2003

An Alternative Theory of Legacy Information Systems

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Abstract

Organisational dependence upon IT continues to grow yet experiences of satisfaction vary widely. Problematic, aged IT is often cited as being a fundamental problem in this respect and this is commonly termed legacy information systems. However, in this paper the author offers an alternative, and arguably more comprehensive, theory of legacy information systems that accommodates multiple viewpoints and recognises its inherent dynamism. The paper suggests a theory of legacy information systems that comprises of the concepts of temporal effects, interpretations and characteristics. It is argued that legacy information systems are constructed of many 'legacies' that are handed down continuously, forming an amorphous set of socio-technical interdependencies and relationships.

Keywords

Legacy Information Systems, organisational change.

1. Introduction

Organisational dependence upon information technology (IT) continues to grow and is at the heart of many organisations operations and strategies, particularly in the 'e-era'. In the midst of this, it is easy to focus upon the latest technologies, organisational concepts or just the 'buss' of the moment and hope to reap instant rewards (Markus and Benjamin 1997; Howcroft 2001) - but what about fundamental issues such as legacy information systems that we do not traditionally view as interesting? The benefits of, information systems are espoused by vendors, consultants, people in organisations and academics yet we still struggle with them. Legacy information technology, information systems and legacy systems have become widely favoured terms for the description of problematic IT by such groups. Although many studies have argued for multiple perspectives in areas such as systems thinking (Checkland 1981), systems development (Wood-Harper et al. 1985) and strategic information systems (Ciborra and Associates 2000), attention to legacy information systems is scant. In response, this paper explores the multiple meanings and characteristics of legacy information systems. I have adopted the term 'legacy information systems' for the remainder of the paper as it this is more inclusive and comprehensive than legacy IT or legacy Systems[1]. I aim to demonstrate the connections and overlaps that exist

[1] Legacy IT focuses upon technology and legacy Systems ignores the informing role that the term legacy information systems captures.

amongst the constituents of legacy information systems and recognise that attempts to demarcate the subject introduces problems. In offering a structure for the argument the idea is that the overall flavour of legacy information systems emerges.

In the next section, I outline an alternative theory of legacy information systems. This is followed by a detailed review of the characteristics of legacy information systems as reported in the literature – the review is organised in subsections dealing with issues of longevity, functionality, perceptions of technology and structure. The review is used to exemplify the proposed theory and is followed by a summary incorporating an illustrative theoretical framework.

2. Multiple Views of an 'Old' Problem

Throughout the field of IS the concept of legacy information systems is widely recognised. However, the most pervasive notion has been that of technology that is old, outdated, in a state of disrepair and that does not satisfy organisational demands (Nassif and Mitchusson 1993; Alderson and Shah 1999). Furthermore, they are commonly associated with high maintenance costs, obsolescence, poor documentation and lack of technical support (Warren 1999). As Wendy Robson notes:

> Whilst legacy information systems a beneficial thing in lay terms in an IS management sense it represents the problems caused by *past* acquisitions that no longer fully match *current* needs. (Robson, 1997: p. 456)

Of course, the list could be extended, yet it communicates the idea of the dominant perception of legacy information systems as problematic (and we shall explore the range of characteristics in greater depth as the paper progresses). I would suggest that legacy information systems are not necessarily problematic or focused on IT. Instead, legacy information systems can also be viewed as an asset to an organisation. It has for example, been argued that the real value to the organisation of legacy information systems lies in the accumulation of business rules, policies, expertise and know-how that they embody (Kim 1997). However, I do acknowledge that problems can arise when the legacy information system inhibits organisational adaptation to environmental change or strategic vision (Alderson and Shah 1999). Although legacy information systems are often linked with IT, it is important to highlight the inextricable interdependencies and relationships with the context in which it resides. This has been referred to as organisation/business legacy and is, to some extent, a demarcation of the IT and Organisational context (Kawalek and Leonard 1996; Bryant 1998; Kelly et al. 1999). Considering the 'softer' aspects of legacy information systems is essential as will be highlighted throughout this paper.

Strictly speaking, 'legacy' does not embody problematic connotations, nor does it necessarily embody good things. Legacy merely implies something that is handed down and is therefore, in some senses, neutral (Allen 1990). Therefore, legacy *information systems* should be viewed as handed down IS. We can argue however, that the concept legacy information systems embodies less than neutral characteristics when situated in a context. In-context legacy information

systems may hold favourable and unfavourable properties. These properties may also be subject to interpretation via different lenses. For example, the process of implementation of call centre technology into a previously paper based sales department leads to a revision in legacy information systems conditions. At the same time this introduces processes that allow senior management to monitor telesales staff performance. We can see that the legacy information systems conditions improve for senior management, yet they may deteriorate for those that are being monitored more closely.

Furthermore, legacy information systems are not static. Robson (1997) in her discussion of systems migration states that a legacy information systems issue is concerned with how to keep enough processing and human resources working to permit the phasing out and replacement with new systems. Laudon and Laudon (2000) offer insights in much the same vein indicating that, typically an organisation's legacy does not support newly designed business processes and that these business processes are islands in a sea of inherited legacy business practices from long ago. Singh (1997) also refers to legacy as the 'previously installed'. The term installed, implies that 'once it's in, it's in' and it will not change. Legacy information systems are dynamic, particularly when the in-context situation is an organisation. In the previous example of the call centre, the IT based replacement for the paper-based system merely becomes part of the legacy information system. The process of implementation could also be seen as part of this. If the senior management communicated that the technology was being implemented to monitor staff for instance, this would undoubtedly influence staff perception of the modified legacy information systems.

3. Towards a More Comprehensive View of legacy information systems

This section reviews the literature relating to the dominant characteristics traditionally associated with legacy information systems in order in order to highlight the problems of the current theories. The issues are categorised as being associated with longevity, functionality, perceptions of technology, and structure. The author is aware that these issues are rooted in IT and that the argument for the theory of legacy information systems recognises organisational and social issues. Admittedly, much of what follows is very much the traditional view of legacy information systems as bad, old technology. The review merely reflects the literature, even though on the surface it may be seen as conflicting with the aims of the paper. In response, the author prefers to see the review as a useful platform for the development of an alternative theory of legacy information systems by highlighting the futility of predominantly technically loaded thinking.

3.1 Longevity

Henderson (2000) rightly points out that as systems get older, inter-relationships evolve resulting in complex dependencies amongst various system components. Lauder and Kent (2000) infer a

problematic consequence of the longevity of legacy information systems stating that mature IS grow old disgracefully. They argue that although their lives may begin with a flexible architecture, repeated waves of hacking [changes] tend to petrify them resulting in accidental, inflexible architectures. Adolph (1996) concurs stating that constant patching makes the system's reliability questionable. Swanson and Beath (1989) also argue that as a system grows, it loses architectural integrity, staff become less familiar with it and maintenance activity increases. Therefore we have issues of complexity and inflexibility.

The Swanson and Beath (1989) view introduces further issues related to staff. These include the need to consider the capability of the organisation to be able to maintain and develop legacy information systems that has been in existence for a number of years. This issue can then also be divided into two areas: capability to do it for themselves or availability of someone else to do it for them. Legacy information systems may well have been constructed by people with skill sets that are scarce or unavailable in the current organisation and its environment (Singh 1997; Taylor et al. 1997). In 1995 for example, it was stated that fewer people were available with skills in the programming language, Assembly (Bennett 1994). In the late 1990s there was a deficit in certain packaged software configuration skills (Sumner 2000; Willcocks and Sykes 2000). These skills and knowledge sets therefore become incredibly valuable to user organisations and contractor/vendor organisations. This situation may also be exacerbated when organisations are pushing and being pushed to develop IS staff to equip themselves with the skills sets necessary to implement new and emerging technologies (Brancheau, Jans et al. 1996). There are also issues related to this in terms of perceptions of legacy information systems. Are they just seen as what Adolph (1996) terms an 'old piece of crap'? Obviously the skills problem, discussed above, could also be applied to external sources, however there is a further problem from the external perspective in terms of the availability of the hardware and software itself (Adolph 1996). How do people in organisations deal with discontinued product lines if a piece of equipment fails or they need to re-install software they have lost? The author encountered an extreme example of this when engaged on another piece of research in 1998. An external consultant working for a large retail group mentioned in an interview that he had spent the last four days searching the United Kingdom for a Winchester disk (which he obtained in the end!).

3.2 Functionality

Issues of functionality manifest themselves in many ways. The most obvious is concerned with whether functionality meets existing requirements and, where it does not, how easy this is to remedy. As Ramage et al. (2000) describe, legacy information systems is often what is left after a change has occurred in the organisation, but not the system(s), leading to a gap between the functionality they provide and the needs of the organisation. Again, we can see connections amongst the characteristics of legacy information systems as contributors to this state of affairs. For example, in the accompanying covering letter of the Kearney Management Consultants (1984) report it is suggested that it may be related to changes in emphasis from the 1960's and 1970's where relatively inflexible, costly and complex machinery was used to automate simple repetitive tasks. Looking at this in greater detail, Adolph (1996) suggests that functionality difficulties may occur for instance where users want features that can't be grafted onto the 'old' system, where there are limited storage capabilities or unusual restrictions such as 80 column records (perhaps due to a short term view of the longevity of the system, or limitations of the

build later). The issue of functionality, where this becomes problematic, is to some extent concerned with responsiveness Edwards et al. (2000). Changes in functionality may be required to respond to changes in the organisations macro-environment. However, legacy information systems may also be responsive to user needs. Bennett (1994) points out that the system may still do useful work and be reliable. However, he also notes that users may extensively rely on undocumented features meaning that although the system may have value, issues may arise if that functionality fails at any time. Recently, work has emerged which attempts to elucidate the problems of evolutionary complexity. Kaasbøll (1997) focuses upon developing an understanding of adaptive maintenance in relation to how numerous improvements may add up to negative effects. In his example, several user led functionality improvements to the legacy information systems gradually slowed down the operation of the system to such an extent that the users complained. Kaasbøll (1997) cages this as 'counter finality' - the concept that individual actions may create collective results that were not intended.

3.3 Perceptions of the Technology

Many people in organisations do not realistically anticipate how long the information systems that they introduce are going to last for. For example, in 2002, one of the largest financial services companies in the UK is still using legacy information systems that were developed in the 1960s using the Assembly language. Indeed, the year 2000 revealed many problems inextricably linked with perceptions of how long the various information systems would be in use for. The problem with not perceiving that technologies may be in use for a number of years leads to the emergence several of issues. In consideration of the dynamic characteristics of legacy information systems it has been conceptualised as forming part of the environment for new developments (Warboys et al. 2000). As reported several years ago:

> "difficulties are foreseen in interfacing with existing equipment or systems. To a large extent, this is a criticism of the suppliers of both office automation and data processing facilities who have failed to anticipate future needs and supply flexible interfaces. It is also a result of a piecemeal approach to finding a solution where short term expediency has been taken at the expense of long term integration. Today's opportunity to buy a multiplicity of different equipment was quoted as 'leading to greater, and not fewer, such problems'."
>
> (Kearney Management Consultants, 1984: p. 27)

Even though the quote was taken from a report dated 1984, organisations are still experiencing legacy information systems problems bound up with this issue. It is clear that that people in organisations and suppliers, need to take a longer-term view of what is essentially the development of their legacy information systems. The problem also involves academia and society in general. For example, associated with the idea of longevity are peoples' attitudes to how long they anticipate working with an information system and this has no doubt been influenced by a number of groups. Lehman (1980) for instance, argues that in the 1950's the ecstasy of instructing a machine to undertake computations at undreamt of speeds overshadowed the rather dull need for a guiding theory and discipline. Equally, it has also been suggested that

developers think 'legacy information systems' work is tedious (Adolph 1996), and that they may prefer to work on new developments instead (Bennett 1994). How many undergraduate and postgraduate students want to learn about Fortran or Cobol after the advent of Java, Visual Basic and XML? Moreover, it has been suggested that, historically, IS development has received a higher priority than maintenance due to the growth of IS in the 1960's and 1970's (Swanson and Beath 1989). This may lead to action not being taken that attempts to synchronise the software with the organisational needs, the absence of knowledge management regarding legacy information systems and consequently, the need for the deployment of increased levels of resources required to understand legacy information systems when maintenance does occur (Bennett 1994; Taylor et al. 1997).

A further issue associated with perception is organisational comfort in dealing with legacy information systems problems. It is suggested that a dominant characteristic of problematic legacy information systems is that they are confusing, not well understood and display high levels of entropy (Taylor et al. 1997; Kelly et al. 1999) even though developers may assume that organisations know all about them (Adolph 1996). This confusion is equally traceable with regard to perceptions of what may 'solve' the problem. Legacy information systems is often cited as embodying the critical business processes. Indeed, Ramage et al. (2000) suggest that legacy information systems may be the sole explicit embodiment of a business process that has otherwise passed into tacit knowledge. Lauder and Kent (2000) concur in arguing that legacy information systems can be an asset, as through years of debugging effort, they will have grown to reflect essential tacit knowledge. A different approach is taken by Alderson and Liu (2000). When trying to understand legacy information systems, they assume that any documentation, including source code, is out of date and inaccurate. They also assume that staff with technical knowledge of the system are unavailable. Their suggested approach is to observe the operationalisation of the system. Another view suggests that due to enormous investments in software, there is little likelihood that it can be replaced, it would be too costly to reprogram and there is minimal knowledge about what it does. Therefore, despite the imperfections of legacy information systems [where they exist] portions must be reused (Blum 1996). There are problems with all of these approaches: i) assuming that legacy information systems reflect reality denies the existence of users developing coping strategies such as work-arounds, ii) relying solely on observation of the operationalisation of the legacy information system cannot afford a full appreciation of the detail of its workings and iii) to assume that in *every* situation that it is not possible (or necessary!) to rebuild legacy information systems runs counter to organisational experience - not least the trend toward the replacement of bespoke/custom software with packaged software.

3.4 Structure

It has already been suggested that, over time, the structure of legacy information systems may degrade and this can lead to problems in understanding how the system works for the purposes of development and maintenance activities in response to organisational requirements. Bennett (1994) suggests that legacy information systems will usually be characterised by absence of structure, little documentary support and generally only source code as a lens for understanding. He also suggests that the reason for this state of affairs can be linked to the early days of software engineering where system clarity and structure were subservient to the need for

operational speed. Even though state-of-the-art techniques may have been used at the time, such an approach may encourage maintenance that rapidly degrades structure. The views of Lehman (1980) and Arthur (1988) agree with this arguing that software changes may have been poorly designed, imposed and implemented with little thought given to the need for a possible re-write of the design or the potential for the introduction of bugs. Kearney Management Consultants (1984) have also stated that short-term expediency has overtaken the need for a view of long-term integration. Moreover, the problem is exacerbated by the lack of formal documentation. If documentation does exist, there is often a discrepancy between the documented description of the system's function and its actual function (Adolph 1996). The problem of having to deal with untidy structure is compounded in consideration of the dimensions of the legacy information systems. It is argued that large software programs will comprise thousands of lines of code. Arguably this makes them difficult to deal with, unlike small software programs (Bennett 1994). Unfortunately, the issue is not that simple. The complexity of the legacy information systems cannot be viewed in 'lines of code' terms. Even from a technical perspective, the complexity may be in the line of code its self rather than the number of lines. How does the line of code interact with other lines of code? What language has been used? How common is it? Who understands it? Is the program connected to others? Critically from the organisational perspective we need to consider the importance of the program and to whom.

4. Discussion

The analysis of literature reviewed for this paper reveals the prevailing view of legacy information systems as old and problematic. However, the literature also opens up areas where the value of legacy information systems is very much subject to interpretation. The fact that a system (and its constituent parts) has been in place for some time does not necessarily equate with negativity. People in organisations that are part of the legacy information systems will be valuable in themselves as may be the technical component - it may contain data of value and staff may be comfortable with its outputs and the way it operates. Fine-tuning over a number of years may also mean that even though it is costly to maintain, it may support distinctive competitive strategies. Conversely, more recent legacy information systems may display problematic characteristics for many reasons including the way they were introduced or the skills available to support a technical aspect if it has proved popular with other organisations (such as ERP packages).

Despite predominantly focusing upon the technical perspective of legacy information systems the literature opens up inextricable links with 'non technical' issues. These offer significant support for a more comprehensive and inclusive view of legacy information systems that recognises social and organisational characteristics. A lack of technical expertise to maintain a system (new or old) is obviously not a technical problem although it is often treated as such. It is perhaps more readily though of as a staffing problem. Similarly, whether the technical component of a particular legacy information system is viewed as problematic or favourable may very much be concerned with the perceptions of the role and longevity of it by organisational members.

Finally, contrary to their general treatment in the literature, legacy information systems can be interpreted as dynamic. The environment comprises technical, social and organisational artefacts and we can see that these are constantly changing and impacting upon each other. For

example, the technical - through development and maintenance activity, and the organisational - through staff turnover, and strategic responses to macro-environmental changes. Thus, legacy information systems can be seen as a critical consideration in organisational change efforts.

Figure 1 details the thinking presented in the paper in the form of a theoretical framework. It uses three concepts – characteristics, interpretations and temporal effects.

> **'Characteristics'** refers to the nature of the legacy information systems. In this paper I have compartmentalised these under the headings of longevity, functionality, perceptions of technology and structure. Clearly, these are artificial boundaries and badges, as the characteristics of legacy will vary dependent upon the situation and interpretations of that situation as shown in figure 1. That is, for something to be characterised as legacy information systems, it has to be interpreted as such.
>
> **'Interpretations'** are concerned with how the characteristics of legacy information systems are viewed – essentially this highlights its subjective and interpretive nature. The argument here is that different viewpoints of the characteristics that constitute the legacy information systems may exist. Note however, that some of these may have greater resonance due to the formations of intersubjectivities. What is not discussed here is which characteristics are the ones that are 'accepted' and worked with – that is beyond the scope of this paper but clearly various areas of interest such as information systems maturity and evaluation hold potential interest here.
>
> **'Temporal Effects'** suggests that legacy information systems are subject to time-based considerations. Essentially, the characteristics of legacy information systems will change over time due to such things as modifications to code, functionality extension and staff changes. As a result of these changes, and changes in context, the way that these characteristics are interpreted will change too.

In summary, the framework asserts that legacy information systems will have a variety of characteristics that are variously interpreted over time.

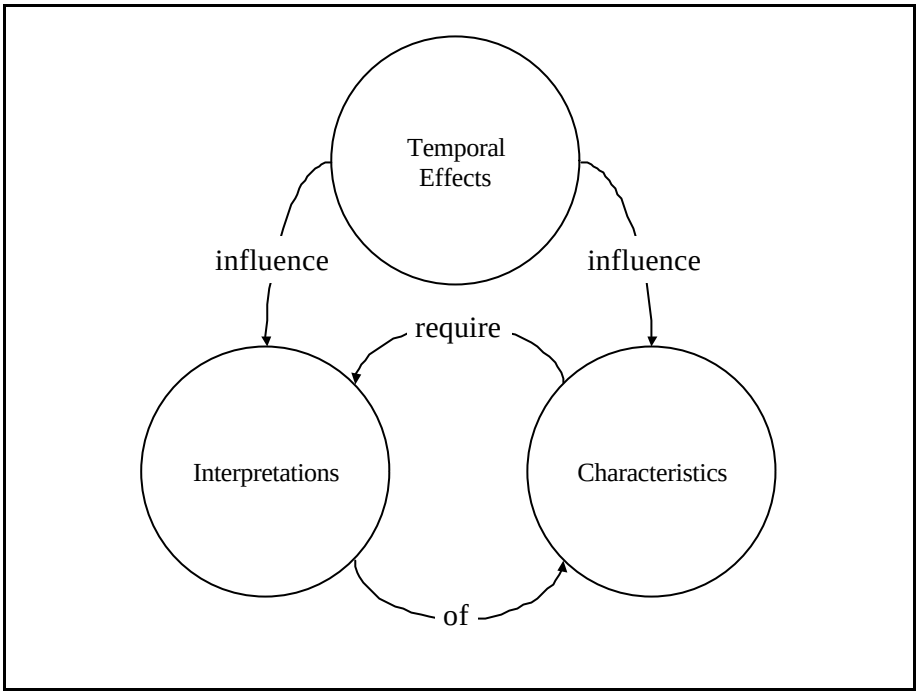

Figure 1: A Theoretical Framework of Legacy Information Systems

5. Conclusions

This paper acknowledges that organisational dependence upon IT continues to grow although many still struggle to obtain the full benefits from its implementation and usage. One source of the problem that is strongly represented in the literature has been conceptualized as legacy information systems. Unfortunately, the concept has been used illegitimately throughout the Information Systems and Computer Science academic communities, and the commercial world. Connotations of legacy information systems are generally strongly linked with ageing, static and problematic IT although some aspects of the literature do argue otherwise. However, these arguments have not been translated into a comprehensive view. The alternative theory of legacy information systems that I offer here attempts such a view. I am acutely aware that there may be problems with existing information systems that form part of organisations, particularly where these have existed for some time. However, it is also clear that legacy information systems (old, and not so old), may sometimes offer immense value to organisations, particularly when the concept is broadened to include social, organisational and technical considerations. Perhaps therefore discussions should revolve around legacy information systems problems and legacy information systems benefits. A final important strand in the paper is the advocacy of legacy information systems as inherently dynamic. The interactions amongst social, organisational and technical factors are made clear – processes of implementation, maintenance and organisational restructuring are some of the exemplars that highlight this point very well. I have been involved in discussions regarding a system developing into a legacy information system on many

occasions. Perhaps the answer in consideration of the alternative proposed here, is that everything already is a legacy information system.

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