied to addressing the

financial crisis that UK healthcare systems are currently experiencing. The application of the smart community concept to improving healthcare efficiency is supported by literature that associates the concept with finding solutions to social problems including healthcare (Bencardino and Greco, 2014; Walletzký, et al, 2016).

METHODOLOGY

To define smart community I conducted a literature review. This was split into two sections. The first was a literature search, specifically on articles that refer to the concept of smart community. The next stage expanded the search into related concepts. This second stage was needed for two reasons. The first, there was a paucity of articles that specifically referred to the terms smart community and smart communities. The second is that due to the inconsistent use of digital concepts, to gain a richer understanding I needed to examine articles that discussed related digital concepts.

Initially I searched the first 100 entries that included the words smart community or smart communities in the following databases; Business Source Premier, Emerald, ProQuest Central, Scopus, Sheffield Hallam University Library Gateway, Google Scholar and Researchgate. This process was then repeated including the terms health and healthcare, this time up to 200 entries were included. However in most cases less than 200 entries emerged. For example in ProQuest a total of 144 search terms emerged.

Through this process I found 75 articles with references to smart community or smart communities. 49 of these include references to health or healthcare. Not all were however considered relevant. Articles that refer to smart community in a non-digital sense were rejected, as were articles that refer to very mechanistic definitions of smart community. For example the *"Cloud based management and control system for smart communities"* (Mital et al, 2015, p163) is excluded because it defines a smart community as:

a multi-hop network of smart homes that are interconnected through radio frequency.

Whilst this may be a valid definition within the context of looking at smart technology from an engineering perspective, it is not healthcare related and so was excluded.

After the refinement process had been completed, I ended up with 37 relevant smart community articles. Due to the low number, and the relevance of articles that use other terminology I then opened up my search process to include related concepts including smart cities, cyber physical systems and collective intelligence.

MAPPING THE EVOLUTION OF SMART COMMUNITY

The Early Years, Before 2002

Common themes in early smart community literature include: collaboration, significant change, collaborative learning and internet enabled governance arrangements.

- **Collaboration:** Collaboration was a central theme in many early smart community articles (Coe, Paquet, and Roy, 2001; Hughes and Spray, 2002; Wilson, 1997). In articles published before 2002, the focus was primarily on how people can collaborate more effectively through information technology. This included collaboration between the public, business and government officials (Wilson, 1997; Coe, Paquet, and Roy, 2001).
- **Significant Change:** Another idea that featured highly in early literature was the notion of significant not just incremental change (Eger 1997, Wilson 1997; Downes, 2000; Coe, Paquet,

and Roy, 2001). Downes proposes that smart community is about a fundamental change in the way that communities do business.

- **Learning:** Coe, Paquet, and Roy, (2001) refer to several concepts related to the generation of knowledge through information technology enabled connectivity. These include collective intelligence and networked intelligence. They claim that this is omnipresent in smart communities. They associate collaborative intelligence with the idea of creative interactions in real-time. At this time, their reference to these ideas was an outlier. Reference to networked learning becomes more common in more recent literature after social media become mainstream.
- **Governance:** The smart community concept is often associated with internet-enabled government. It is a collaborative form of governance that involves citizens, business and government officials acting together that is relevant to the operations of services including healthcare (Wilson 1997; Hughes and Spray 2001; Coe, Paquet, and Roy, 2001).

Evolving 2002 – 2010

During this time developments including social media and smartphones started to take hold and become part of online communication and collaboration (Goldsmith and Crawford, 2014).

- **Collaboration:** Collaboration remains a central feature in more recent literature (Milner, 2002; Albert and Fetzer, 2005; Komninos, 2006; Krebs and Holley, 2006).
- **Significant Change:** The idea of significant change also remains in articles during this period (Lindskog 2004; Eger, 2009). Eger argues that a truly smart community is one that has made a conscious effort to use information technology to transform life and work in "significant and fundamental," rather than incremental ways. Lindskog makes a similar point when she argues that technological enhancements should result in fundamental rather than incremental change.
- **Vision of the Future:** Vision is an idea that becomes central (Lindskog, 2004). Lindskog (2004, p3) defines a smart community as:

a community with a vision of the future that involves the application of information and communication technologies in a new and innovative way to make the most of the opportunities that new applications afford, such as better healthcare

Milner (2002) places vision at the centre of her book and argues that it may be necessary to outline a vision of the future to understand how to improve efficiency.

Recent 2011 – 2018

As indicated by the number of references given in this section there has been a minor explosion of academic smart community literature since 2011. It may have been in part due to advances in information technology, for example, developments such as social media which existed previously became mainstream during this time (Goldsmith and Crawford, 2014).

- **Collaboration:** Collaboration remains, but it starts to involve collaboration with, as well as through technology (Gaochao et al 2013; Hao et al, 2014; Nahrstedt et al., 2016; Kinkar, Hennessy, and Ray, 2016). Collaboration connects smart community to the concepts of social computing and cyber physical systems. For example, Kinkar, Hennessy, and Ray (2016, p1) define smart communities as

networks of physical, social, and cyber entities

and states that members can be:

humans, physical objects, the cyber world, and even the social media world.

Nahrstedt, p2 propose a similar definition suggesting that smart communities are:

a collection of interdependent human-cyber-physical systems

Li et al (2011) put forward a definition that emphasises the role of technology, defining smart community simply as a class of cyber physical systems. Xia and Ma (2011) give a wider perspective arguing that smart communities will evolve by bringing together social computing and cyber physical systems. The number of writers who make the link with cyber physical systems indicates that there is some, if not universal, consensus in recent literature about the inclusion of cyber devices as smart community members.

- **Citizen Engagement:** Links with citizens don't simply remain in more recent literature but become more prevalent (Townsend, 2013; Gurstein, 2014; Granier and Kudo, 2016).
- **Smart City:** Although emphasis on citizen engagement had been a differentiator between smart city and smart community, in recent literature, as more community and citizen centric conceptualisations of smart city emerge the two concepts become more closely aligned (Nam and Pardo, 2011; Gurstein, 201; Walletzký, et al., 2016). The convergence of these two concepts can be partially explained by some thinking about smart cities moving away from a focus on technology and other hardware and starting to include softer aspects such as management and administration (Michelucci, Michelucci, De Marco, and De Marco, 2017).
- **Social Innovation:** Within smart city and smart community literature, citizen engagement is often connected to social innovation (Townsend 2013; Bencardino and Greco, 2014; Goldsmith and Crawford 2014, Goodspeed 2014, Granier and Kudo 2016, Michelucci and De Marco 2017). Bencardino and Greco argue that smart communities are central to social innovation and to achieve social innovation a collection of smart people and smart governance is necessary. The idea of social innovation is relevant to this article, as social innovation is a process that might be able to help improve efficiency.
- **Governance**: Smart community and smart city literature frequently refer to different models of governance enabled by information technology (Bencardino and Greco, 2014; Walletzký, et al, 2016; Goldsmith and Crawford, 2014). Smart city governance is sometimes described as a technical managerial issue and whilst smart communities are often included, they are often related to the social side of governance (Gurstein, 2014).
- **Learning**: Another idea that is prevalent in recent smart community literature is the idea of learning enabled by online networks (Walletzký, et al., 2016; de Oca, Ambar Murillo Montes, Nistor, Dascalu, and Trausan-Matu, 2014; Goldsmith and Crawford, 2014). Walletzký, argues that smart communities can help address social and economic challenges because they can stimulate social learning, something they claim is a condition of efficiency. A related concept that frequently emerges is collective intelligence (Walletzký, et al., 2016; F. Michelucci and De Marco, 2016; Valetto et al., 2015; Vermesan and Friess, 2014). Network enabled learning is sometimes referred to as the collective intelligence of the city (Albino, Berardi, & Dangelico, 2015; Harrison et al., 2010; F. Michelucci and De Marco, 2016).
- **Social Capital:** Social capital frequently occurs in smart community literature (Bencardino and Greco, 2014; Caragliu, Del Bo, and Nijkamp, 2011; Granier and Kudo, 2016b; Gurstein,

2014; (Grotherr et al 2020). Whilst social capital emerged in older literature it was referred to more frequently in recent articles (Albert and Fetzer, 2005; Coe, Paquet, and Roy, 2001). The connection could be expected as social capital and smart communities both connect to networks, communities and relationships.

DEFINING SMART COMMUNITY

Bringing together ideas from recent literature with core ideas from earlier articles, as illustrated in figure 1, I define smart community as:

Human and non-human agents collaborating with the stated aim of significant change

I now clarify how the above discussion about the evolution of smart community concept resulted in this definition. As outlined in literature from all three time periods, collaboration, citizen engagement and change are themes that frequently occur in smart community literature. Ideas of collaboration and citizen engagement connect the concept of a smart community both to community development concepts such as coproduction and to more recent information technology ideas such as mass collaboration and Health 2.0.

Within literature that discusses and defines the term smart community, there are two extremes. At one end of the spectrum is literature that focuses on technology (Gunardi, Adriansyah, and Anindhito, 2015; Li et al., 2011a; Xia and Ma, 2011). At the other end are definitions that emphasise the collaboration of people through information technology (Downes 2000; Coe, Paquet, and Roy, 2001; Albert and Fetzer 2005;Granier and Kudo, 2016). In my definition, I have consciously brought together elements of both.

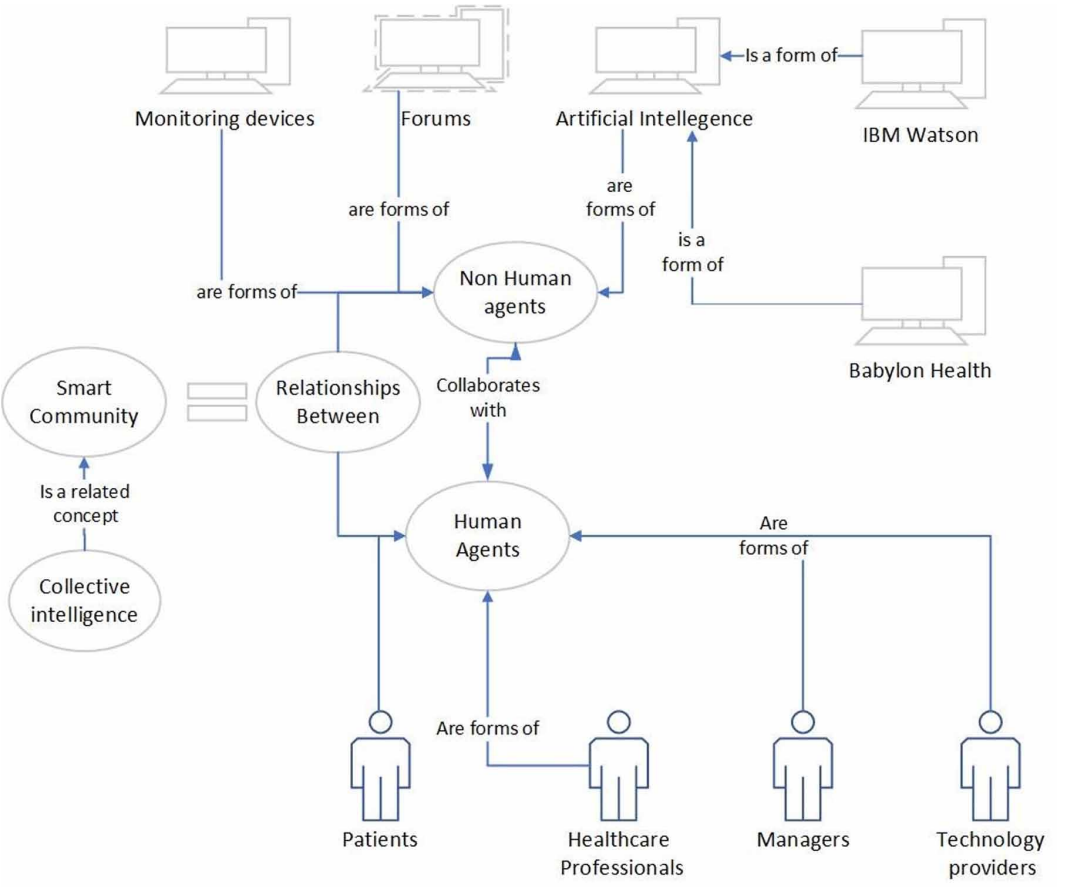
The inclusion of non-human agents into my definition incorporates social computing and cyber physical systems. These are reflected as recent smart community literature makes frequent references to such terms. Non-human agents are most obviously connected to the cyber physical concept, as the cyber element is not human. Connecting human and non-human agents is also supported by articles that identify smart communities as socio-technical (Grotherr et al 2020).

The smart community definition given by Kinkar, Hennessy, and Ray (2016), is helpful as they retain ideas of citizen and governmental involvement but connect these with ideas of data analytics given by Xia, Ma (2011). In other words, my definition includes people communicating with each other through information technology as well as the interactions of computational devices in internet enabled communications systems. From early literature, I have retained the idea of working towards significant change within the definition of smart community. The idea of significant change is also one that is retained in some recent literature (Grotherr et al 2020).

In figure 1 I illustrate what the emergent smart community definition might look like. Here we can see monitoring devices (including internet forums and artificial intelligence) as examples of non-human agents collaborating with human agents (including patients and healthcare professionals). The connecting of human and cyber worlds that we see here is reflective of recent definitions whilst retaining the notion of collaborating between people found in earlier definitions. In line with the dialogue above, Figure 1 is informed by the literature outlined in the "*mapping the evolution of smart community section"*. It however represents the emergent definition, not all of the ideas outlined in that section.

Recent definitions of smart community contain concepts including cyber physical systems, web 4.0 and social computing. It is possible that these were not part of initial smart community definitions because when the term smart community emerged in the early 1990's the internet as it was then didn't include the technical means for them. There are however many reasons why understanding concepts such as smart community might have real world value. One is that the application of information

Figure 1. An illustration of the new smart community definition



technology systems has a long history of failure, and so understanding the interconnectivity between the technology and the systems and structures that it will fit into may be of crucial importance if we want to avoid remaking the mistakes of the past (Greenhalgh et al 2010). Another issue potentially of greater concern is the risk that failing to understand technology at a conceptual level opens up the potential of dystopian consequences (Lupton, 2014; Rich and Miah 2014). Potential risks include reduced privacy and social control.

RELATED CONCEPTS

In this section, I expand the exploration of the smart community concept beyond just articles that specifically refer to the smart community concept. It does so in recognition that other concepts include ideas that help give a more complete understanding of what smart community means and how it could be applied to healthcare efficiency. Within this discussion I relate smart community ideas to practice and to the ideas of collaboration and significant change that I argue are at the core of the concept of smart community in this context. In figure 2 I illustrate how the core ideas in this section fit together with each other and how they connect to the concept of smart community.

Coproduction and Social Capital

As outlined earlier, social capital frequently occurs in smart community literature. Its existence is logical given the synergy between the two concepts. Both connect to networks, communities and relationships. This is not to suggest that they are in any way the same. I am simply suggesting that smart communities may include social capital within them as part of the fabric that holds together the relationships between the members of a community.

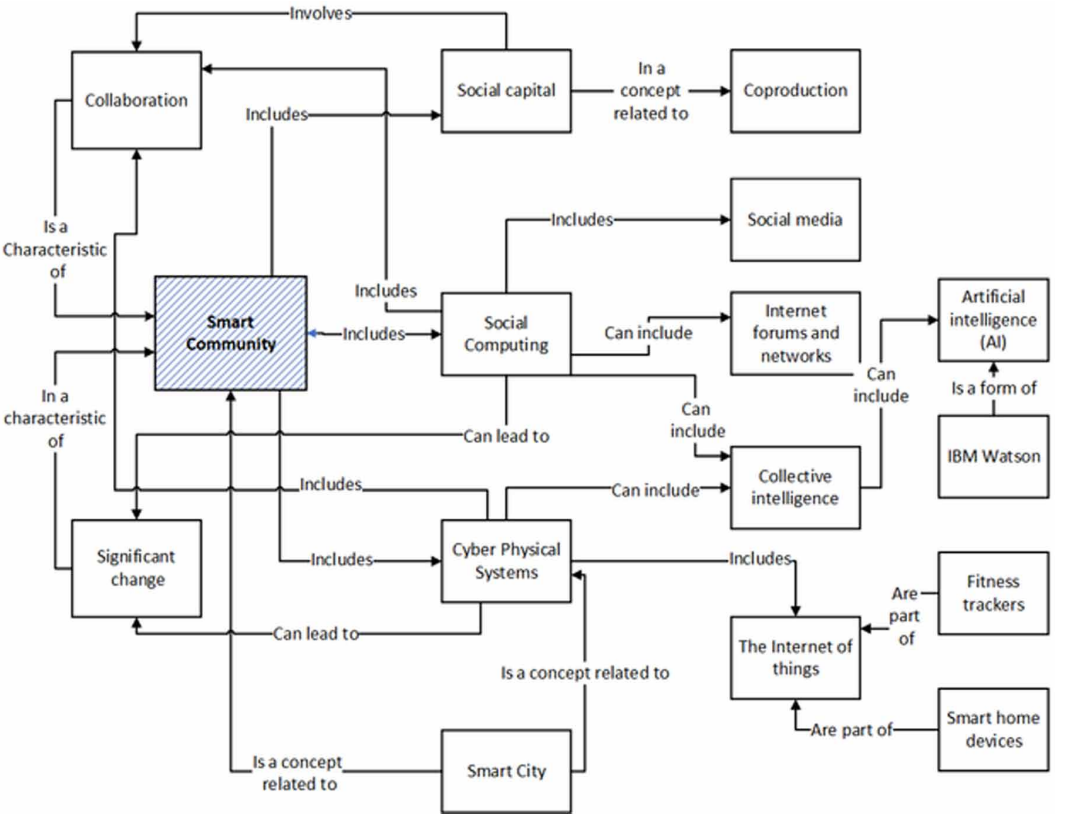
Collaboration

Social capital relates directly to efficiency improvement through collaboration as the ability of agents with smart communities to effectively work together may be dependent on the amount of social capital that members of a smart community can access. Bourdieu (1983, p249) defines social capital as:

the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition'

One way that smart community might be able to improve efficiency is through enabling a more equal balance of power between patients and health providers. Such a shift might improve efficiency as it would enable the social capital of patients to be actualised through greater involvement in healthcare decisions.

Figure 2. How smart community concepts fit together



Arguments about efficiency improvements through such a change is often found in coproduction literature. The logic for why coproduction and social capital stems from two ideas. The first is the notion that patient and other community members could be harnessed as a resource to deliver health activity in a voluntary capacity. Tritter and McCallam support the first of these positions arguing that people with chronic diseases have considerable knowledge and experience of their own illness, expertise that can be applied to enable them to play a bigger role in managing their condition. The second is a shift away from a system based on the treatment of disease towards one more focused on maintaining good health. In some articles these two ideas are connected (Nicol and Sang, 2011; Chang et al, 2016). It is frequently argued that coproduction might help improve efficiency in part because communities contain social capital (Bovaird 2007; Dunston et al, 2009; Realpe and Wallace 2010). Coproduction and user involvement are frequently linked to efficiency improvements (Tritter and McCallum, 2006; Bovaird, 2007; Needham, 2008).

Significant Change

Consistent with the definition of smart community stated earlier coproduction and other community development ideas are often associated with significant rather than incremental change. In advocating the potential for coproduction to improve efficiency, Bovaird (2007, p847) argues that:

By the 1980s the limitations of traditional provider centric models of the welfare state had become obvious.

Bovaird advocates coproduction as an alternative that would be significantly more efficient. Bovaird's idea represents a shift from a top down management position to a more collective position where the recipients of services share power and responsibility. In terms of efficiency however a more extreme idea is that of radical efficiency (Gillinson, Horne, and Baeck, 2010). Gillinson, Horne, and Baeck propose that more equal power relations in the delivery of public services could result in significant cost savings. They claim that evidence from case studies indicate cost savings of 20-60% as well as better outcomes. They are far from alone in suggesting that community engagement could result in cost savings or efficiency improvements. Dunston (2009, p40) states that:

The application of coproduction principles may be crucial for the achievement of necessary service improvement and system sustainability.

Researchers frequently state that coproduction is based on the sharing of information (Cahn, 2000; Bettencourt et al, 2002; Needham and Carr 2009). Needham and Carr argue that coproduction is built on the assumption that service users (such as patients) and producers (such as healthcare professionals) both contribute different and essential knowledge. Cahn builds on this idea describing the relationship between health professionals and health consumers as a learning partnership.

Bovaird and Loeffler (2010) make a more direct link between coproduction and smart community within their discussion of the role of emerging technologies to enable the coproduction of public services. They directly refer to the term smart community and state that web enabled platforms make it easier for actors to introduce others into the conversation and that collective coproduction has become more practical through this technology. They describe collective coproduction as groups of people engaged in public services. Consistent with earlier comments about coproduction the idea of collective coproduction is a management shift from top down to more collective decision making and as such is consistent with my earlier assertion that smart community could improve efficiency through enabling patients to be more involved in healthcare decision making.

I suggest that where coproduction is digitally enabled and focussed on public service delivery, it is very closely related to the idea of smart community. As such, I argue, that digitally enabled

collective coproduction is a mechanism for the application of smart community. My position is influenced by Bovaird and Loeffler who suggest that social network theory and complexity theory are drivers of collective coproduction. Bovaird and Loeffler argue that complexity theory and social network theory are connected by a non-linear relationship between systems and outcomes. Bovaird and Loeffler are not the only coproduction writers to refer to how information technology might be able to enable community development; Realpe and Wallace (2010, p7) state that:

mass media such as the internet have challenged the assumption that providers have sole control of information.

Access to information is significant as for patients to improve decision making as part of a smart community, they would require access to reliable information if their involvement was likely to result in better decisions.

Risks and Issues

It is important to note however that not all of the narrative about coproduction is positive. Critics suggest that it places too much emphasis on the individual, and that it risks blaming individuals and communities for the challenges that they face rather than looking at the wider system that may have created them (Friedli, 2013). Social capital is another concept that faces criticism. Some argue that it can reinforce the prestige and power of affluent social groups to the detriment of others in society. Another issue is that social capital can reinforce negative values and behaviours. High levels of social capital can for example make it more difficult for people to make positive lifestyle changes if the communities that they feel a strong connection to have normalised unhealthy behaviours such as poor diet, lack of exercise or smoking (Fukuyama, 2001; Wakefield and Poland, 2005).

SOCIAL COMPUTING

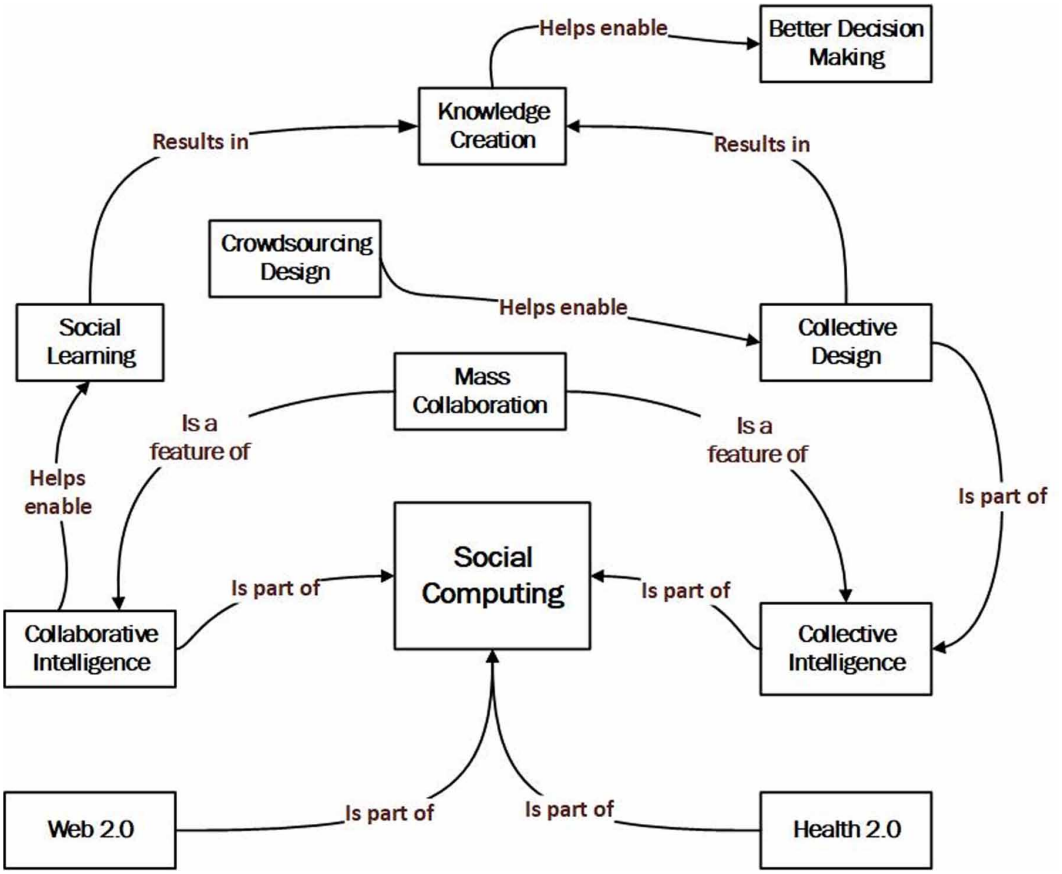
Collaboration

Social computing is all about collaboration with and through the internet. It is the virtual interconnections of people (Xia and Ma 2011). As illustrated by figure 3 and outlined below, this process of interconnectivity relates to several other concepts including collective intelligence, social media, web 2.0 and health 2.0.

In figure 3 I illustrate how social computing connects to some of its related concepts and due to these connections how it could improve efficiency in the healthcare system through better decision making. It is based on the articles referred to in this section of this paper. Here I am suggesting that health 2.0 and collective intelligence are part of social computing and that social computing is part of smart communities. Mass collaboration, collective intelligence and collaborative intelligence are all forms of digital collaboration that reflect the smart community definition I outlined earlier.

By encompassing social computing, smart community may improve healthcare efficiency by opening up the possibility for new patterns of interaction as virtual interactions are less confined by time and space than face-to-face ones. Communication technologies such as forums and social media enable people to interact with others in different geographies with flexibility about when messages are sent and received. Both patients and healthcare professionals can now engage with each other through internet forums. Communication through forums have led to the emergence of a health specific area of social computing with new terms including health 2.0 and medicine 2.0. Although some literature suggests subtle differences between them, both are collaborative approaches to engaging patients and healthcare professionals through information technology (Eysenbach, 2008; Hughes, Joshi, and Wareham, 2008).

Figure 3. Concepts relating to social computing



Significant Change

Social computing relates to the definition of smart community I outlined, as the process of social computing can include interactions between human and non-human agents. It is connected to three sub-concepts that are particularly relevant and significant to this study. These are: Health 2.0, collective intelligence and web 4.0. Web 4.0 is sometimes referred to as the symbiotic web is the space in which it is argued that human minds and machines can interact in symbiosis (Aghaei et al, 2012; Naphade et al., 2011; Roche and Rajabifard, 2012; Choudhury, 2014). The involvement of the symbiotic web opens up the potential to significant change as the concept of web 4.0 is close to the ideas of collective and collaborative intelligence. These move beyond merely sharing ideas with other people towards creating knowledge with other people. As such knowledge creation is between human (patients and healthcare professionals) and non-human agents (computers) it would be an application of smart community.

Creating knowledge has been connected to social learning, which in turn is related to creating conditions for efficiency (Krebs and Holley, 2006; Hughes, Joshi, and Wareham, 2008b;Tapscott and Williams, 2008; Eger, 2009; Wicks et al., 2010; Hall, Caton, and Weinhardt, 2013; Vermesan and Friess, 2014). The Covid19 pandemic sparked the application of a plethora of collective intelligence knowledge creation including gamification to assist with drug creation and crowdsourcing of maps to signpost where masks were available to buy (Peach and Berditchevskaia 2020).

Some argue that collective intelligence can improve evidence based medicine by drawing on a larger knowledge base (Tapscott, Williams, and Herman, 2008). Online networks enrich and contextualise health information and reduce misinformation (Boulos and Wheeler, 2007; Hughes et al, 2008; Aghaei, Nematbakhsh and Farsani, 2012). Similarly, collective intelligence might be the solution to concerns about health information quality. As thousands of bloggers exchange ideas daily they are effectively acting as filters for information-overloaded web surfers (Boulos and Wheeler, 2007).

Risks and Issues

Mass participation is central to the ideas of social computing and collective intelligence. It is however one that is subject to criticism. In reality only a small proportion of users may actually be active producers (Van Dijck and Nieborg, 2009). There is also a risk that within mass participation individuals are discouraged from expressing views that differ from those that appear to be the norm. Le Bon (1897) poetically describes conformity as the individual being hypnotised by the crowd. Le Bon argued that being part of a crowd gives people the confidence to act, when doing so along with others. His idea is relevant as people may hold outdated views if others appear to hold the same view, conversely, they may be more likely to accept utopian views about the potential of new technology if many others appear to share them. Either way it implies a tendency for people to uncritically align with the majority. In the context of exploring how smart community ideas might be able to improve the efficiency of the healthcare systems the influence of other people is problematic for two reasons. The first is that people in the current system may resist change if others around them are sceptical. The second is that people may apply new technologies unquestioningly if others around them are enthusiastic about the techno utopias they appear to offer.

Collective intelligence is not the only aspect of social computing to face challenge, critical digital health authors highlight risks including: loss of privacy, social control and commercialisation (Roszak, 1986; Postman, 1992; Rich and Miah 2014; Lupton 2014). A theme that flows through these criticisms are ethical dilemmas about the extent to which we are prepared to sacrifice freedom or privacy for the sake of potential efficiency improvements.

CYBER PHYSICAL SYSTEMS

Collaboration

The concept of cyber physical systems is all about collaboration between human and non-human actors. A cyber physical system contains two layers, the real physical layer where devices and people are situated and the digital layer where information is stored, communicated and analysed (Gurgen, Gunalp, Benazzouz, and Gallissot, 2013). It is an *"intimate coupling between the cyber and physical"* (Rajkumar, Lee, Sha, and Stankovic, 2010, p731). Cyber Physical Systems are automated systems that connect physical reality with computing and communication infrastructures (Jazdi, 2014).

Cyber physical systems are an example of how smart community could be applied, as human and non-human actors interact with each other through both the physical (such as face to face interactions between patients and doctors) and the information layers (where information about a patient's wellbeing may exist e.g. data from fitness tracking devices).

By connecting with the information layer the 'real-time' data that is captured by internet of things (IOT) devices can be analysed and harnessed to inform decision-making. The term 'real-time' is often used as a characteristic of smart and cyber physical cities, to help describe how cyber digital infrastructures can inform decision making almost instantly.

The idea of cyber physical systems connects web 4.0 and collective intelligence to the IOT. Internet forums can now include information uploaded by devices as well as information uploaded by people. An example is a lifestyle forum where participants can see the number of steps recorded by the devices of other participants.

A smart community could be enabled by connecting a cognitive computing systems such as IBM Watson (a non-human agent) with people in the system (patients and healthcare professionals). By bringing these agents together we can imagine a complex form of human computer interaction with multiple computing devices symbiotically thinking with people to create knowledge. Sheth & Henson (2013) propose a similar idea in their conceptualisation of cyber physical social computing. They describe a form of collective intelligence that is characterized by a form of advanced reasoning that bridges machine and human perceptions. IBM Watson is a form of artificial intelligence that has been trialled by Sloan Kettering Cancer Centre with the aim of helping oncologists make better informed treatment decisions (Schmidt, 2015). It is however currently limited as most of the data Watson has at its disposal is from clinical trials. We can imagine that if such analytics capability was also able to access data from IOT devices in the form of both smart home devices and fitness trackers then its decision making capability might be vastly increased. The potential impact of healthcare analytics linked to IOT monitoring is a theme that frequently emerges is digital health literature (Barnaghi 2012; Broy 2012; Sheth and Henson 2013).

The fusion of the computer and physical world conjures up futuristic imagery that forms the foundations of utopian visions. Utopian visions might contain within them the seeds of what is possible and how efficiency might be improved. In healthcare such visions proclaim the idea of ubiquitous healthcare where body area sensors monitor psychological as well as physical symptoms. These may then become integrated as part of the smart home monitoring system where billions of interconnected objects interact with each other (Tiwari 2016).

Risks and Issues

Like the related area of social computing, in the healthcare realm cyber physical systems are awash with risk and challenges. These range from the practical to the philosophical. Practical issues include balancing the need to protect patient data confidentiality, whilst sharing enough to enable effective data analysis (Wang et al 2018). Another issue is that sometimes the reality of what technology is capable does not always live up to the hype. Several articles have for examples indicated that IBM Watson is yet to deliver the revolutionary breakthrough in healthcare decision making that were initially speculated (Ross and Swetlitz 2017; Strickland 2019). At the more philosophical end is the question of how much privacy we are prepared to sacrifice in order to improve decision making and by doing so to improve efficiency. The dystopian ideas of: loss of privacy and social control are often highlighted as a counter narrative to techno utopian smartness. We can for example imagine a future where the use of an IOT fitness tracking device has become a condition of health insurance, healthcare provision or even employment (Roszak, 1986; Postman, 1992 ; Rich and Miah 2014; Lupton 2014).

CONCLUSION

I have made a contribution to theory by creating a creating a new smart community definition and applying it to discussion about related concepts and the issue of healthcare efficiency. Through doing so I have added to understanding about how actions related to the concept could be applied to practice.

The inclusion of human as well as non-human actors to the emergent definition makes it conceptually different from some techno utopian visions of what future digital health might look like. Its collaborative nature makes it close to the concept of collective intelligence. However, in the new definition of smart community, agents can be engaged far beyond simply creating knowledge. I have argued that the community aspect of the term is related to community development concepts including social capital and coproduction. In this space, communities can include active citizens able to: provide support, help design and deliver services.

In one sense, I believe that techno-utopian writers are correct, digital change is almost inevitably going to impact the future of healthcare. Through this change, as I indicated within discussion in the related concepts section of this paper, smart community ideas certainly have the potential to improve

efficiency. What is less certain however is what the future looks like. I have argued that developments can have negative as well as positive consequences. To avoid risks such as social control, I suggest we need to develop conceptual understanding of our relationship with existing and emerging technologies. This literature review is intended to be simply a starting point into exploring such a relationship.

There might be value in further work in this area, including empirical research. It would for example be possible to create a theory based on the smart community definition that has emerged from this study. Creating a smart community theory could be a future research project and testing the emergent theory another. There might also be value in scoping out in more detail emerging technologies that could be applied to smart community ideas. The Covid19 pandemic opens many more related research areas as digital health ideas become reality, emerging research need includes evaluating the positive and negative impact of smart community ideas that have been implemented.

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