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Citation:

WOOLLISCROFT, Tim and POLOVINA, Simon (2017). Improving healthcare through human city interaction. In: HAMMOUDI, Slimane, SMIALEK, Michal, CAMP, Olivier and FILIPE, Joaquin, (eds.) Proceedings of the 19th International Conference on Enterprise Information Systems, April 26-29, 2017, in Porto, Portugal. Scitepress, 172-177. [Book Section]

Improving Healthcare through Human City Interaction

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Keywords: Agents, Cyber-physical Systems, Healthcare, Human City Interaction, Human Computer Interaction, Internet of Things, Smart Cities, Smart Communities, Structuration Theory.

Abstract: The study of information technology has given insufficient focus to a) the structural factors and b) the community perspective. As information systems become increasingly integrated with human systems these wider influences are more important than ever. Human city interaction concepts including their interplay with cyber-physical systems and social computing are appropriated to healthcare. Through Structuration Theory, insights are given into how healthcare through the human city interaction lens can most effectively be improved.

1 INTRODUCTION

This paper explores how the concept of human computer interaction and its notions of social computing and cyber-physical systems can improve the efficiency of healthcare. Human city interaction moves the conceptual basis of human computer interaction from the micro, individual user scale towards a macro, city wide scale. As such it can also impact healthcare practices given they are inherently community-based.

As NHS digitisation continues to meet resistance, we argue that greater focus needs to be given to the social aspects involved. Indeed, two-thirds of potential health information systems have not yet materialised (House of Commons, 2013; Waterson, 2014). We postulate that a greater focus on the structural factors might have had a different result.

The paper is laid out as follows: Structuration Theory is used to appropriate human city interaction concepts to healthcare. Based on this approach, the human social challenges are highlighted and the research gap addressed including the system design issues. The paper concludes with the insights that human city interaction can bring to improving healthcare.

2 STRUCTURATION

Structuration Theory is a theory of agency and structure to help understand how people behave (Giddens, 1984). Agency and structure is the extent to which people are free independent agents or are agents whose behaviour is socially determined. Structuration Theory emphasises the role of everyday social practice in consistently recreating social structure (Jones and Karsten, 2008). Structuration Theory is often argued as relevant to dealing with 'wicked' unstructured problems in the public sector (van Veenstra et al., 2014).

Structuration Theory has frequently been applied to information systems research to help understand the relationship between information systems and the people using them including the surrounding social context and social processes (Jones and Karsten, 2008; Checkland and Holwell, 1997). The need for this approach is evident from the seismic impact that information technology is already having on human computer interaction by extending it beyond individual users interacting with individual computers towards interaction between many people and many computers across the internet.

3 HUMAN CITY INTERACTION

The idea of human city interaction emerges from smart cities literature, connecting it to cyber-physical systems and the internet of things (Naphade et al., 2011; Jin et al., 2014). Human city interaction is distinct from the idea of the smart city, in that the smart city describes the urban environment whereas

Woolliscroft, T. and Polovina, S.
Improving Healthcare through Human City Interaction.
DOI: 10.5220/0006368401720177
In *Proceedings of the 19th International Conference on Enterprise Information Systems (ICEIS 2017) - Volume 3*, pages 172-177
ISBN: 978-989-758-249-3

we define the concept of human city interaction as the complex web of human computer interaction in the smart city environment. Smartness is proportional to the increased awareness that these digital technologies bring in as they extract this information from the physical environment (Gurgen et al., 2013). Human city interaction emphasises the complex web of human computer interaction in the smart city environment. Over the next few subsections we outline several key important concepts the building blocks of human city interaction and its relevance to healthcare.

3.1 Smart Communities

A smart community brings together the interplay of the cyber, physical, and social worlds; within this environment humans and physical things will interact with each other through ubiquitous networks (Xia and Ma, 2011). The combination of a focus on human interactions and a connection with cyber-physical systems connects the concept of human city interaction with the concept of smart community (Li et al., 2011; Xia and Ma, 2011). These communities are also connected with social computing and finding solutions to societal problems including healthcare.

3.2 Social Computing

Social computing includes human social dynamics connected to ICT technologies, with theoretical underpinnings in both computational and social sciences (Wang et al., 2007). Although the idea is usually associated with social media the origin of the term can be traced back to the 1940's to a paper by Vannevar Bush that predicted many changes that have now become reality, such as computer-supported collaboration (Wang et al., 2007). There are specific examples of some of the components of social computing including blogs, wikis, social bookmarking, peer-to-peer networks, open source communities, photo and video sharing communities, and online business networks (Parameswaran and Whinston, 2007). Social computing is shifting computing to the edge of the network where individuals with relatively low technical skills can apply their creativity and work collectively with others (Wang et al., 2007; Parameswaran and Whinston, 2007).

3.3 Web 2.0

Definitions of Web 2.0 are very similar to that of social computing. Both emphasise collaboration and the ability of users to interact with each other. Web 2.0 includes features that enable collaboration including well-known examples such as wikis and blogs (Aghaei et al., 2012). The collaborative nature of Web 2.0 has been emphasised by the phrase *prosumers*, which emphasises that users of 2.0 are both consumers of it and producers of it (Lupton, 2015). The key difference between Web 2.0 and social computing however is the emergence of terms including Web 3.0 and Web 4.0. As such, Web 2.0 is becoming associated with a point in time that we are moving beyond (Aghaei et al., 2012).

3.4 Medicine 2.0 and Health 2.0

The terms Medicine 2.0 and Health 2.0 have been coined to describe the application of Web 2.0 to the healthcare arena. Some however have gone further than this and suggest a movement towards a different more equal relationship between patients and healthcare professionals (Bos et al., 2008). Given the collaborative nature of the Web's evolution, information technology will change healthcare significantly; Web 2.0 technology in the form of Medicine 2.0 will impact on all areas of medical practice (Hughes et al., 2008). Similarly, Health 2.0 is shaping health care with Web 2.0 tools with the result being a whole new way of involving consumers in the health care system including the transition towards participatory healthcare (Belt et al., 2010; Bos et al., 2008). Collaboration, participation, openness and change are common themes in the Health 2.0 literature (Belt et al., 2010; Eysenbach, 2008). These ideas of collaboration and change are key components of effective human city interaction.

3.5 Collaborative Intelligence

Collaboration is a central theme in social computing, Web 2.0 and Medicine 2.0 literature. The term collaborative intelligence however builds on this and suggests a shift into a deeper form of collaboration that is often referred to as collective or collaborative intelligence. Collaborative intelligence has the potential to result in positive change, extending into a claim that mass collaboration changes everything (Tapscott and Williams, 2008).

3.6 Collective Intelligence

There is a subtle distinction between collective or collaborative intelligence. Collaborative intelligence is a system where each person or machine interacts autonomously as part of decision making network. Collective intelligence takes this idea a step further with a shift in power from the individual to the collective. Collective intelligence is not a new idea, but it has received a new meaning through the emergence of Web 2.0 applications (Leimeister, 2010). This new meaning depicts the ability for people digitally connected by the internet collectively to create knowledge. There have been instances of amateur knowledge surpassing professional knowledge, and Wikipedia is given as the most recognised example of this (Surowiecki, 2005; Boulos and Wheeler, 2007).

In relation to healthcare, collective intelligence can improve evidence based medicine by drawing on a larger knowledge base (Tapscott and Williams, 2008). Online networks enrich and contextualise health information and reduce misinformation (Aghaei et al., 2012; Boulos and Wheeler, 2007; Hughes et al., 2008). 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).

Mass participation is central to the ideas of social computing and collective intelligence. This assumption is however subject to criticism. In reality only a small proportion of users may actually be active producers (Dijck and Nieborg, 2009). Also, mass participation must ensure that the individual is not hypnotised by the crowd (Le Bon, 1897).

3.7 Web 4.0

The Web is evolving far beyond Web 2.0 to Web 4.0 (Aghaei et al., 2012; Patel, 2013; Choudhury, 2014). Web 4.0 is described as the symbiotic Web in which the human mind and machines can interact symbiotically, including Medicine 4.0 and its links to human city interaction (Choudhury, 2014; Naphade et al., 2011; Roche and Rajabifard, 2012).

4 HUMAN-SOCIAL CHALLENGE

Certain social system problems are ill formulated, have many different clients or agencies with conflicting values, and have been referred to as ‘wicked problems’ (Churchman, 1967; Rittel and Webber, 1973). Health services (in particular cancer services) are such a wicked problem (Ferlie, 2013). Human city interaction and its interplay with cyber-physical systems realises the collaborative user interactions that are similarly of benefit to healthcare (Xia and Ma, 2011; Cockerham, 2005). The wicked problems however present number of human social challenges that can be usefully considered by referring to the theory of structurisation that we met earlier.

4.1 Structuration and Wicked Problems

Structuration Theory connects directly to the idea of addressing wicked problems (van Veenstra et al., 2014). Structuation uses the term routinization to describe the idea of structure being continuously produced and reproduced through action. Through repeated actions a social order is established and certain patterns of behaviour and ways of engaging in tasks become institutionalised (Giddens, 1984). From routinization in healthcare we might conclude that there are necessary structural constraints upon both patients and professionals that might be preventing them from moving towards a perfectly collaborative position.

Medicine 2.0 introduced the idea of including patients and professionals working more closely together, but routinization may still be evident in the cyber-physical models of healthcare. It has been assumed that patients will simply behave as required for the efficiency gains from healthcare cyber-physical systems to be achieved (Broy et al., 2012). However, for the efficiency to be harnessed a wide variety of complex social factors need to be considered including psychological factors linked to human interactions and lifestyle habits that have developed over time. This assertion is supported elsewhere, as health lifestyles are not the uncoordinated behaviours of disconnected individuals, but are routines linked to interactions within groups (Cockerham, 2005).

After IT systems have been adopted, they need to be assimilated to change existing work practices. Until this has happened productivity may decline and if innovation is not successfully assimilated they could be worse off as previous successful routines will have been lost (Setia et al., 2011). Further support arises from social constraints, both in relation to cyber-physical systems and IT artefacts that are shaped by messy processes. Rather they are influenced by the social system they are embedded in. Furthermore cyber-physical systems are particularly uncontrollable due to feed- back loops and the behaviour of some parts of the system being difficult to predict (Beverungen, 2013).

Perhaps more significant than the issue of integrating patients into a new health system based on human city interaction are the cultural factors that impact on the behaviour of healthcare professionals. Resistance to change and conformity to routinization may emerge from the desire to hang onto power and status linked to current structures, reinforced by the perception that change is just part of the government’s agenda to cut services or it might be based on unconscious ideas about how things have always been done.

5 ADDRESSING THE GAP

Failure to consider wider structural factors in information technology, health and health economics research is far from superficial oversight. This goes right to the heart of the philosophical assumptions of most researchers in these fields. Health economics has remained insulated from theoretical debates that have taken place in other areas of the social sciences (Rickles et al., 2007; Lessard, 2007; Giddings, 2006). Helpfully though, Structuration Theory has been interrelated with other approaches, including a useful study where this theory meets actor-network theory (Greenhalgh and Stones, 2010).

Whatever the merits and demerits of the various approaches, in the realm of healthcare technology there is rarely sufficient consideration of social context. As we've previously stated, information technology has evolved far beyond a system of individual people interacting with individual computers; it is now increasingly a complex Web of many people interacting with a complex Web of digital devices through the internet. Structuration Theory and human city interaction at least provides a fulcrum for improving healthcare given its community-oriented approach. Human agent collectives are described as systems where people routinely collaborate with autonomous software (Jennings et al., 2014). That work highlights flexible social interactions between humans and the computers as they engage in synergistic human computer collaboration, neatly fitting with the idea of human city interaction. This area however has also been under-researched; although some research domains are beginning to explore aspects of this area, none are dealing with it in its totality (Jennings et al., 2014). Perhaps the time to emphasise the community context in human-computer interaction and the consequent effects on the associated technologies as we have described has arrived.

5.1 Design Issues

Human city interaction raises the challenge of influencing human behaviour and the use of design as a tool (Naphade et al., 2011). Given that human city interaction includes a complex Web of interactions between people as well as machines, system design in this area is not straightforward. Most current systems assume altruistic and benevolent behaviour from users and fail to consider behavioural issues such as the need to provide other pertinent aspects such as incentives in a collective context (Jennings et al., 2014). The ethical issue of accountability also emerges from the fact that the systems at times instruct us and at other times are instructed by us, thus heightening the potential tension between the human and computer agents in the collective (Jennings et al., 2014). Enterprise Architecture however might be a useful framework to help overcome some of these design challenges. It offers a perspective that holistically brings together the myriad human and technological agents needed to fulfil the collective purpose of the city, including its provision of healthcare (van der Weel, 2017).

In linking the ideas of design to Structuration Theory for healthcare efficiency the process of design needs to be applied akin to the complex web of city structures. As people are as much the fabric of a city as the technology, a change programme would involve the people in designing the information technology rather than changing peoples' behaviour to fit it. At the same time, at a higher layer of conceptualisation the people as well as the technology should be considered as components that need to be factored into the system design.

Our approach is represented in Figure 1. Essentially, this figure depicts the concepts and their direct and indirect relationships from human city interaction to improving healthcare.

6 CONCLUSION

The appropriation of human city interaction to healthcare could improve its efficiency. Ideally, it would address the present healthcare information systems failures as illustrated at the beginning of this paper (House of Commons, 2013; Waterson, 2014). It is not however that simple and difficulties can be expected along the way. Introducing the technology that could enable the improvements as we've described are as likely to reduce efficiency as to increase it especially at least in the short term. At least as much attention is needed in creating the human conditions as the technology.

Social theory including Structuration Theory as we have highlighted can highlight the social issues that need to be considered to achieve the necessary efficiency improvements. The ideas of routinization and structural influences contained within Structuration Theory we suggest contain insights that can make efficiency improvement more likely. In short, greater consideration of the structural factors that impact on how people interact with each other and with the com-

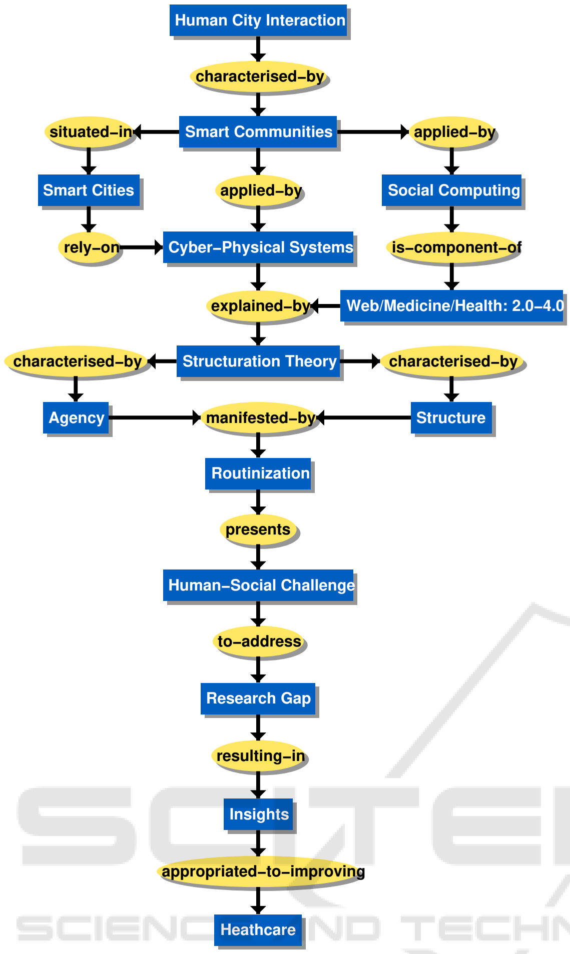

Figure 1: From Human City Interaction to Healthcare.

puting power that is increasingly interwoven into the fabric akin to that of a smart city.

We have only 'scratched the surface' so to speak of the complex social analysis that is required, and we are not suggesting that Structuration Theory is the only theory that can help understand this issue. Rather, this theory articulates the probable challenges and the ways to address them in the effective human-computer interactions for improving healthcare.

REFERENCES

Aghaei, S., Nematbakhsh, M. A., and Farsani, H. K. (2012). Evolution of the world wide web: From web 1.0 to web 4.0. *International Journal of Web & Semantic Technology*, 3(1):1. ID: 503.

Belt, T. H. V. D., Engelen, L. J., Berben, S. A., and Schoonhoven, L. (2010). Definition of health 2.0 and medicine 2.0: a systematic review. *Journal of medical Internet research*, 12(2):1–14. ID: 507.

Beverungen, D. (2013). On the design of IT artifacts and the emergence of business processes as organizational routines. ID: 529.

Bos, L., Marsh, A., Carroll, D., Gupta, S., and Rees, M. (2008). Patient 2.0 empowerment. In *SWWS*, pages 164–168. ID: 508.

Boulos, M. N. K. and Wheeler, S. (2007). The emerging web 2.0 social software: an enabling suite of sociable technologies in health and health care education1. *Health Information & Libraries Journal*, 24(1):2–23. ID: 511.

Broy, M., Cengarle, M. V., and Geisberger, E. (2012). Cyber-physical systems: imminent challenges. In *Monterey workshop*, pages 1–28. Springer. ID: 517.

Checkland, P. and Holwell, S. (1997). Information, systems and information systems: making sense of the field.

Choudhury, N. (2014). World wide web and its journey from web 1.0 to web 4.0. *International Journal of Computer Science and Information Technologies*, 5(6):8096–8100. ID: 520.

Churchman, C. W. (1967). *Guest editorial: Wicked problems*.

Cockerham, W. C. (2005). Health lifestyle theory and the convergence of agency and structure. *Journal of health and social behavior*, 46(1):51–67. ID: 530.

Dijck, J. V. and Nieborg, D. (2009). Wikinomics and its discontents: a critical analysis of web 2.0 business manifestos. *New media & society*, 11(5):855–874. ID: 515.

Eysenbach, G. (2008). Medicine 2.0: social networking, collaboration, participation, apomediation, and openness. *Journal of medical Internet research*, 10(3):e22. ID: 509.

Ferlie, E. (2013). *Making Wicked Problems Governable?: The Case of Managed Networks in Health Care*. Oxford University Press. ID: 185.

Giddens, A. (1984). *The constitution of society: Outline of the theory of structuration*. Univ of California Press. ID: 532.

Giddings, L. S. (2006). Mixed-methods research positivism dressed in drag? *Journal of research in nursing*, 11(3):195–203. ID: 388.

Greenhalgh, T. and Stones, R. (2010). Theorising big it programmes in healthcare: strong structuration theory meets actor-network theory. *Social science & medicine*, 70(9):1285–1294. ID: 534.

Gurgen, L., Gunalp, O., Benazzouz, Y., and Gallissot, M. (2013). Self-aware cyber-physical systems and applications in smart buildings and cities. In *Proceedings of the Conference on Design, Automation and Test in Europe*, pages 1149–1154. EDA Consortium. ID: 525.

House of Commons, T. (2013). The dismantled national programme for IT in the NHS. `https://www.publications.parliament.uk/pa/cm201314/cmselect/cmpubacc/294/294.pdf`.

Hughes, B., Joshi, I., and Wareham, J. (2008). Health 2.0 and medicine 2.0: tensions and controversies in the field. *Journal of medical Internet research*, 10(3):e23.

Jennings, N. R., Moreau, L., Nicholson, D., Ramchurn, S., Roberts, S., Rodden, T., and Rogers, A. (2014).

Human-agent collectives. *Communications of the ACM*, 57(12):80–88. ID: 535.

Jin, J., Gubbi, J., Marusic, S., and Palaniswami, M. (2014). An information framework for creating a smart city through internet of things. *IEEE Internet of Things Journal*, 1(2):112–121. ID: 524.

Jones, M. R. and Karsten, H. (2008). Giddens's structuration theory and information systems research. *Mis Quarterly*, 32(1):127–157. ID: 263.

Le Bon, G. (1897). *The crowd: A study of the popular mind*. Fischer.

Leimeister, J. M. (2010). Collective intelligence. *Business & Information Systems Engineering*, 2(4):245–248. ID: 510.

Lessard, C. (2007). Complexity and reflexivity: two important issues for economic evaluation in health care. *Social science & medicine*, 64(8):1754–1765. ID: 387.

Li, X., Lu, R., Liang, X., Shen, X., Chen, J., and Lin, X. (2011). Smart community: an internet of things application. *Communications Magazine, IEEE*, 49(11):68–75.

Lupton, D. (2015). Health promotion in the digital era: a critical commentary. *Health promotion international*, 30(1):174–183. ID: 505; LR: 20150214; CI: (c) The Author 2014; JID: 9008939; OTO: NOTNLM; ppublish.

Naphade, M., Banavar, G., Harrison, C., Paraszczak, J., and Morris, R. (2011). Smarter cities and their innovation challenges. *Computer*, 44(6):32–39. ID: 521.

Parameswaran, M. and Whinston, A. B. (2007). Social computing: An overview. *Communications of the Association for Information Systems*, 19(1):37. ID: 504.

Patel, K. (2013). Incremental journey for world wide web: introduced with web 1.0 to recent web 5.0-a survey paper. *International Journal*, 3(10). ID: 519.

Rickles, D., Hawe, P., and Shiell, A. (2007). A simple guide to chaos and complexity. *Journal of epidemiology and community health*, 61(11):933–937. ID: 189; LR: 20140904; JID: 7909766; RF: 68; OID: NLM: PMC2465602; ppublish.

Rittel, H. W. and Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4(2):155–169.

Roche, S. and Rajabifard, A. (2012). Sensing places' life to make city smarter. In *Proceedings of the ACM SIGKDD International Workshop on Urban Computing*, UrbComp '12, pages 41–46, New York, NY, USA. ACM.

Setia, P., Setia, M., Krishnan, R., and Sambamurthy, V. (2011). The effects of the assimilation and use of it applications on financial performance in healthcare organizations. *Journal of the Association for Information Systems*, 12(3):274. ID: 533.

Surowiecki, J. (2005). *The wisdom of crowds : why the many are smarter than the few*. Abacus, London. Includes bibliographical references.; ID: 44SHU_ALMA2127598670002501.

Tapscott, D. and Williams, A. D. (2008). *Wikinomics: How mass collaboration changes everything*. Penguin. ID: 513.

van der Weel, H. (2017). A city trip to enterprise architecture. www.linkedin.com/pulse/city-trip-enterprise-architecture-harald-van-der-weel. (Accessed on 01/26/2017).

van Veenstra, A. F., Melin, U., and Axelsson, K. (2014). Theoretical and practical implications from the use of structuration theory in public sector information systems research. In *The European Conference on Information Systems (ECIS) 2014, Tel Aviv, Israel, June 9-11, 2014*. ID: 531.

Wang, F.-Y., Carley, K. M., Zeng, D., and Mao, W. (2007). Social computing: From social informatics to social intelligence. *IEEE Intelligent Systems*, 22(2). ID: 502.

Waterson, P. (2014). Health information technology and sociotechnical systems: A progress report on recent developments within the uk national health service (nhs). *Applied Ergonomics*, 45(2):150–161.

Xia, F. and Ma, J. (2011). Building smart communities with cyber-physical systems. In *Proceedings of 1st international symposium on From digital footprints to social and community intelligence*, pages 1–6. ACM. ID: 522.