Why is it difficult to achieve e-health systems at scale?

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Introduction

Information and Communication Technologies (ICTs) have been seen as a solution to the challenges confronting health care, transforming services by integrating across organisational boundaries, delivering improvements in efficiency safety/quality of care (Ellingsen and Monteiro 2008). Current visions of e-health portray ICTs as a means to deal with the anticipated escalating costs of providing care to an ageing population experiencing extended periods of multiple morbidity as well as delivering new models of health care in which empower the patient (Chatterjee and Price 2009, Greenhalgh at al. 2012).

These expectations sit uncomfortably alongside widespread contemporary reports of failed or failing e-health procurements. Foremost amongst these is the untimely demise of the National Health Service (England) National Programme for Information Technology (NPfIT), This was a procurement on an enormous scale by what is reputed to be the largest organisation in the world after the Chinese People's Liberation Army – with expenditure exceeding £13 billion it constituted the largest civil procurement in history. From the outset the programme was widely criticised - for its inflexible and highly centralised approach, for the failure to involve local staff (Randell 2011; Robertson et al 2011). Indeed such a wide range of concerns had been expressed about the approach adopted that the eventual failure was considered unsurprising (Anderson et al. 2010, Campion-Awwad et al. 2014, Flinders 2011, Maughan 2010).

Multiple reasons can and have been advanced to explain these frequently encountered difficulties in implementing e-health systems. The accompanying paper by Harvey emphasises the strength of these visions of technology-driven transformation, and the industrial and political interests that drive these visions and their accompanying expectations. It would seem that the odds are stacked against success.

But it is important not to over-generalise from particular contexts and episodes of technological change. In a period in which novel, complex and initially unproven technologies are being put in place, reports of difficulties encountered may be expected to gain salience. At a later stage these will ultimately become part of taken-for-granted electronic infrastructures upon which effective health care provision depends – though this dependence may by then be largely invisible (except on breakdown [Star and Ruhleder 1996]). Moreover progress has been uneven. The extent of system adoption and use differs within and between health services in ways that may not always be appreciated by researchers or practitioners in their particular locales (Adler and Williams 1991). For example integrated electronic prescription in primary care was widely adopted in the UK some decades ago with almost no fanfare whilst in the USA its successful introduction was considered remarkable - a potentially

difficult thing to achieve (Tamblyn et al. 2006). Thus Rodon and Silva (forthcoming 2015) describe the failure of a Spanish electronic prescribing system for primary care in Spain and the subsequent success of a system in Catalonia).

This paper explores these issues from within a particular tradition in Science and Technology Studies that, in interaction with Information Systems and Organisation Studies has addressed the development and consequences of technologies at work. We examine current issues surrounding the design, procurement and implementation of e-health systems and in particular infrastructures. It highlights tensions which are salient in the current period between technology developers and users with their different knowledges, experience and concerns.

Analytical frameworks for understanding these developments

Macro-, meso-, or micro level explanation

At what level should we seek to understand these developments? Here we argue that, whilst we may seek to explain failure in terms of particular combinations of local factors, these form part of broader patterns. As a result, "an individual project may be a misleading scope of analysis" (Hyysalo and Lehenkari 2002: 101).

National/structural type explanations.

This is not to discount what we could characterise as *National/structural type explanations.* The well-rehearsed difficulties encountered in UK and elsewhere in the public procurement of large-scale ICT systems (POST 2003) seem remarkably persistent (HC 123 2013). Outsourcing these developments has not eliminated risk in the ways confidently predicted by laissez-faire proponents. There seems to be a generic problem – described by economists as 'incomplete contracting' issues – in designing and enforcing contracts to supply complex systems in a context in which technologies are changing and user needs are not fully-stabilised but evolve in the course of (often protracted) implementation processes as the users gain familiarity with the new system and its potential uses/affordances. The need to fix requirements at the outset for competitive tendering and to maintain "arm's length" contractual relationships between provider and users is in tension with the need for joint learning between them (Pollock and Williams 2009, Lee et al. accepted paper).

These kinds of issues apply in the area of e-health systems – as exemplified by the NPfIT experience. Health systems procurement problems have been accentuated by periodic changes in government policy for health service administration which often cut across the extended timeframes for procuring, implementing and further developing health infrastructures.

Meso level explanations of sociotechnical dynamics

A growing body of work draws our attention to the important role played by dynamics at the *meso*-level – of interaction between diverse organisational players.[i] We find particularly instructive the study by Hyysalo and Lehenkari

(2002) of the Finnish ProWellness Diabetes Management System (PDMS). They discovered what they describe as 'a graveyard of withdrawn diabetes databases"'(ibid.:97) whereby only four of 21 previous attempts in Finland to introduce such Diabetes Management Systems had prevailed, and none of these had extended beyond the hospital district in which they were initially developed.

> *These results indicate that the problems in PDMS not only stemmed from relations inside the particular project, or that they only reflect general societal laws governing the interaction between certain positions held in capitalist society. There seems to a similar ending to every story. No matter whether the systems had been created solely by the IT people, only by the users, or in collaborative participation. We find results of this kind indicative of long term dynamics at play within the sociotechnical processes involved in designing diabetes databases.* (Hyysalo and Lehenkari 2002:100)

Methodologies for addressing these developments

These considerations also raise questions about what methodologies are needed to capture long-term processes of change. Here we have argued the need for long-term biographies of artefacts instead of the short-term 'snap shot' studies of technology development or implementation that have tended to prevail (Pollock & Williams 2010). A longer-term perspective is particularly important in relation to emerging information infrastructures (a term that draws attention to the spread and increasing salience of these long-lived 'systems of interconnected systems') (Hanseth et al. 1996, Monteiro et al 2013).

The initial establishment of new information infrastructures and their extension into domains that had little prior direct experience of information technology poses particular challenges. There is evidence to suggest that reimplementation and upgrading systems may be less risky and painful.

Particularities of health care in relation to informatisation

What may be the particularities of health care that affect these developments?

Child (1984) was one of the first writers to draw attention to some distinctive features of health professional expert work from the point of view of technical change – in a period in which technology induced rationalisation was widely presumed. He noted that the high risks of failure and the ability to draw upon influential professional ideology of medicine served to resist the formalisation and rationalisation of health professional work. As a result Health professionals exhibit a very unusual form of expert knowledge work.

Health-care professionals must bridge between generic medical knowledges and the specific circumstances presented by the patient and their particular disease/care trajectories which vary significantly from case to case. The continued (and accelerating?) development of medical knowledge is reflected in the increasing elaboration and differentiation of medical specialities and roles

and of health practices. As a result, enormous importance continues to be attached to the exercise of clinical judgement. Health professional expertise remains a rather open-ended knowledge system characterised by a high level of local autonomy and discretion. One consequence is that marked differences in practice prevail between trusts, hospitals and even individual health practitioners that seem to confound repeated attempts to standardise care pathways and treatment regimes.

These features of health professional work underpin what is perhaps the central dilemma surrounding attempts to informatise health work: How to manage the tensions between the diversity of health practices and pressures for standardisation? These have particular implications for attempts to develop increasingly integrated e-health information systems

Health Information infrastructures

A body of work has investigated the particular challenges of developing large scale electronic information infrastructures. The multiplicity of current and potential future users and the increasing array of purposes supported present challenges to planful implementation (Ciborra 2000) particularly in relation to the tension between standardisation and differentiation (Hanseth et al 1996).

However studies of those involved in building, maintaining and further developing information infrastructures have documented the often rather sophisticated strategies they have evolved for managing the trade-offs between short term local exigencies and longer-term system extension. A recent Special Issue of the Journal of the Association for Information Systems, on 'Innovation in Information Infrastructures', (Monteiro, at al 2014) explored new strategies emerging – particularly in relation to health care.

These issues about the development of electronic information infrastructures are particularly pertinent to current ICT developments in the health sector. ICT is conceived as a solution – as the technological correlate - to the various contemporary challenges in the health sector. This includes for example the idea of integration of health care services – delivering improvements in quality and efficiency of care delivery; overcoming key boundaries between primary and secondary care and with social and welfare services.

Large investments in developing and implementing ICT are currently being made – particularly in face of growing demand for health services arising with an ageing population and the growing challenges of managing chronic disease. Across many societies we note the shared expectation (or do we mean desperate hope) that ICTs will somehow delivery cheaper (as well as safer/better) care, allowing escalating demand for services to be met within finite budgets.

The meso dynamics of Innovation in health ICTs

The prospects for e-health (and more general health technology) innovation would appear to be enormous. One the one hand there is enormous demand for improvements, coupled with a huge reservoir of potential innovations – arising

in part from enthusiasts within the health service as well as technical specialists and firms anxious to cater for this expanding market.
However the exploitation of these opportunities is subject to marked pressures: To expand the depth of the information infrastructures in terms of expanding the range of information carried and activities supported taking place in tandem with expanding the breadth of institutional settings and roles across which information is exchanged. This generates acute tensions surrounding the development, implementation and extensions of e-health systems.

At this point it may be instructive to consider an intriguing divergence of view between accounts emerging from two centres of scholarship that are addressing these issues in current e-health developments. We note differences between analyses of the UK case where there has been a shift in the aftermath of the failure of NPfIT towards commercial provision of e-health solutions and of the Norwegian setting where there is a substantial public sector effort to develop e-health solutions. The tensions surrounding e-health development and uptake pan out rather differently between these two settings. In the former we particularly observe the problems surrounding what we describe as top-down generification strategies in the supply of Commercial Off the Shelf Solutions as vendors struggle to cater for a demanding market; in the latter we observe the problems surrounding the generification strategies for exploiting and sustaining at scale the rich resource of bottom-up, user-led innovations.

UK – challenges for top-down generification strategies
We see how these factors beset attempts at centralised procurement such as NPfIT and the more loosely coordinated attempts that were subsequently pursued in the UK to build new e-health infrastructures through the commercial supply of more or less standardised off-the-shelf systems. Our work on the difficulties surrounding the current procurement and implementation of hospital electronic prescribing and medicine administration (HEPMA) systems has drawn our attention to the weakness of the learning economy – the nexus between suppliers and adopters in this sector.[ii] This is reflected in a failure by vendors to create generic models that bridge to the diversity of hospital users settings and practices and a lack of user awareness of the exigencies of utilising packaged solutions. Given user expectations that systems will be designed around their specific practices,[iii] vendors have been overwhelmed with 'untamed' user customisation requests (Mozaffar et al. accepted paper).

Barriers to bottom-up generification strategies

There is an apparently never ending supply of ideas for health innovation, particularly in the area of e-health, driven by the enthusiasm of health practitioners and would-be suppliers. However many enthusiast driven projects lack an effective exploitation strategy. They may be tied to particular organisational settings or technology platforms. There is a failure to attend to standardisation. The focus is on what the solution can do for the organisation. Commercialisation strategies are often rudimentary. As a result, many cases do not progress beyond the pilot (Andreassen et al 2015).

So whilst some commentators highlight the extraordinary *generativity* of local innovation in relation to e-health (Grisot et al 2014), there seem to be difficulties in combining this with the *generification* needed to move a product out of its circumstances of origin and reinvent it and make it able to bridge to a wide range of organisational settings (Pollock and Williams 2009). The problems seem rooted in the context in which these solutions emerged. For example Hyysalo and Lehenkari (2002) exploring the reasons for the failure of diabetes management systems to be more widely taken up note that the systems were designed primarily to meet the research goals of medical staff but imposed costs/ additional work on those involved in routine health care delivery who did not perceive benefits.

Some cases have recently been reported in which particular circumstances enabled these local innovations to be taken up and more widely adopted (Silsand & Ellingsen 2014) – though we do not yet have a full understanding of how to bring about such bottom up generification. And there are experiences from the UK in which the locally developed Lorenzo system the slow rate of development and roll-out of additional functionality (delayed by over 5 years) and concerns about the limited clinical functionality posed questions about whether it would be adopted, how long it would remain in use and whether it would receive continuing support (Sheikh et al. 2011).

Looking towards the future of health care (optional section)

We are currently entering an era of ambient intelligence, characterised by pervasive ICTs – widely dispersed sensors and monitors and their integration through the internet and wireless communications infrastructure. Novel ICT paradigms are emerging – for example around Web 2.0, the use of social media such as Facebook, including more radical conceptions of information sharing such as the quantified self movement , open data and citizen science. In the area of health services delivery and research, specific information governance (e.g. privacy/consent regulation of health data) and dependability requirements pose big challenges and may limit the scope for adopting the more experimental approaches to information sharing that have driven rapid innovation in the digital economy

In this period however we note the emergence of a compelling vision informing expectations that new ICTs will transform health research and health care by sharing information. The vision holds out the promise of health telematics systems that allow detailed monitoring of the health of remote patients and the effectiveness of care regimes, and of powerful databases that will allow the interplay between genetics, lifestyle and health to be explicated. The vision is beginning to drive major (especially biomedical research) investments. However it runs well ahead of our ability to deliver. It conflates a number of issues (for example the informational requirements for health research and health service delivery are rather different and not automatically aligned). The generic technical vision diverts attention from the need to address obdurate issues of

information governance; redistribution of authorities and roles; the costs of creating and sustaining such a massive infrastructure.
Who is the technology user? In current medical practice thinking the user shifts from the health professional to patient and their carers/family. This throws up new challenges regarding the usability of systems by those with limited technical or health education. Who owns this data? Who may have access?
And who will be responsible for collating, interpreting huge and accelerating volumes of health related data. Overburdened HPs unlikely to be able to do this.
Against such a setting it may be hard to reconcile the diverging agendas and needs of diverse stakeholders e.g. medical researchers; doctors, nurses and ancillary staff involved in care delivery. These various needs cannot readily be met by the same information systems. Perhaps because of the strength of the generic vision there has been failure to acknowledge the diversity of stakeholder requirements. In this context there is a risk that some sets of needs (and perhaps most particularly the needs of lower status staff) may not be adequately catered for.

Conclusions

We have reviewed the challenges surrounding the development of electronic health infrastructures.

We have drawn attention to the intricacy and differentiation of health professional expertise and practices which counter efforts to standardise health care pathways and regimes and the challenges these pose for e-health infrastructure design and implementation.

In the current period health care is becoming increasingly mediated through electronic information exchanges. This calls for complex new information infrastructures to be developed, procured, implemented and embedded in care practice. We see intense demands placed on both vendors and users to develop and refine systems that can support complex and diverse care processes in a context in which each have relatively limited knowledge of the other (the detailed structure of care practices; the affordances and limitations of available ICT solutions) and supplier-user linkages remain relatively embryonic.

We reviewed specific problems with *top-down generification* strategies surrounding the creation of generic solutions that can bridge to diverse user contexts. We also noted the enormous *generativity* and creativity in the health sector. However local innovation runs into problems with *bottom-up generification strategies* in terms of a failure to develop exploitation strategies to carry forward, exploit more widely and sustain local innovation.

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[i] We note here that conventional languages of 'organization' map rather poorly to health services which themselves are comprised of complex organizational assemblages with often-fuzzy boundaries and overlapping constituencies.

[ii] One element of the weakness of the UK e-health learning economy, that we will attend to in future work concerns the strength of health professional roles. As a result, health professionals who have been seconded to e-health development and implementation projects tend to return to health practice. Their expertise and experience in how computer solutions may be configured to support health practices is thus NOT made more widely available. Though a small number may migrate to the supply side (eg as implementation consultants) we do not see the emergence of a stream of hybrid experts (that we may see for example around commercial enterprise system provision). Other hospitals and trusts may therefore be forced to learn the same lessons from scratch.

[iii] In the USA, in contrast, HEPMA implementation is often combined with efforts to standardize care regimes.