Value Propositions for Information Systems in Healthcare

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Abstract

Creating a value proposition for an Information System (IS) is challenging: often consideration must be given to a broad set of users and range of individuals which may be directly or indirectly impacted by what can be both tangible and intangible factors. This becomes further complicated for large-scale deployments involving a number of disparate stakeholder groups and across multiple co-operating or competing organizations. Unfortunately, this is exactly the context within which many healthcare IS solutions must operate. A diverse set of arguments is being used by the different players variously seeking to design, develop, procure, implement and operate the IS solutions. This paper explores how the value proposition for IS in Healthcare can be created, providing examples of different approaches in use. It discusses the relative merits of four different approaches favoring one which appears to provide the most expedient and robust method - here termed 'Pragmatic Modeling'.

1. Introduction

Despite the amazing span of the literature on evaluation [1-20], it remains difficult to connect this corpus of knowledge to the world of business planning. Here, we review four quantitative methods that could be used to bridge the divide. We comment on what remains to be done if such methods are to make an impact upon the procurement of healthcare IS services, and note the potential of such methods to drive continued development in the sector.

It is not that the academic world is disinterested in valuing information systems or the products or businesses that are based upon them. With respect to outsourcing, for instance, Levina and Ross [21] note: "Worldwide spending on IT outsourcing services reached almost $64 billion in 2001; in 2000, IT outsourcing represented about 30 percent of IT budgets… Despite these numbers, both vendors and their clients are struggling to understand the outsourcing value proposition." From an industrial perspective, Newman and Westrop quote a company's financial director, as follows [22]: "I mean to say it's an act of faith, I think you get to a stage where you are where you are and you've got sunk costs, I mean we've got huge sunk costs and all we can focus on now is just driving out and using it…"

If anything, the position in healthcare is more extreme. Kaplan [23] has noted a 'lag' with respect to other sectors and even now full articulation of healthcare benefit is not possible. In auditing the UK's National Programme for IT, a program worth many billions of pounds sterling, the National Audit Office notes [24]: "In its business case for the components of the programme, the Department put a financial value on benefits where it could, but, as the main aim is to improve services rather than reduce costs, it was not possible to do so in all cases."

The concept of a value proposition is both highly attractive for healthcare IS and highly elusive. To be able to assign a financial value to a purchase would ease much of the debate within organizations. This is especially relevant to decisions that compare investment in IS, for instance, to extra staff, new drugs, or other technology. However, it would also help to drive development of IS features, by underpinning a dialogue between suppliers and purchasers, based on a commonly accessible view of the value of those features.

While value propositions need not always be reduced to hard currency, at their best they convey a clear concept of the currency-equivalent value of a service and take account of the apportionment of risk. From a procurement viewpoint, the value of an information service (which is hard to gauge) sets the upper limit for price (which should be easier to establish). In development terms, it enables a vendor to prioritise different value-adding options, and to focus on those that offer greatest cost-benefit advantage to customers. At their best, value propositions will quantify a range of benefits in a robust and transparent manner that all parties to a decision may endorse.

In this paper, we list four methods for deriving value propositions for healthcare IS, using a series of case studies. We start with the simplest approach, namely the return-on-investment (RoI), or related calculations, such as Net Present Value (NPV), or Internal Rate of Return (IRR). Next, we explore a more rigorous example of health technology assessment applied to the evaluation of an early Picture Archiving and Communications System (PACS).

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We shall see that each has serious drawbacks – one in failing to capture essential elements of value, and the other in being overly complex for general use – and so other methods will be sought. In particular, simulation may be used to derive rapid assessments of value, even with incomplete information. Lastly, we consider other ways in which risk and reward are assessed by looking briefly at the stock market. Having reviewed these approaches, we will consider:

- What methodological development is needed.
- Whether and how value propositions shape IS provision in healthcare.

2. Accounting methods

As indicated above, this is perhaps the most familiar way of analysing any investment where it is hard to impute an intrinsic value. Essentially, to overcome the problem of valuing a proposal with a significant element of 'intangibles,' this approach considers the value expressed as a series of future income streams which are created because of the investment. The way in which these are balanced against the initial investment creates a variety of methods. However, RoI, IRR, and NPV are so widely understood that they are commonly available as spreadsheet functions.

A healthcare example of this is given as Case Study 1. Although more than a decade old, it is a compelling illustration because it captures both the simplicity and inadequacy of the approach. The attractive quality of turning abstract concepts into a series of investments and consequent savings, or income streams, creates a framework that can accommodate such factors as inflation, and the opportunity cost represented by competing demands on the funds being invested.

Case Study 1: Return on Investment

Glan Clwyd District General Hospital [25] wanted to combat the loss of patient notes or delay through their being mislaid by buying a module for the PAS (Patient Administration System). Essentially, the capital cost of the model was £22,000 and installation came to £5,000. Savings of £20,000 a year were identified in terms of the time taken by clerks to search for the notes, while it was recognized that the new module would require staff time to run, estimated at £3,000 per annum. On this basis, a £27,000 investment was predicted to save £17,000 a year. There are several ways to turn this into a business case, including the internal rate of return or net present value.

However, the difficulty lies in capturing the true value of all the benefits. In the case cited [25] a number of benefits – such as faster finding of case notes – are cited, but do not make their way into the calculation, and so the real value of the purchase is not quantified. Interestingly, it is precisely these benefits that would have driven the purchase to eliminate the elusive cost of teams of doctors waiting around for case notes, or to prevent patients from being put on hold until their notes surfaced. However, the financial justification implies that the prime benefit lies in replacing an administrator with a software application.

In summarising methods such as this, Irani at al [26] note: 'However, such methods are unable to accommodate the intangible benefits and indirect costs associated with an IT deployment.' Moreover, the sums of money used to calculate this case are miniscule when set against the real cost of delay and mislaid notes, not to mention the running costs of the hospital.

Case Study 2: Economic Assessment

In the 1990s, the Department of Health asked the Health Economics Research Group at Brunel University to undertake an assessment of a new piece of IS radiology: the Picture Archiving and Communications System (PACS) at Hammersmith Hospital [27]. After a study that involved several researcher-years and lasted 5-6 years, the team found a range of benefits around support of diagnosis, availability of images, and avoidance of repeated scans with an attendant reduction in exposure to radiation. It was also popular with clinicians. However, it was not possible to identify any improvement in patient outcomes or even in surrogate measures (such as reduced length of stay) as a result of these 'important indicators of benefit.'

Such methods are accessible and widely understood and so appeal to a wide range of stakeholders in a purchasing dialogue. However, they fail to capture the intangibles. In healthcare, as the UK's National Audit Office report makes clear [24], intangibles are a significant part of the picture. Moreover, in diverting attention from the difficult problem of clinical practice and focusing attention on more tractable problems (in this case, of direct salary savings), this approach sets the quest for value propositions on an unfortunate footing. Of course, if it were easier to value the intangibles as equivalent value streams, the benefits of accuracy and appositeness would sit more readily alongside the attraction of accessibility. However, such a development is still some way away.

3. Health Technology Assessment (HTA)

HTA consists of a wide range of methods, including economic evaluation, which sets out to quantify such intangibles, by linking benefit to clinical outcomes. This, of course, provides the gold standard in assessing value-for-money, and the systematic balancing of cost against

benefit underpins the rigour of economic evaluation. An IS example is provided by Case Study 2. While PACS is now ubiquitous and vital, the idea of replacing film with electronic images required formal justification at the time. Figure 1 shows that the team was able to identify a significant range of benefits (up arrows). However, the critical evidence linking the new technology to better patient outcomes, even in the surrogate form of shorter stays, proved elusive.

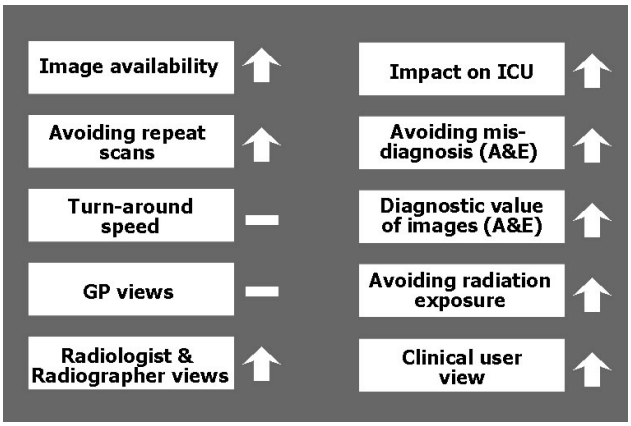

Figure 1 – Findings from an evaluation of PACS (up arrows: improvement)

It is worth asking whether this is an appropriate study, since it was the first of its kind and much of the time was spent in considerable turbulence, as the care delivery system attempted to roll out and apply the technology. Moreover, the form of the enquiry was set under the terms of the original procurement, and, as a piece of research, it had a broader aim to inform policy around PACS procurement [28]. We contend that such challenges beset many attempts at a value proposition, but accept the lack of a rule to establish equivalence between the different exemplars we explore. Nonetheless, the size, skill, and team experience, hold out the promise of insight from considering this case study.

Germane to this discussion are two observations. Firstly, anything approaching this size of team or this length of study is unlikely to provide a practical basis for creating value propositions. Secondly, since it was performed by such a high quality team, this exemplar shows how difficult it is to link IS investment to patient outcomes. Generating the evidence for a rigorous case is extremely difficult, to say nothing of the challenge of doing so with a disruptive technology that continues to evolve quickly. The authors catch something of this difficulty: despite the lack of evidence of cost-effectiveness, they make this interesting prediction: 'In the hospital of the future, PACS will be seen as standard'.

Case Study 3: Pragmatic modeling

In early 2005, British Telecom (BT) explored the potential market opportunity for IS support services to patients with long-term conditions that would improve well-being and alleviate the cost of healthcare management. The main driver was the fact that more than 75% of healthcare spend in most western countries is associated with long term conditions and that such populations are expected to continue to grow [29]. A range of services were proposed that might translate into significant revenues associated with network traffic, systems integration, hosting services, call-centre operations, in-home and mobile device supply and application provision.

A study was initiated to assess the business value of such services. The study questions were:

- What benefits would each stakeholder enjoy from potential functions and features that BT could build into the service, and over what timescale are these benefits realised?
- What incentive structures pertain to these stakeholders to the adoption of a service?
- What budgets are available at each stakeholder level and what is their propensity to buy the service?

To support the benefits component of the analysis a Systems Dynamics model of a 100,000 patient population was created to track savings and costs. This model with approximately 700 variables was developed in-house and reviewed independently by health economists. It supported a rough, but surprisingly robust, benefit-incentive-budget analysis. In parallel, BT undertook primary market research (interviewing the market stakeholders) to ascertain levels of budget availability and, also in parallel, a detailed investigation of the incentive structures by comparing the (publicly-available) contracts/metrics existing between the NHS Stakeholders. In doing this BT was effectively answering the three key questions identified above. Critically, once the information had been gathered the work clearly indicated that those with most incentive to adopt a given service lacked the budget to do so. More generally, the lack of alignment across the benefits-incentive-budget landscape defined a huge 'no profit zone' into which market entrants targeting the primary care sector (General Practitioners, Primary Care Trusts), the acute sector (Hospitals), or even Strategic Health Authorities (there are 10 covering the UK) would struggle to make money.

4. Pragmatic modeling

So far, we have noted that the most accessible methods fail to address intangibles in any realistic way,

while those that can do so are complex and consume significant levels of resource and time (during which, a market can significantly evolve). Is there a compromise between rigour and accessibility?

An interesting example is provided by Case Study 3, which is reported for the first time here. The IS services considered included:

- monitoring and support services for home-based or mobile patients;
- services based on alerts or reminders to patients, carers or other specialists;
- information services to patients, carers or other specialists via mobile phone, internet, call centre support, Personal Digital Assistant (PDA), Interactive Digital Television (IDTV), etc;
- services to General Practitioners and Consultants based on continuously updated patient data;
- call-centre support staff with escalation to specialist nurse advisers trained in management of long-term conditions and co-morbities.
- motivational services to support improved concordance with care plans.

A team of 5-6 people worked for about 5 months in a focused study of a relatively complex market. The core modelling technique was system dynamics, but a range of ad hoc measures were applied around it. This initiative was unashamedly commercial in its approach to identifying value, in contrast to Case Study 2 which adopted a purchaser perspective. Moreover (and again in contrast to Case Study 2), while it involved consultation, there was none of the field work. In terms of cost, it was probably quite similar, although it was compacted into less than half a year.

As figure 2 shows, considerable work was done during Case Study 3 to identify a range of services at all levels from the individual patient, including the NHS and the Department of Health. While it is clear that there is cost-benefit for some services at all levels, it is usefully contrasted by a view of the available budgets, shown in figure 3. Combining these indicates that the only opportunities for selling such services into healthcare in UK are either to individual patients, or nationally through the government. The critical issue is that in the NHS even when there is co-ordination of infrastructure deployment through the Connecting for Health (CfH) programme, the Service has devolved procurement responsibility so that hospitals and Primary Care Trusts (PCTs) make their own purchasing decisions to allow optimal local/regional choices for care delivery.

Currently there is no co-ordination of provision for a local, regional or nationwide purchase of IS services for long-term conditions even though these conditions dominate expenditure across the NHS. Additionally, the analysis shows that, even where benefits do accrue to some degree (i.e. in primary care), during the first years of operation the economics of a service only marginally 'cost-in' for any single Primary Care Trust (PCT) within a 3 year timeframe. Those monitoring NHS politics will recognise that such a planning horizon typically lies well outside the concern of most PCT Chief Executives. Recognition of this picture allowed the company to course-correct its go-to-market plans and apply its efforts to that part of the market where the opportunities for alignment could be finessed.

The critical finding lay in identifying features of the market which had not been visible before – namely the misalignment between those who held the budgets and those with the incentive to adopt IS solutions for the management of long term conditions. A by-product of such a detailed understanding of the market dynamics was that the company was able to adopt a strong thought-leadership position with both key stakeholders in the NHS and private sector players, being able to describe why the market would not spontaneously take off without fundamental changes in the benefits-incentives-budget landscape. Furthermore, although the analysis and financial models were constructed purely looking at the UK's NHS, the misalignment of benefits, incentives and budgets appears to resonant strongly with a number of other European countries.

5. Other methods of risk and value

The stock market represents a world where it is important to value products and services. Moreover, the decisions have often to be made on short time-frames. While stock markets have very sophisticated tools for assessing risk and assigning value, in a sense, the entire system presents an integrated view of the participants, who are in some way expert in the field (Case Study 4).

Case Study 4: Stock Market

Ye and Ranganathan [30] surveyed 346 companies in 6 major sectors to assess the 'abnormal' impact upon stock prices that resulted from an announcement of a software investment related to their supply chain management. Their main finding was that between 2000 and 2003, on average, the stock market valued such an IS investment at an extra 0.97% of stock price during a five day window around the announcement.

This approach is interesting because it sheds a very different light on the problem of valuing IS investments.

It also raises some interesting questions as to whether methods that incorporate human views of risk and reward are appropriate for building value propositions, and the extent to which they may complement other methods.

Unfortunately, the stock market is subject to a range of confounding factors that would not impact upon more traditional approaches – such as the state of the market, the popularity of the sector, and, perhaps, a degree of short-termism. This having been said, some of these attributes can be a positive benefit, for example, the stock market, may determine that due to, say, a broader economic downturn, a particular IS transformation may be ill-timed due to looming cost-cutting pressures on that market and decline to make investments in projects that although beneficial to the stakeholders can never be realised due to external market forces. A more fundamental issue for business is that often significant mobilisation, business commitment and investment has been made by the time the stock market judges the proposed IS solution/business change. Ideally one would wish to understand the market's perception of the business benefit and risk *a priori*.

To alleviate some of these problems one could create a *decision market* as proposed, in other contexts, by Hanson [31] – and which, for example, was briefly implemented by MIT's Technology Review for evaluation of and trading in *Innovation Futures*. For a exploration of how a *decision market* can be constructed and the associated complexities and issues, see [32].

6. Discussion

We note that many of the benefits of a successful IS implementation result from its impact on practice, and are therefore intangible, so it is difficult to quantify the full range of benefits. This, in turn, makes it difficult to build value propositions in the way that would be possible in other sectors. So far, we have explored four methods of establishing a value proposition for IS investments – this Pragmatic Modeling reflects the practical realities of building a business case for investment. Table 1 sets out the advantages and drawbacks of the identified approaches.

Clearly, RoI-type methods remain the most accessible, with many people understanding them and most spreadsheets programmes supporting the production of investment cases in this way. At the other end of the spectrum, there is no doubt that economic evaluation under an HTA or Health Economic banner remains the gold standard for overall accuracy. However, the critical finding is that there is currently no clear or agreed method for developing value propositions that is both accessible and truly accurate. However, from the range of approaches highlighted the Pragmatic Modeling identified in this paper appears the best available approach – combining a high degree of insight with a reasonable level of accuracy and timeliness. In this case, the critical development required is to establish a wider consensus about which 'ad hoc' measures to adopt, since these decisions current vest in the team undertaking the study.

	Advantages	Drawbacks
Traditional RoI, etc	Widely understood and used. Accessible tools Quick.	Failure to capture intangibles benefits and the 'soft' side of benefit.
HTA & Health economics	Rigorous. Provides a basis for comparison with other options (e.g. staffing or pharmaceuticals)	Complex approach required time and resources. Evidence to link investment to outcome may not emerge.
Pragmatic modeling	A portfolio of methods are available. Combines sufficient analysis with short enough timescales to delivery meaningful results. Identifies 'no profit' zones and what changes need to be made to bring about alignment in benefits-incentive-budget landscape.	Still rather specialized. Will take further time to link rigorously to outcomes. Tension between doing enough to make it rigorous and making enough simplifications to achieve process within time and budget.
Stock market	Models tend to be good at risk. Exploits human intuition.	Limited perspective of health benefits. Open to non-health influences.

Table 1: Attractions and drawbacks of different methods.

Although it requires access to a wide range of expertise and skills, it can be completed in a relatively short time, and succeeds in providing a basis for informed dialogue. It has relevance outside healthcare and, following Case Study 3, the company successfully applied this approach to IS solutions in a range of other domains including road-user congestion charging and energy management services which, like healthcare, have complex stakeholder dynamics, diffuse benefits and conflicting metrics/reward systems [33]. In all cases the insight offered by Pragmatic Modeling has had a profound affect on determining the course of action the business would take and yielded more timely and comprehensive recommendations than the other three approaches could offer.

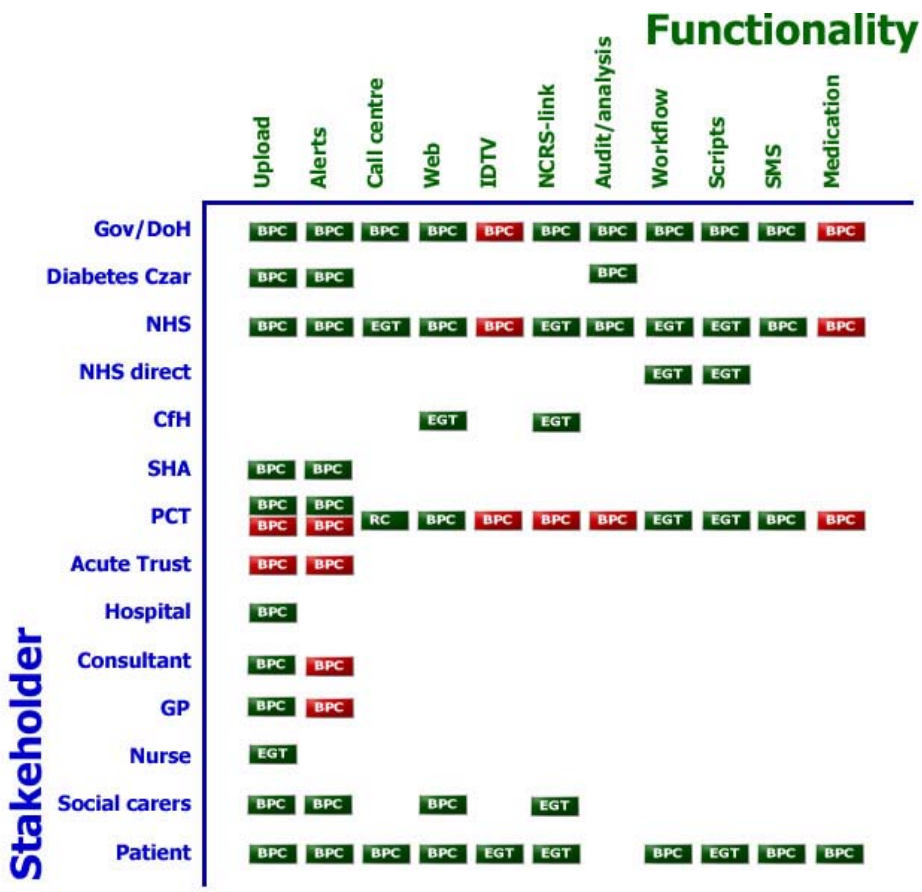

Figure 2: Summary analysis of stakeholder benefit for each service functional component (shown here for diabetes). Benefits/dis-benefits are characterised as: Red = increased cost, Green = reduced cost. BPC = Better Patient Care, EGT = Efficiency Gain in Time, RC = where benefit is purely as Reduced Cost.

Explanation of terms (Stakeholder or y axis):	
Gov/DoH	Government/Department of Health
Diabetes Czar	Oversee the spread of good practice and provides professional leadership for the National Service Framework for diabetes
NHS	National Health Service – UK's publicly-funded health system and the principle form of healthcare delivery in the UK.
NHS Direct	Existing 24hr telephone support service in England funded by NHS
CfH	Connecting for Health (formerly NpfIT) - England's major IT system overhaul in the NHS
SHA	NHS Strategic Health Authorities – of which there are now 10 in England. Responsible for ensuring that the regional health care delivers the best services and value-for-money for the local population. Provide strategic leadership to their regional PCTs.
PCT	NHS Primary Care Trusts – of which there are now 152 in England. They are responsible for delivering health care and health improvements to their local area.
Acute Trust	NHS Hospitals are managed by acute trusts, which make sure that hospitals provide high quality health care, and that they spend their money efficiently
GP	General Practitioners

Explanation of terms (Functionality or x axis):	
Upload	Ability to upload biometric/vital-signs data to the service
Alerts	Ability to send automated alerts/messages to the patient
Call centre	Call centre telephone support to the service able to take in-bound and make out-bound calls to patients in the service
Web	On-line secure patient access to the patient's data (eg biometric readings, care plan and appropriate motivational content).
IDTV	Interactive digital television access to the patient's data.
NCRS-link	Interface between the service and CfH's National Clinical Records Service (NCRS)
Scripts	Ability to create/trial new care pathways to optimise/tune the patient journey and patient experience in the service
SMS	Short Message Service (for use as a channel of interaction with the patient)
Medication	Ability to detect whether the patient has opened their pill dispensing system (eg from a dispensing carousel)

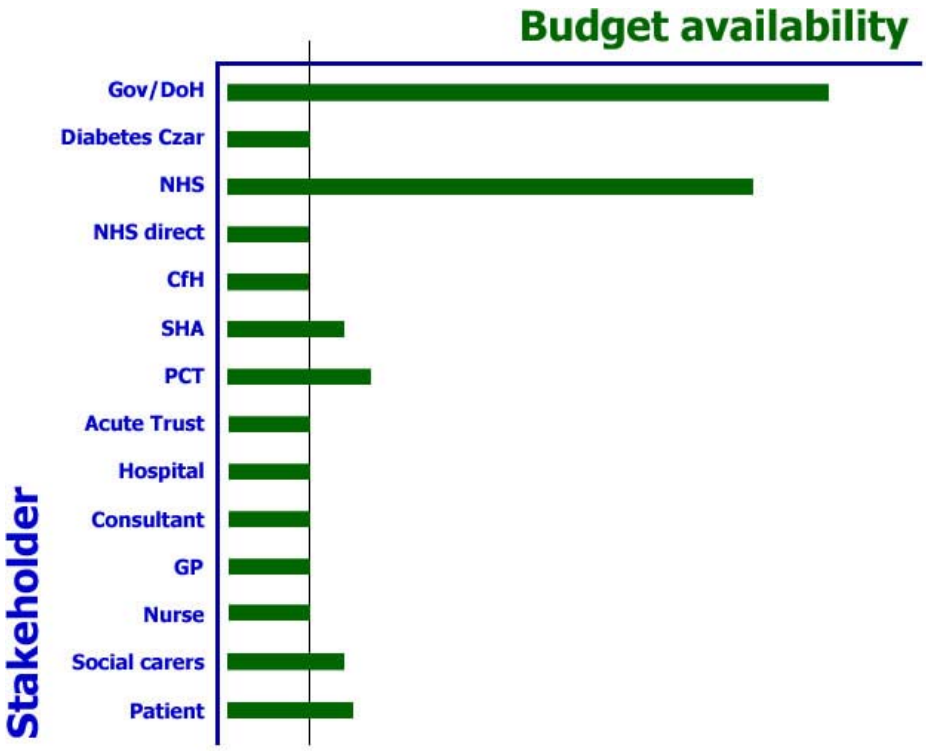

Figure 3: Summary analysis of stakeholder budget availability for investment in potential diabetes service

There is scope for research with each of these methods. Clearly an approach based purely on the stock market would be difficult to envisage in healthcare because its exposure to the market is limited and where it exists, is often indirect. However, the idea of creating systems that might capture community views in some way, remain attractive. The critical issue would lie in establishing accountability and in finding a way to train the system in the way that the market responds to forces of reward and retribution. Research into ways of capturing and training the knowledge held by communities in ways analogous to the operation of the stock market, also looks very interesting.

The Pragmatic Model can be enhanced by combining its approach with Decision Market techniques to provide what should overall become a more robust and reasoned business value argument. Such a combination would offer advantages from offering an expedient exploration of the market opportunity across all key stakeholders while allowing 'stock market'-like interpretation of the tensions and intangibles identified in the delivery of healthcare. Unfortunately, blending these techniques is non-trivial and would require a trading environment to be created which offers a broad and balanced set of investment opportunities (to allow effective trading of the proposed IS solution amongst a portfolio of other competing investment candidates) and, similarly, a broad and balanced set of traders. Meanwhile, better means of representing intangibles as income streams would add rigour to the accessibility of RoI-type investment cases. Similarly, research into robust ways to reduce the effort and resource required for rigorous economic evaluation could bring such methods within the ambit of more commercial usage. For the authors, more research into how modelling methods may be better mixed together looks promising, and indeed, research is underway in this field [34].

Our final consideration concerns whether the availability of robust and accessible value propositions influences the provision of IS, and if so, how. It would be tempting to assume that where well-defined value propositions were available, it would be easier to justify investment and to better compare one system against another. Such a dialogue might be expected to enhance development of services. This could be achieved by comparing the findings of this paper with a model for healthcare IS adoption that one of the authors has developed with Avison [35] and in more depth with

Connell [36]. The latter paper indicates that there are three tensions that are unusually, perhaps uniquely, applicable to healthcare:

- ***Clinical vs Control:*** This shows how a management agenda can supplant or dominate the clinical. Benson, for instance, notes: "In hospitals computing was treated as a management overhead, and doctors had no incentives to become involved" [37]
- ***Local vs National:*** This tension lies between the local, personal, IS support of care delivery and the need to provide care across a country, and to follow patients as they move around within a country.
- ***Interpersonal vs interactive:*** This tension describes the way in which healthcare requires an unusual degree of face-to-face communication, which goes beyond simple information sharing.

At this stage, although the Pragmatic Modeling approach goes further than the other models, there is no way of formally connecting these tensions directly to the question of value propositions. Given this, it is worth examining whether the absence of robust and accessible value propositions has had an impact on the market When looking into the market behaviour we recognise it is easier to justify the purchase of management systems (where one could argue the value by analogy with other sectors), over equivalent investments in clinical systems (where the health economics case is very hard to articulate). This suggests that the market would be skewed in favour of management applications as opposed to clinical - and this appears to be the case. Similarly, we also recognise the interpersonal value of healthcare IS to be harder to justify than, say, the interactive (where again, one could argue that record systems, procurement systems and scheduling systems have added value in other sectors). As is argued [34,35], the market has favoured the development and deployment of systems that have strong analogies in other enterprise sectors, rather than those designed to provide a unique service in connecting up interpersonally communicating teams of clinical workers. The net impact of these is that the absence of robust models may have led to a bias in the market towards investment in IS solutions that have easy-to-construct business cases. More research is needed here.

7. Conclusions

We have examined how to create value propositions for IS solutions in healthcare using four approaches, illustrated by case studies, to explore how value is characterised. At present, the most accessible appear to lack robustness, while the more accurate are complex and time-consuming. We present a 'Pragmatic Modeling' approach which offers considerable promise in providing a relatively rapid assessment of the value of a potential IS solution and identifies which specific stakeholders benefit. A greater consensus of what 'ad hoc' measures are acceptable to all stakeholders might assist the wider uptake of such methods.

Finally, we argue that better value propositions can support the case for a greater use of clinical IS applications and systems for greater interpersonal communication and information sharing between healthcare workers and their patients but note that the characterisation of the business case will require refinement or combination of the identified evaluation models to properly include what are currently tensions in healthcare delivery and/or intangible benefits.

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