Background paper by Trish Greenhalgh, based on an ongoing research collaboration with Harvey Maylor

The NASSS framework and NASSS-CAT tools

Executive summary

THE PROBLEM

Technology is widely viewed as a major part of the solution to the growing challenge of providing health and social care to an ageing population. But despite significant investment and high expectations, five problems persist (abbreviated **NASSS**): digital technologies are either **not adopted** or soon **abandoned** by professionals or their patients and clients, or else the technology-supported service succeeds as a small-scale demonstration project but fails to **scale up** locally, **spread** to other comparable settings or be **sustained** over time.

THE ROOT CAUSE

Planners and policymakers have been distracted by simplistic models and metaphors of technology adoption by individuals. They have paid scant attention to the **dynamic socio-technical system** into which new technologies and care practices must become embedded. This system is characterised by complexity in **multiple interacting domains**: the condition or illness, the technology, the intended adopters, the organisation(s), the external (policy and regulatory) context and how all this is likely to evolve over time.

THE SOLUTION

Focus on the system. Use the NASSS-CAT tools to

- **understand complexity** and how it plays out across the system;
- **reduce complexity** where possible (including systematically weeding out low-value technologies and high-risk ventures at an early stage); and
- **manage complexity** by (e.g.) strengthening individuals' and organisations' capacity to innovate and adapt, building relationships, and harnessing conflict productively.

Background

In the context of an ageing population, rising rates of chronic disease and frailty, and high levels of investment in technological solutions, failed technology programmes in health and social care remain ubiquitous. Contrary to developers' claims, many new technologies are unlikely to save lives, save money or 'empower' patients. Indeed, the technology on offer may not yet have the necessary regulatory approvals – indeed, it may not yet exist at all. If it does exist, it is probably clunkier, less trusted, less useful, more expensive and more of a headache to accommodate into care practices than the sales pitch implies.

To those who study failed IT projects in healthcare, none of this is surprising. Five problems recur, abbreviated as NASSS: **non-adoption** (professionals or patients never use the technology), **abandonment** (they stop using it) and failure of **scale-up** (the technology doesn't get beyond a small 'proof of concept' demonstration), **spread** (the technology is popular locally but is not picked up elsewhere) and **sustainability** (the technology falls into disuse over time as technical or organisational developments render it obsolete).

The underlying reasons for these five problems are complex and interacting. Technologies are typically introduced by *professional entrepreneurs*: front-line health and care workers whose primary motivation is to improve patient care, and who may have strong digital skills, but who know little about the organisational, business or regulatory aspects of innovation. Technologies typically take a lot more *time, effort and money* to get up and running than the well-intentioned entrepreneur assumes. And new health and care technologies are *unlikely to drive radical changes in how services are delivered*.

Let's look at why not.

From 'technology' to 'complex system'

Adoption of digital technology in health or social care rarely follows conventionally-described patterns – such as Rogers' diffusion of innovations model (which divides people into 'innovators', 'early adopters', 'laggards' and so on) or Gladwell's 'tipping point' (a point in the spread of a technology at which almost everyone decides they need one). Indeed, these models, which focus on adoption of single innovations by individuals, serve to distract us from the multiple and complex challenges associated with introducing and embedding technology-supported care into a health or care *system*.

The business literature on technology adoption in healthcare (and social care too, though there is less written on this) sometimes assumes that these sectors operate as 'markets', driven predominantly by economic concerns. But organisations that provide professional services are better conceptualized as *institutions*, driven primarily by historical patterns of behaviour, professional standards, societal expectations and regulatory constraints. We should be wary of treating the NHS, for example, as a market in the conventional sense.

Other authors have use the terms 'assemblage' to refer to the complex, interdependent and constantly-evolving network of individuals, technologies, provider organizations, suppliers, regulatory agencies and other actors into which any new person, technology or practice must be fitted. The various actors (human and non-human, individual and organisational) each act semi-autonomously – but each is influenced by the behaviour of other actors. In other words, the assemblage follows the logic of a *complex adaptive system*, characterised by unpredictability, interdependencies, and emergence.

The NASSS framework

The NASSS framework was developed to analyse complexity in evolving health and care technology projects. NASSS has seven domains, each of which has several sub-domains (see diagram). Each domain (and sub-domain) can be classified as simple (few components, predictable – as in making a sandwich), complicated (multiple components but still largely predictable – as in building a rocket) or complex (dynamic, composed of multiple interacting elements, and unpredictable – as in raising a child).

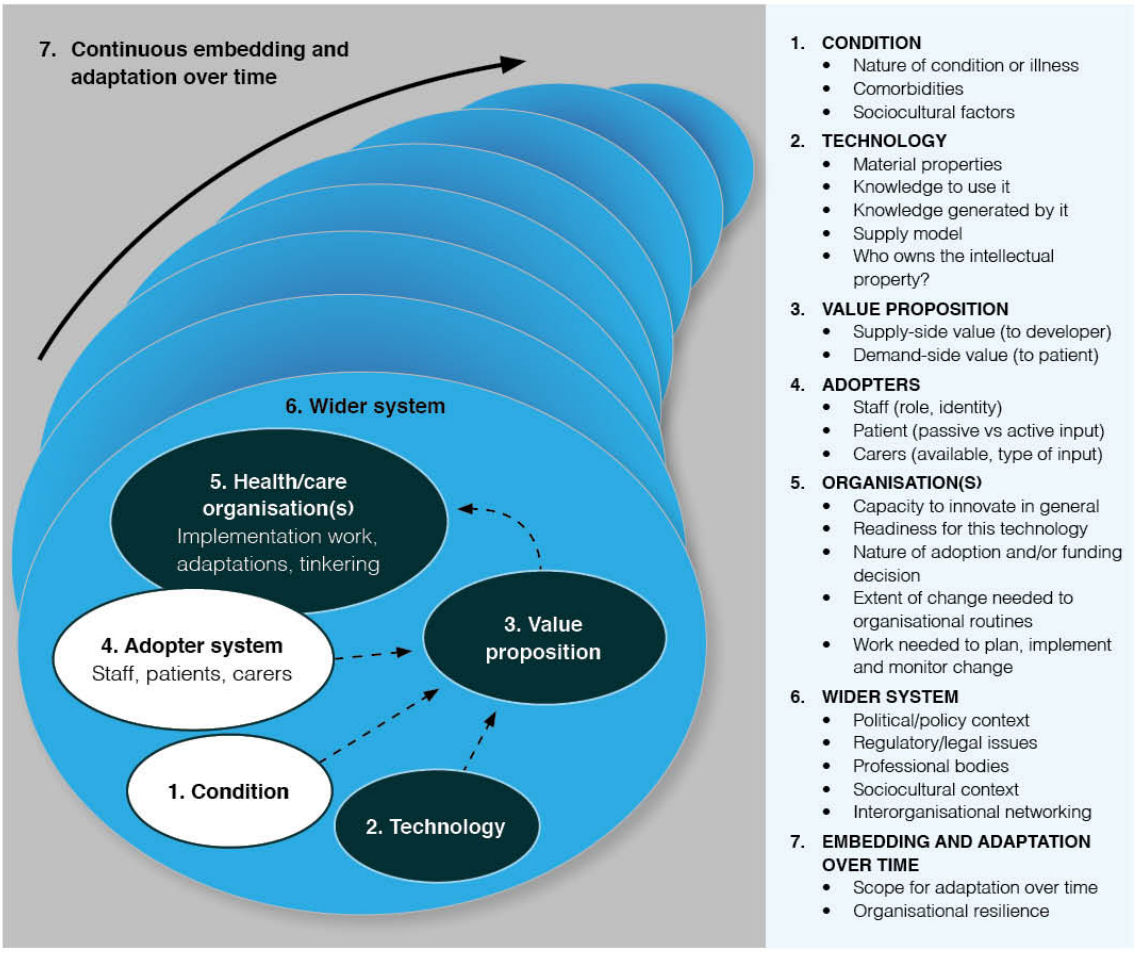

Diagram: The NASSS framework, showing 7 domains and 23 sub-domains

Domain 1: The condition or illness

A broken ankle is a simple condition, but so is a heart attack (in that it is usually easy to diagnose and has a clear treatment pathway that is more or less the same for everyone). Cancer is more complicated, because it requires coordination of chemotherapy, surgery and radiotherapy. But cancer treatment, too, is often largely predictable. Now take a *complex* case – say an IV drug user who is also alcohol dependent and has psychosis and hepatitis C. And let's say the person is also from an immigrant group and speaks limited English. How much of this person's trajectory can you predict with confidence?

Domain 2: The technology

A simple technology – an ECG machine for example – is dependable, freestanding, cheap and substitutable (i.e. if the manufacturer withdrew from the market, you could easily get another one that would do the same job). It generates data that is easy to interpret, trusted by professionals and which clearly reflects changes in the patient's condition. A *complex* technology is less dependable (it keeps 'crashing'), less freestanding (e.g. it is designed to be 'tethered' to the patient's electronic medical record), and less substitutable (e.g. because of a block contract with the supplier). It generates data that is hard to interpret or which professionals do not trust, and it may raise tricky questions about who owns the intellectual property (e.g. in an algorithm derived from NHS data but held on a private-sector system).

Domain 3: The value proposition

A simple value proposition for a new health or care technology offers a clear business case for investors *and* evidence that patients and the health service will benefit. In a complex situation, the business case for developing the product is implausible or rests on unverifiable assumptions. Sometimes, developers assume an evidence base rather than systematically determining whether the technology is desirable for patients, whether it extends life or improves its quality (efficacy), whether it does harm (safety) and whether its benefits are worth the cost (cost-effectiveness). These questions should ideally be answered through formal research studies known as health technology assessment (HTA).

Domain 4: The intended adopter(s)

The commonest single cause of technology failure in health or social care is that staff refuse to use it – and this is rarely due solely to ignorance or laziness. Professionals, by definition, are members of an exclusive club with collectively-defined values and standards of excellence. If the adopter domain is simple, the technology supports staff to act and interact in a way that resonates with their professional identity and values. In a more complex situation, the technology requires them to act in a way they believe is inappropriate or wrong (e.g. by sharing patient data across systems, which they perceive as in conflict with their duty of confidentiality).

Domain 5: The organisation

In a simple situation, participating organisations have high capacity to innovate, tension for change (most people want the new technology), good innovation-system fit (the technology aligns with core business), formal links with partner organisations (e.g. an existing sub-contract), a budget that can be allocated flexibly, and work routines that can be readily adjusted to accommodate the technology. Things get complex when organisations lack the capacity to innovate, do not wish to change (or have people who wield 'wrecking power'), lack formal partnership arrangements, or have no available budget – or when disruptive changes are needed to hard-wired organisational routines. A technology may make it possible to shift work to organisation A (e.g. a GP practice), thereby generating savings in organisation B (e.g. the local hospital) – but without a mechanism for redistributing savings across the system. Note: the NHS is a much-loved 'brand' but it is not a single organisation.

Domain 6: The wider system

If the wider system domain is simple, there will be a clear policy push for the technology to be adopted and financial incentives to do so. Furthermore, the intended adopter(s) of the technology will know and accept that it is legally approved, professionally appropriate *and* the expected thing to do. In a complex situation, there is (say) a national directive to change but no available funding locally, and/or regulatory or professional bodies have not yet taken a position on whether the technology is effective, safe and recommended.

Domain 7: Emergence over time

In a complex system, nothing is static. People's health and social circumstances change over time. Individuals lose (or gain) motivation, change their priorities or move on to new jobs. Organisations go through cycles of development and decline. New research reveals that something is more (or less) effective or safe than we had assumed. Rival technologies emerge and (sometimes) render current practice obsolete. Governments lose elections; policy priorities change. The economy grows (or shrinks). The dynamic nature of complex systems raises two questions. First, what flexibility can be built into the technology to maximise its future adaptability? Second, can we help organisations develop *resilience* – that is the ability to weather shocks and setbacks and shift direction to accommodate them?

The NASSS-CAT tools and how to use them

We have recently extended the NASSS framework to produce a practical complexity assessment tool (CAT) for policymakers, project planners and implementation teams. The tools are intended to be used to do three things: **understand** the complexities in your technology project (including how they interact); **reduce** complexity where possible; and **respond to** the complexities you can't reduce.

The NASSS-CAT is available in three versions (available on request):

- NASSS-CAT SHORT is a 'taster' pdf document designed to introduce the tool and gauge interest. It is semi-quantitative in that it seeks 'agree' / 'disagree a little' / 'disagree a lot' responses on questions relating to the NASSS domains.
- NASSS-CAT LONG is a more detailed version of the tool, in paper/PDF and online format. It is intended to be used when there is an idea, suggestion or broad goal to introduce a technology but not yet a formal, agreed project. NASSS-CAT LONG can be used for detailed reflection, due diligence (especially weeding out technologies and projects with limited chance of success), and preliminary project planning. Typically with support from a trained facilitator, NASSS-CAT LONG invites discussion among project stakeholders across the NASSS domains, using an interpretive (free-text) component designed to surface uncertainties and interdependencies; detailed survey questions for quantifying different kinds of complexity; and a collaborative planning component aimed at shaping the project.

- NASSS-CAT PROJECT is a 4-page, 31-item validated survey instrument for assessing, monitoring, reducing and responding to the perceived complexity of a technology project over time. Project teams may use this tool in a variety of ways – perhaps in an initial in-depth kick-off workshop followed by periodic reviews – and usually with a trained facilitator or project consultant.

Broadly speaking, project complexity may be **technical** (to do with the technology's supply chain, dependability, interoperability, need for key infrastructure etc), **structural** (to do with things like scale, deadlines, costs, or interdependencies of work packages) or **socio-political** (to do with local politics, personalities, buy-in, conflicts of interest etc).

The principles of **good project management** (covered elsewhere in this course) are key.

Also relevant to reducing project complexity are the **seven principles for spreading and scaling up innovation under conditions of complexity**:

1. *Acknowledge unpredictability*: designers should contemplate more than one possible future (e.g. more than one 'right' way of using the technology).
2. *Recognise self-organisation*: expect technologies to be modified, perhaps extensively, as they are adopted and used in real-world settings.
3. *Facilitate interdependencies*: identify, assess and (where appropriate) take measures to reinforce key interdependencies across the system.
4. *Encourage sensemaking*: bring staff together; encourage them to ask questions, admit ignorance, explore paradoxes, exchange viewpoints and reflect collectively.
5. *Develop adaptive capability in staff*: train them not just to follow protocols but to question current ways or working and tinker with technologies and processes.
6. *Attend to human relationships*: since embedding innovation requires people to work together and 'muddle through', building familiarity and trust is important.
7. *Harness conflict productively*: there is no single, 'right' way of achieving complex change. Treat conflicting views as the raw ingredients for multifaceted solutions.

References

This briefing document is based on the following academic papers:

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