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Can Signalling Theory and the Semaphoric Nature of Information Systems Explain Clinicians' Ambivalence to Informatics?

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Abstract

Investment in information systems has traditionally been justified in terms of productivity or value-added gain. From this point of view the slow rate of adoption of IT in the healthcare sector appears paradoxical because the rapid increase in medical costs has created an urgent need for productivity improvements. Spence's market signal theory may explain why some information system investment decisions are made and may, in part, explains the reluctance of clinicians to embrace informatics. Case studies are presented where we argue that information system investment was made primarily to send a market signal. We call information systems that are used primarily to send a market signal, semaphoric information systems. Characteristics of semaphoric information systems are presented. It is postulated that the therapeutic relationship between doctor and patient is central to current models of healthcare, and that the semaphoric 'message' of the current generation of IT systems may be detrimental to this relationship. This suggests that clinicians will continue to be reluctant to embrace information systems until information systems are developed that can send signals that enhance the doctor-patient relationship.

Keywords:

Semaphoric, Doctor-patient relationship, Market signal, Economics, Clinical informatics, Consultation.

Introduction

It is generally recognised that clinicians and the healthcare sector have been slow to afford themselves of the opportunities offered by information technology. Yarbrough and Smith noted that "the proliferation of information technology has been a revolutionary force that has increased efficiency and effectiveness in many industries. However, health care organizations, particularly physician practices, are noticeably lagging in the adoption of such technologies" [1].

The semaphoric nature of information systems may, in part, explain this. A signal can be considered semaphoric if:

1. The signal reveals some quality of the organisation as a whole, or of the goods or services it produces. The signal recipient must regard the quality signalled to be of importance.

2. The costs involved in generating the signal are significant and do not in themselves increase productivity, and the risks of signalling are proportionally higher for dishonest signallers than they are for honest signallers.

Traditional evaluation methods of IT use quantitative and objective measures derived from accounting. These approaches are based on the principle that the purpose of information systems is to improve operational efficiency or productivity of the organisation [2-4]. The success of It investment is typically measured in terms of return on investment and improvements in efficiency, although the need to take a broader approach that includes organisational criteria based on the structured consideration of financial and non-financial concepts is also recognised [2, 5-8]. While there is considerable debate on how best to measure the benefit of information technology, it is clear that information technology has resulted in a substantial increase in productivity in many areas.

For clinicians this may be beside the point. Clinicians offer their professional skills for the benefit of patients, and the interests of the insurance industry or the taxpayer are secondary. From the clinical point of view it is the effectiveness, not the efficiency, of health interventions that is of primary interest.

We suggest that the economic theory of market signalling is applicable to information systems in general, and present case studies from non-medical fields to support this assertion. The application of this theory to clinical informatics systems suggests that the clinicians' conservative attitude to the current generation of health information systems is rational economic position, given the current structure of medical practice in the industrial world. Clinical information systems that are designed to overcome this before may gain a more enthusiastic endorsement from clinicians.

Market signalling theory

Akerlof [9] observed that information in the marketplace is distributed asymmetrically, with gaps in information between a seller and a buyer. Typically, while buyers have information

about the market as a whole, sellers have better information about the particular good on offer. As buyers only have information on the market as a whole and not the specific good, buyers will only offer average prices for the good. This will benefit sellers of inferior goods but will not be attractive to sellers of superior goods. Akerlof concluded that adverse selection would occur – sellers of superior goods would leave the marketplace.

Spence [10] developed this further by noting that sellers need not leave the marketplace if they could signal the superior nature of their goods to the buyer and thereby command a higher price. This signal would be cost-effective even if the cost of issuing the signal was significant and this investment did not itself increase productivity. Spence's worked showed that costly and unproductive signalling could occur in equilibrium, even if markets operate with gross inefficiencies introduced by costly unproductive signalling.

Attempts have been made to classify costly signals according to the way the costs are incurred [11]. For example, costs could be incurred as an up-front expense, or deferred and taken in the loss of future income. Costs could also be fixed or dependent on other factors, such as sales. While these distinctions may be important for some of the wide variety of market signal types, for the purposes of this paper costly signals will be classified as semaphoric if the investment required to generate the signal is both visible and unproductive, irrespective of how this cost is met. This expenditure can be used by the recipient as a sign of sincerity and gives the signal more credibility.

Characteristics of Semaphoric Signals

The above discussion has listed a large number of costly signals, and these signals differ from sending the market a signal through, for example, a press release. We term these semaphoric signals. They reveal some quality of the organisation as a whole, or of the goods or services it produces. The signal recipient must regard the quality signalled to be of importance. The costs involved in generating the signal are also significant and do not in themselves increase productivity, and the risks of signalling are proportionally higher for dishonest signallers than they are for honest signallers.

Information Systems as Semaphoric Signals

In the following cases we consider examples of investment in Information Systems where the justification for such investment cannot be conventionally supported but is made on the grounds of the value of its market signal. We call such systems 'semaphoric information systems'.

Real-time parcel tracking.

United Parcel Service (UPS) and Federal Express (Fedex) have both established themselves as major international players in the logistics market. Both offer a high quality service, and both enjoy high levels of customer satisfaction [12]. They have also both deployed semaphoric IS in the form of real-time parcel tracking.

While there are many similarities between these two organisations, there is a significant difference in corporate culture. UPS began as a bicycle messenger service and prides itself on reliability and dependability. "[The] press describe us as a plodding and disciplined company" said then UPS Chairman Jim Kelly [13], but dull and reliable were attributes that UPS were proud of. In contrast, Fedex was funded by venture capital, began with a purchase of a fleet of aircraft and established itself in the niche overnight delivery market.

Fedex pioneered web-based package tracking in 1995 [14]. It was a development that UPS did not immediately appreciate. "I thought … that the cost of supporting real-time package tracking would never be justified", admitted Jim Kelly [13]. Kelly was not alone in this view. "We don't want you to remember tracking an overdue package: if the package is overdue, the sooner you find it and forget about the whole thing, the happier we will be" suggests web design commentator Bernstein [15]. Nevertheless UPS quickly followed Fedex and introduced the service. We argue that the justification for doing so lay in their intention to send a signal to their customers of their reliability.

Ultimately, this signal was appreciated by UPS' customers despite their reputation for reliability. By 1996 UPS were receiving 1 million queries a month. By 1998 this hit 1 million queries a day, and by 1999 it had reached 2.5 million per day. By 2002 the figure had risen to 6.6 million tracking requests per day [16,17].

Signalling with Enterprise Information Systems 2: Clinical Trial Registries

The success of the pharmaceutical industry in developing medicines that have cured disease and alleviated suffering might have made them the heroes of the age, but is this the case? Fiona Godlee [18], in an editorial for the BMJ, wrote:

"If there's one group in urgent need of repositioning it is, as even members acknowledge, the pharmaceutical industry. … When your customers see you as 'manipulative, dark, menacing,' you could be said to be losing the battle for hearts and minds."

The pharmaceutical industry itself is highly regulated, and the medicines development process involves a rigorous process of clinical study design, conduct and reporting. As part of the regulated process all clinical studies are reported to the relevant authorities. Requirements and coverage of regulated systems is patchy and not always publicly available. The European Union clinical trial registry, EudraCT, in which studies are recorded as a part of the regulatory process is not openly accessible [19].

Information is disseminated via publication in peer review journals, where the results are open to careful scrutiny. While peer reviewed journal articles have been the standard method for disseminating scientific knowledge for decades this system has serious shortcomings. Some information may not be published and so not reach the wide range of interested parties such as prescribers and other medical practitioners. Peer review journals also have a built in time lag and give no assur-

ance of a complete disclosure of information, there is also a bias in published studies in favour of positive or promising results [20]. Trials are frequently reported several times, leading spurious weight to the findings [21] and it may be difficult to determine how many trials have in fact been done [22]. By 1999 both the British Medical Journal and The Lancet felt the case for a register of randomised trials was unanswerable [23].

The lack of trust in pharmaceutical companies, and the need for transparency to signal honesty, is appreciated by the industry, and in 1998 the Chairman of GlaxoWellcome Richard Sykes announced that a basic clinical trials registry would be set up. This would be an internet based application, openly accessible, in which variable amounts of information about clinical studies being undertaken would be recorded and published, and would cover all of GlaxoWellcome's completed Phase 2 to Phase 3 studies which are the studies required for registering a medicine. Protocols for completed studies were to be registered at regulatory approval. Sykes stated:

"GlaxoWellcome has taken the lead in disclosure of information, and I hope that the rest of the pharmaceutical industry will join this initiative. As knowledge based industry we understand well the value of information, and we want to create a climate of openness where the evidence for prescribing our products is clear" [24].

In 2004, Eli Lilly & company launched its clinical trials registry, which it claimed was 'the most comprehensive effort to date, by either a public or private entity, to publicly disclose clinical trial information' [25]. Novo Nordisk made a similar release of their register stating 'We're conducting our business in a transparent way, and offering information on our clinical trials activities should be seen in this perspective'[26]. By 2008 most major pharmaceutical companies had clinical trial registries publicly accessible via the internet.

Once Glaxo had signalled its honesty, other pharmaceutical companies were obliged to do the same because not to signal would imply something to hide.

While clinical trial registries appear to display the features of an semaphoric system, there is a further factor to consider. In 2004 Glaxo faced prosecution for failing to make public clinical-trial data that raised concerns about the safety and efficacy of one of their products used to treat children with depression [27], and this renewed calls for compulsory registration of clinical trials in a public registry. The International Committee of Medical Journal Editors instituted a policy that required that clinical studies be registered in order to be considered for publication [28]. In 2009 Section 113 of the FDA amendment act came into law [29], requiring registration of clinical studies for current and future trials.

The trend is clearly for clinical trial registration to become a regulatory and stakeholder requirement but ahead of this many large companies have developed their own publicly available registries, and advertise that they are exceeding the requirements and the timelines. This illustrates that some aspects of semaphoricism are not only non-optional as far as competitors are concerned, but may even become a regulatory requirement within a sector.

Discussion

The case studies described above lead to the following observations on the characteristics of semaphoric systems.

The signal reveals some quality of the organisation as a whole, or of the goods or services it produces. Real-time parcel tracking signalled reliability, while the Controlled Trials Registry signalled honesty and transparency. In the case of PowerPoint the quality was professionalism and preparation. These are all qualities that the signal recipient regards as being important.

The costs involved in generating the signal are significant and do not in themselves increase productivity. The cost of installing a real-time parcel tracking system provides information for customers but does not ensure trucks leave fully-laden or on time. However, a logistics company that has a highly efficient operation with good quality assurance systems will find the cost of implementing a real-time parcel tracking service less onerous than a logistics company that does not have these systems in place. The same is true for Clinical Trail Registries. Making clinical trial data accessible limits the company's ability to market its products, but an honest pharmaceutical company that has a solid evidence-based foundation for the efficacy of its products will find this less limiting than a company that does not have this evidence.

Implications for Clinical Information Systems

Adoption rates for clinical information systems are driven by a variety of factors, and the clinical maxim *Primum non nocere*, 'First do no harm', applies here. The negative effects of clinical information system manifest themselves in increasing demands on clinician's time and decreasing patient satisfaction.

The effect of clinical information systems on clinicians' time is controversial, and may vary between implementations and between individual users. Saving time is frequently cited as the motivating factor in adopting information technology (Hier et al. 2005; Ash and Bates 2005; Irani et al. 2009). Implementing information systems is a hazardous undertaking in healthcare and other sectors, and a large number of implementations fail. Systems which place burdens on the clinicians' limited time are less likely to succeed [30].

Several studies on the effect of the use of clinical information systems have, in general, found that the effects on patient satisfaction are neutral or slightly positive [31], and that computers can be integrated into the clinical consultation without a detrimental effect on patient satisfaction [32]. This is consistent with a review of earlier studies done between 1980 and 1997 [33]. While clinicians do express reservations about the effect of the computer on professionals' interactions with patients [34], the literature suggests that clinical information systems do not have a negative impact on patient satisfaction.

While this may be true of clinical information systems in general, it is not be true of all clinical information systems. While clinical decision support systems have been shown to improve patient safety and clinical decision-making, there is evidence that patients do not value the benefits of computerised decision

support systems and have less esteem for clinicians who use these systems[35, 36].

One explanation for this is that patients expect clinicians to be concerned, compassionate and knowledgeable, and expect clinicians to signal these qualities. It can be argued that computerised decision support systems send the opposite signal. They suggest that the clinician is not knowledgeable because they need to look up information, that the clinician is more concerned about recording 'hard' data and following protocols than about the patient's idiosyncratic needs, and the impersonal nature of the CDSS's knowledge base is contrasted unfavourably with human judgement, which balances compassion with necessity.

An awareness of the signals sent by clinical informatics systems may result in improvements in the design and structure of these systems. For example, a system that emphasises a primary care clinician's gatekeeper role, and demonstrates their knowledge of the availability and quality of locally available services sends a positive signal. A similar system which concentrates on patient workflow and requires the clinician to behave as a clerk in bureaucracy sends a different signal.

Conclusion

The rate of diffusion of information technology has been slower in the healthcare sector than it has in other sectors, this cannot be ascribed to an anti-technology bias. It has been noted that physicians are adopt new technology enthusiastically, have embraced PACS, video cameras and BlackBerries, and will be more than happy to adopt information technology solutions that will improve their own lives and the lives of their patients [37].

Information technology is not neutral. The adoption of new technology does send a signal about some quality of the organisation as a whole, or of the goods or services it produces. In the case of the clinical information systems, the 'organisation' is embodied in the person of the clinician, and clinical information systems send a very personal signal about their quality.

Developers who would like clinicians to adopt their information technology solutions need to be aware of the signals that technology sends, and to concentrate on developing systems that send appropriate signals.

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