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Making Research Real: Is Action Research a Suitable Methodology for Medical Information Security Investigations?

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Abstract

In the medical field, information security is an important yet vastly underrated issue. Research into the protection of sensitive medical data is often technically focused and does not address information systems and behavioural aspects integral to effective information security implementation. Current information security policy and guidelines are strategically oriented which, whilst relevant to large organisations, are less supportive to smaller enterprises such as primary care practices. Further, the conservative nature of the medical profession has been shown to hinder investigation into information technology use and management, making effective improvement based on research problematical. It is an environment which relies greatly on trust, inhibiting good security practice. Research into how information security practice in this setting can be improved demands an interpretivist approach rather than a positivist one. Action research is one such interpretivist method that allows a creation of scientific knowledge with practical value. Whilst there is some opposition to the action research method on grounds of rigour, its fundamental cyclic process of participation, action and reflection promotes internal rigour and can overcome many of the barriers to research inherent in the primary care medical environment.

Keywords

Primary care, general practice, risk assessment, electronic medical records (EMR), security, privacy, risks.

INTRODUCTION

It is widely accepted that the application of information and communications technologies can assist in the changes required to healthcare globally (Coombs and Hull, 1996; Cullen, 1998). Indeed information technology has been seen as a panacea for efficiency in this knowledge intensive area of society. Yet, despite the development of the Internet and electronic information delivery, the medical profession has not readily adopted these technological advances particularly in relation to electronic clinical record sharing (Williams and Mahncke, 2006). However, in Australia medical practice has been encouraged by the governments' Practice Incentives Program (Liaw and Tomlins, 2004, p.547) to use electronic systems. By 2004, 95% of general practices were using computers, with 84% for accounting, 87% for prescription printing and 70% used the Internet and email (Britt et al., 2004, p.14). This indicates that there is the need for good security practice at the primary care level as the percentage of use grows and sharing of sensitive patient record data becomes a priority for the government (NEHTA, 2006).

The terms computer security and information security are used interchangeably in general discussion. However the terms need clear delineation if an understanding of why information security is essentially an information systems activity is to be achieved. *Computer security* is defined as the "measures and controls that ensure confidentiality, integrity, and availability of IS assets including hardware, software, firmware, and information being processed, stored, and communicated." (Committee on National Security Systems, 2006, p.13), whilst *information security*, more commonly referred to as 'information systems security (INFOSEC)' is defined as the "protection of information systems against unauthorized access to or modification of information, whether in storage, processing or transit, and against the denial of service to authorized users, including those measures necessary to detect, document, and counter such threats" (Committee on National Security Systems, 2006,

p.33). In broad terms computer security is the term used for security objectives and tends to be technology focused, whilst information security is data focused and technology independent. In securing information we use software, hardware and process measures to protect the entire information system, inclusive of people and technology. In order to achieve adequate protection it is necessary to select a suitable research method to investigate why current implementation is inadequate, and to derive and test alternative solutions.

Currently, much of the research effort in security is focused on the technical aspects of problem solving. Kotulic and Clark (2004) attribute this to the intrusive nature of the investigation required to assess the risks in information security. Like any research, it can be approached from many perspectives: operationally, tactically or strategically. For instance Whitman (2004), Doherty and Fulford (2006), and Kankanhalli et al. (2003) have used strategic or managerial approaches to investigate critical success factors and other strategic indicators aimed at senior management. This is increasingly important in light of new information governance requirements (Moulton and Coles, 2003; Sarbanes-Oxley, 2002; von Solms, 2005). Other researchers have approached it from the tactical perspective in meeting standards such as ISO17799 and providing deterrents to computer crime (Foltz et al., 2005). To date this type of research into information security has focused on policy and guidelines. Minimal research has been undertaken in this area as the operationalisation of the tactical approach has been taken on by various professional bodies (AHA Insurance Resource, 1999; Schattner, 2005). However, research is now emerging into the effects of organisational culture on information security (Chang and Ho, 2006; Tsohou et al., 2006) and why security is handled so poorly at the operational level (Furnell, 2005; Furnell, et al., 2006; Leach, 2003).

Research has shown that systems developed with significant user input are more widely accepted and consistently used (Schwartz and Griffin, 1986), particularly where the methodology behind the design is understood by those who will use it. Therefore an information systems approach rather than information technology approach can be more beneficial when there are social and procedural, in addition to the technical and data, dimensions (Benson and Standing, 2002). Consequently, investigation into information security necessitates an information systems research approach if sustained adoption of well grounded and beneficial changes is to be made. This paper provides a comprehensive discourse in research methodologies and academic perspectives on research paradigms as they relate to information security research in a primary care medical context. In addition, the rationale for why action research may be the most appropriate research paradigm is undertaken, and the validity issues associated with this approach, are identified.

A Unique Research Environment

The medical environment has been shown to have specific barriers to research which is information systems in nature. The conservative nature of the medical profession has been shown to hinder investigation into information technology use and management. There exists a distrust by clinicians of computer based information systems and obvious discomfort when such systems are not well understood by users (de Dombal, 1993). Information security awareness has also been identified as a key issue for medical practice (Leach, 2003; Whitman, 2004; Williams, 2005a, 2005b). Further, the overriding cultural issue of trust inhibits clear distinction of the dangers inherent in protecting sensitive information (Stetson, 1997). Finally, deficiencies in the ability of staff to implement technical and process solutions have also been recognised (Furnell, 2005; Furnell et al., 2006; Holzer and Herrmann, 2002; Williams, 2006).

INFORMATION SYSTEMS RESEARCH METHODOLOGIES

To preface the discussion of methodologies, consideration of the information systems paradigm continuum (from positivist to interpretivist) is given. Subsequently, the methods used in information systems research and the selection criteria underpinning the choice of a specific methodology in scientific research are discussed. "Information systems is concerned with the effective use of information technology by people and organizations" (Shanks et al., 1993, p.2). Information systems research is therefore an applied research method which inherently includes a growth in knowledge within the area under investigation, and challenges how current professional practice can be enhanced (Shanks et al., 1993). Figure 1 demonstrates how an information systems research model can be constructed.

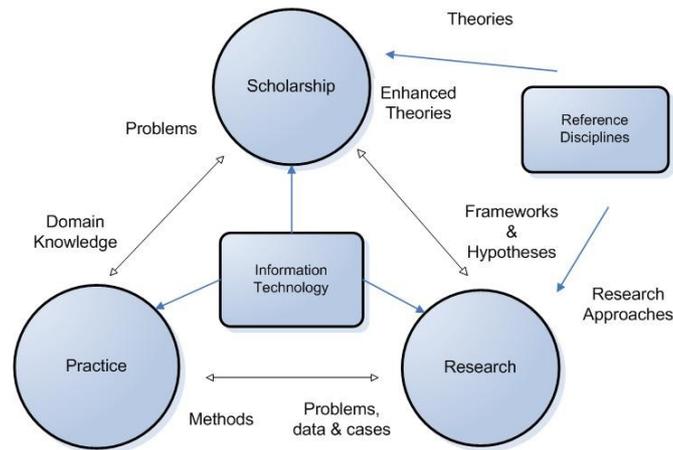


Figure 1. A Model of the Discipline of Information Systems (Shanks et al, 1993).

Positivist and Interpretivist Paradigms

Whilst the model in figure 1 gives a representation of the facets involved in information systems research, further consideration is required of the type of framework under which the research can be examined. Information systems research has traditionally been examined in terms of two differing paradigms, that of positivism and interpretivism. Positivism is the “philosophical system of Auguste Comte, recognizing only positive facts and observable phenomena, and rejecting metaphysics and theism” (Sykes, 1984, p.800). It is a framework using empirical investigation as its basis, and seeks to identify the regularities and interrelationships between elements within the environment under review. When the research environment includes numerous variables over which the researcher has no control, namely sociological factors, this paradigm becomes difficult to implement and may result in unsatisfactory or incomplete explanations of the environment in which social factors play a part (Kaplan and Duchon, 1988). However, there have been substantial publications on using the positivist approach to information systems research (Walsham, 1995).

In contrast to this, interpretivism (post-positivism) attempts to analyse the environment of interest by observing the inhabitants of the environment in situ, gaining insight into their actions based upon social interaction. Interpretivism opposes positivism in that it does not accept that people function in isolation. Interpretivism accepts that people affect, and are affected by, other social contacts and the environment in which they exist. Gaining involvement and raising the consciousness of participants increases awareness of the issues (Wuest and Merritt-Gray, 1997). This results in the participants being more than merely the recipients of the results, they add new dimensions to the problem and may have new perspectives on the solution. Data collection in the interpretivist context-dependent framework is usually qualitative in nature. “Immersion in context is a hallmark of qualitative research methods and the interpretive perspective on the conduct of research. Interpretive researchers attempt to understand the way others construe, conceptualise and understand events, concepts and categories, in part because these are assumed to influence individuals’ behaviour” (Kaplan and Duchon, 1988, p.572). There is an increasing acceptance of the psychological and social factors in the use of information technology (Baskerville and Wood-Harper, 1992; Klein and Myers, 1999; Wuest and Merritt-Gray, 1997), and this approach is gaining in popularity as an alternative to more classical approaches to information systems research (Walsham, 1995).

Within an information systems research framework, the two paradigms differ in that whilst positivism is concerned with research that can be replicated in order to confirm its validity, interpretivism is concerned with the results ‘making sense’ and being understandable within a given context. Therefore investigation into information systems intrinsically includes the way humans interact and function with others and technology. Therefore a positivist approach may not be the most suitable investigative paradigm for information security in the clinical setting, and that the role of prediction and applicability to a universal context is not necessarily desirable in the primary health environment (Wuest and Merritt-Gray, 1997).

Approaches to Information Systems Research

In order to select an appropriate method, it is essential to define the range of these approaches, and the work of Galliers (1992), suggests that there exists a continuum from positivist to interpretivist, between which the various approaches to information systems research can be placed, as in figure 2.

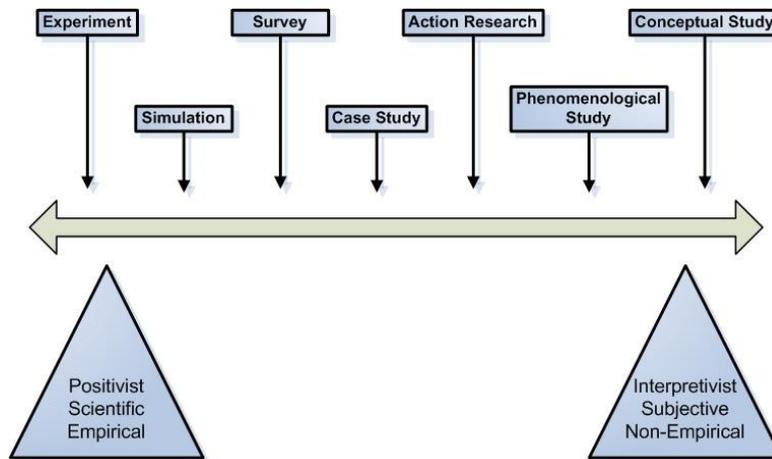


Figure 2. A Continuum of Approaches to Information Systems Research

Each of the methods in figure 2 is discussed in table 1, which is based upon the extensive work of Galliers (1990) and Avison and Fitzgerald (1991).

Table 1. Description of Information Systems Methodologies

Method	Key points of method	Strengths of method	Limitations of method
Experiment: Laboratory	Investigates quantitative relationships between variables to assess causal relationships within a controllable replicated environment. Statistical evaluations used for theorem proof.	Selection and control of a small number of variables.	Does not necessarily model the 'real-world' due to exclusion of possible contributory variables.
Experiment: Field	Undertaken within an organisation or society. Suffers from a lack of control or commitment by the organisation.	A real-world context with a selection and control of a small number of variables.	Not attempting to exert control within a context or limit the study to a small number of specific variables.
Simulation	Observation of situations where influencing factors are known but behaviour of subjects in relation to these factors is unknown. Problems exist in initially creating models of the real-world accurately.	Game/role playing (interpretivist simulation) is an accepted method of medical education and research (Atkinson, 1997),	Unable to simulate all the affecting stimuli of the real environment.
Survey	Description of a situation at a moment in time, relying on representative responses using questioning. Quantitative and qualitative data collected, primarily analysed using quantitative methods. Sample choice and representativeness of population are important in applicability of results.	Ability to derive accurate descriptions of the real-world. Can capture more variables than experimental methods.	Bias control is an issue. Rarely provides reasoning behind phenomenon being studied.
Case Study	Detailed examination of particular issues within an individual organisation or situation (case).	Can provide extensive information on factors under study and useful for hypothesis generation.	Lack of power of generalisation to a wider population and suffers from subjectivity by the researcher in the results.
Action	Similar to case study approach in	Iterative cycle within	Similar to case studies in

Research	describing richness of an environment, and is similar field experimentation in working in situ, however the method adds intervention and reflection.	a real-world context of assessment, action and reflection, with potential participant input. Practical and applicable outcomes.	generalisation to a broader community, lack of control over variables and subjectivity of the interpretations.
Phenomenological studies	Interpretive and descriptive. Designed to dissect and explain the link between social situations and 'thinking' (beliefs, preconceptions, and thoughts).	Can produce explicit understanding of the situation under investigation.	Interpretive nature of the material [researcher biases and assumptions], and the inability to exclude alternative explanations.
Conceptual studies	Critical analysis of a current knowledge base or environment in terms of the 'subjective beliefs'. More free-flowing and less structured than other methods.	'Thinking outside the square' and promoting innovation. New idea development and theory building.	Sometimes seen as argumentative because of the subjective / speculative nature of the data. Inability to identify potential causes of bias and interpretation subjectivity.

Analysis of Approaches

The analysis of the methods in table 1 is undertaken with specific reference to medical information security research. The positivist experimental approach often portrays the user in the context as passive whilst examining variables quantitatively (Kaplan and Duchon, 1988). In information security research causal relationships are not sought, nor would it be possible or desirable to exert control over the research participants and their environment. Information security research aims to obtain an inclusive assessment of the context and real-world environment in which the participants are active rather than passive, and hence an experimental approach is unsuitable. Survey is a possible approach in terms of descriptive outcomes, however it is limited in application to information security as it omits the subsequently required elements of reflection and change. Whilst some survey methods are useful in gaining initial data, influencing and effecting change cannot be achieved by surveys alone. Additionally, the use of surveys does not detect the divergence in the reported respondents' behaviour and their possibly different actual behaviour. Case studies are useful for in-depth descriptions of specific situations, however in information security research it is not an aim to promote existential reasoning, rather to understand how the processes within a situation function, and how these can be affected by change. There is a need to intervene in information security research for which the case study methodology does not accommodate. In action research, the interpretivist philosophy of the method accepts that the researcher is aware of their presence and their research will affect the situation under investigation. This factor is intrinsic to the methodology as the researcher is aiming to produce both theoretical and practical outcomes (Galliers, 1990). The method allows a creation of scientific knowledge with practical value. Whilst phenomenological studies would allow an understanding of the processes used in information security and the thinking behind the implementation, this method does not include intervention and therefore does not support change within the target environment. Finally, conceptual studies may be useful in considering the subjective beliefs of the research participants in their application of information security procedures, however information security research does not aim to investigate the reasoning behind such beliefs, rather to explore how such beliefs and other factors affect information security implementation. This methodology is also non-interventionist.

SELECTION OF AN APPROPRIATE METHODOLOGY

This section presents the rationale for selecting action research as the most appropriate methodology for information security in the primary care environment, together with a consideration of the associated validity issues. Methodology selection requires a correlation of how the method objectives meet the purpose of the research and necessitates consideration of the expected outcomes of the research. In this case these are the suitability to the target environment, modelling the real world and engaging those the research aims to affect, otherwise known as contextual validation. Information security in the primary care context is exploratory and descriptive, and does not attempt to be explanatory. Further, reviewing Galliers' information systems research

taxonomy (1990) confirms that action research promotes theory building. The research objective is methodologically, not technology, based and can be applied in an interventionist manner with groups.

Susman (1983) described action research as intervening in social systems where a systematic method is present within each human activity. This premise was also instrumental in Checklands' (1981) subsequent development of soft systems methodology. Authors in the discipline of action research define it as interventionist, yet inclusive of theory formation, analysis, collaborative alteration of the activity and review (Baskerville and Wood-Harper, 1992; Wuest and Merritt-Gray, 1997).

“Action research can be described as a family of research methodologies which pursue action (or change) and research (or understanding) at the same time” (Dick, 1999, p.1). It is characterised by the cyclic revision of action followed by reflection often culminating in the refinement of the understanding using methods such as modelling. The iterative nature of the methodology promotes convergence to a greater understanding (Dick, 1999). Figure 3 characterises this cyclic process and shows how action research sets out to analyse a state of affairs in a given context. Once analysed, action (change) can be consciously added to the situation to improve it, and its resultant effect observed. Reflection on the change and resultant effects are then made to produce possible further action. The assessment, action and reflection are key elements of the research methodology.

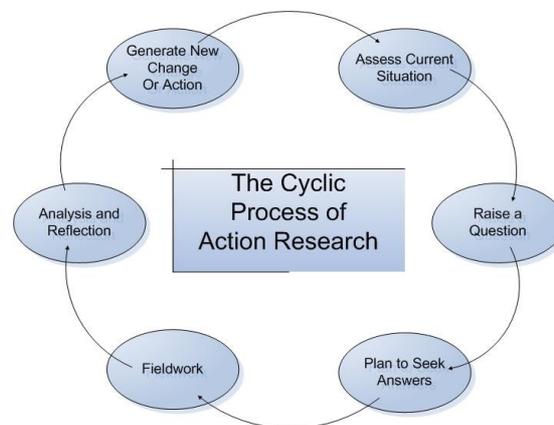


Figure 3. The cyclic process of action research (Wadsworth, 1998)

As a research method it is becoming a popular model for research into areas of social science and health, particularly those involving primary care (Wuest and Merritt-Gray, 1997). The methodology encompasses both the structural formality of traditional research with a sociological perspective. As an overarching methodology for information security research, action research cycle supports assessment of the current theoretical and real-world integration of information security practices to prompt question raising, planning, fieldwork, followed by analysis and reflection. Action research has been shown to take various theoretic frameworks forms when applied in information systems research (Ågerfalk et al., 2006). Such frameworks act as a lens through which interpretation and explanation of phenomenon in information security can take place.

Contextual validation

In order to prove the appropriateness of the method selection researchers must consider contextual validation. The influencing factors in this choice, most appropriate to primary care, includes the target environment, the need to model solutions in a real-world context and therefore the necessity to intervene, and the need to engage participation from the target population.

Target Environment

It has been shown that collaborative research between researchers and participants works well in the medical context where the purpose is to improve the adoption of appropriate research findings (Hoddinott and Pill, 1997a). This is particularly important when cross disciplinary research, involving sociological, cognitive, and computer science is undertaken. However, Jaye (2002) suggests that in-depth qualitative research with

engagement of participants and theory building has not been prevalent in qualitative research in general practice to date. The medical environment in which information systems research is based is well suited to the action research as a form of applied research methodology, where the inclusion of human interaction is paramount. Indeed Jaye (2002, p.560) says “there is growing recognition within general practice that the utility of qualitative methods should be accompanied by some degree of reflection and engagement in methodological issues”, and that this will result in creative problem solutions.

Modeling the Real World

There are “radical shifts in the social construction of medicine and health that are occurring as a result of the transition toward the ‘information society’” (Cullen, 1998, p. 1544). There is a need in health care to develop an environment where collaboration can occur between the technical development of systems and the stakeholders, and where the social and professional processes are aligned (Molina, 1993). Consequently, choosing the most appropriate research method is important, particularly where studies have found that issues arising from the introduction of information technology are mainly based upon the differing cultural and value systems of medical professionals. This has been observed, by Coombes and Hull, (1996) and others (de Dombal, 1993), to be due to an inherent mistrust by the medical profession to relinquish responsibility, and be subject to surveillance and control. Action research has been proven to be a suitable methodology for investigations into human transformations where “the difficulties users have in communicating the “deep knowledge” structures underlying routine or surface behaviours” (Cullen, 1998, p.1543) are apparent.

Engaged Participation

A significant limitation in the application of research to the medical field has been the lack of collaboration with practitioners, and the methods of dissemination of findings of qualitative studies through academia (Swanson et al., 1997). There exists limited literature on qualitative research undertaken in the primary care medical field, whereas in other disciplines such as education qualitative research methods have been employed extensively. Action research is a methodology that is based upon the premise that to promote a commitment to sustained change, an understanding of the processes by the participants will encourage process analysis, leading to changes of which the results are observed and analysed. Swanson et al. (1997, p.253) suggest that “a gap exists between the world of qualitative research and the world of practice. A creative bridge between these worlds is needed.” Engaged participation is one answer and action research can build this bridge.

Rigor and Limitations

According to some researchers, to establish rigor of action research, credibility, transferability and dependability of the research should be established (Dick, 1993; Lincoln and Guba, 1985; Thorne, 1997). Other action researchers suggest that validity is established in the process itself, through the iterative research cycles which enable reflection and confirmation on the previous experience by those involved. However, it is clear that there is an absence of agreed criteria for evaluation of action research studies. Although, any evaluation must be considered in terms of initial research goals. Process control is often difficult to predict and achieve in the cyclic process (Baskerville, 1999). Despite the evolutionary nature of the research, rigor can be maintained if the action research process is clearly defined and each stage documented. In addition, declaration of the research philosophy and objectives, together with the *a priori* knowledge of the researcher, can limit impartiality concerns. Also, it is essential the researcher display a full understanding of the impact their assumptions may have on the research (Jaye, 2002, p.560).

“Rigour relates to fitting the research methods to the problem in order to produce valid scientific explanations” (Baskerville and Wood-Harper, 1996). Adherence to scientific discipline using theoretical constructs, data collection and evaluation can provide evidence of rigour. Action research has been accused of being similar to consulting. However, action research and consulting are clearly differentiated in the rigorous documentation, theoretical justification, lack of time constraints, and the cyclical, non-linear, process employed by action researchers (Andriessen, 2004; Davison et al., 2004). The deductive-inductive interpretation of results means that care must be taken during the research to validate subjectivity and interpret results using complementary techniques such as triangulation and peer review (Barbour, 2001). Klein and Myers (1999) describe a set of seven

principles which interpretive field research should follow in order to ensure validity and rigour of the methodology employed, and in the subsequent result reporting. These principles state that the research must be aware and be cognizant of: the hermeneutic circle; contextualisation; interaction between the researchers and the subjects; abstraction and generalisation; dialogical reasoning; multiple interpretations; and suspicion.

Finally, it must be acknowledged that action research is a context specific research method and therefore generalisations should be avoided. Rigour is often associated with the ability to replicate results, however, Chapple and Rogers (1998) reflect that the theoretical basis upon which much of medical research is undertaken, that of replication in confirming rigour, may indeed not be necessary in the primary care medical setting:

“..the hallmark of good qualitative methodology is its flexibility rather than its standardization. The point of the methodology is not that it can be compared and applied across all other similarly controlled situations, but that it can be modified and be responsive to the peculiarities of situations as they arise in real-life social settings”. (p.557)

Due to the nature of intervention in the target medical environment, it can be argued that the learning achieved from the action research methodology is limited in application, because unlike empirical research specific event occurrences cannot be replicated (Baskerville and Wood-Harper, 1992; Susman, 1983). This issue can be addressed by triangulation, confirming or denying specific findings (Barbour, 2001; Chapple and Rogers, 1998; Hoddinott and Pill, 1997b; Johnson, 1997). Moreover the idea that generalisations can only be made by context independent research for qualitative data collection is being questioned and reframed into transferability (Johnson, 1997). This is particularly valid when considering the goal of descriptive research using qualitative data to understand a problem in depth and to learn from it, rather than the derivation of generalised findings.

Limitations

From a traditional research perspective, the problem in using action research is that it cannot be fully planned or channelled toward a particular path. Whilst the researcher can delineate aims and objectives, the detailed execution of these cannot be designed with certainty as responsiveness to the situation is important and outcomes may not be predictable (Baskerville and Pries-Heje, 1999; Checkland, 1981). This is frequently a source of discomfort for positivist researchers. The choice of action research as the overarching research paradigm dictates that any research design will spiral from general investigation cycles to more specific cycles. Thus, a gradual refinement of the research objectives will be apparent. As this form of research aims to develop both an increased understanding of the context, and to promote appropriate change, an exact map for each cycle is not possible at the start of such research. In addition, action research is time consuming and is only one way of viewing complex problems (Zuber-Skerritt, 1992, p.78). It is also sometimes problematic in terms of validity in that from a positivist stance the method lacks precision and quantifiable results. However, the method does not set out to be unbiased and be objective (Zuber-Skerritt, 1992, p.105). Its very nature ensures that a subjective viewpoint will be derived, and emergent theory from the interpretation of human behaviour within the context under investigation is the result.

CONCLUSION

In the primary care medical context, the barriers to information systems research and information security deficiencies require that responsiveness, participation and reflection are required to fully investigate information security practice. The use of action research can provide a pragmatic approach which is requisite for improvement in real-world practice. As Lau (1999) points out it can “contribute to new knowledge on the consequences of IS through intellectual reflection and learning from the changes instigated”. Research techniques such as action research are ideally placed to undertake studies in general practice and create frameworks for change. Trauth and O’Connor (1991, p.132) suggest such research is necessarily qualitative and should reflect that the “relationship between information technology and society is an iterative one”, and that such investigation requires “an emphasis on triangulation and reflexivity”. Imposing change without engagement in clinical practice most often creates defensive behaviour and non conformance (Greco and Eisenberg, 1993).

Methods such as action research can assist in closing the divide between theory and practice, and overcome some of the inherent barriers to change in general practice.

If information security practices are to be understood then the development of realistic theoretical frameworks are required. The ability to be able to apply and build on such frameworks for the subsequent research necessitates the need for "...systematic understanding to arise from activities which are oriented towards change. It [action research] has a capacity to respond to the demands of the informants and the situation in a way which most other paradigms can not "(Dick and Swepson, 1997, p.1).

Research into changing physician behaviour (Bauchner et al., 2001; Greco and Eisenberg, 1993) indicates that passive dissemination of new information and guidelines are not effective, whilst implementation of these sources through organisational (practice) routes can be effective. It is also iterated that more than one approach to change is necessary and that the barriers to change must be understood. Motivation for such research must be grounded in a desire to promote both a theoretical viewpoint and sustainable practical application. This paper has given a logical justification for action research as the research methodology of choice for information security research. This rationalisation included a review of information systems research methods and the basis for these in terms of the underlying positivist and interpretivist paradigms. Further, in consideration of the context specific factors of target environment, modelling of the real-world and necessity for engaged participation action research has been shown to meet information security research requirements in primary care.

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