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EVIDENCE-BASED INFORMATION SYSTEMS: A DECADE LATER

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Abstract

The "evidence-based practice" paradigm was proposed to IS researchers a decade ago. Since then evidence-based practice has become established across a range of disciplines, but it has received relatively little attention in IS. This paper explains the idea of evidence-based practice and reviews the related work found in the IS research literature. Some possible reasons for the lack of widespread adoption in IS are suggested. Systematic literature reviews (SLRs), a key research method in evidence-based practice, are explained. Recent developments in SLRs are discussed, which enable a richer and more nuanced approach to understanding information systems than found in conventional SLRs. It is proposed that these developments now make SLRs more suitable for synthesising empirical studies in IS. Greater use of SLRs by IS researchers would enable us to develop a cumulative knowledgebase of use to both researchers and practitioners.

Keywords: Evidence-based, Systematic literature reviews.

1   Introduction

At the 2000 *European Conference on Information Systems* (*ECIS*) a paper was presented (Atkins and Louw, 2000) calling for "evidence-based information systems". This call has been repeated in a recent *MIS Quarterly* article (Baskerville and Myers, 2009), which argues that information systems (IS) researchers should be more actively engaged in disseminating their findings to practitioners and "contributing to the practitioner press by providing evidence-based, positive or negative critiques of fashions." Since Atkins and Louw's (2000) call a decade ago, the concept of evidence-based practice (EBP) has become established across a range of disciplines. One objective of this paper is to examine its take-up in IS, revealing that it appears to have received relatively little attention. The main objective of this paper is therefore to introduce EBP to IS researchers who may be unfamiliar with it, focussing in particular on one of its key research methods, the systematic literature review.

This paper's structure is as follows. The paper explains the idea of the EBP paradigm (section 2) and reviews the small body of work concerned with EBP in IS that were found via a literature search (section 3). This search confirmed that the EBP paradigm has not become established in IS. Some possible reasons for the lack of widespread adoption in IS are suggested (section 4). One possible reason is that EBP originated in evidence-based medicine, whose focus, models, positivist research philosophy and research methods do not match those found in much IS research. The paper therefore explains how the original evidence-based medicine approach has now been criticised, adapted and modified in the social sciences, whose foci, models, philosophies and methods are often shared with IS (section 5). An important element of EBP is the systematic literature review (SLR). The paper explains how recent developments mean that a SLR as practised in an evidence-based social sciences approach provides a more nuanced and richer understanding of a topic than the simplistic, positivist approach common in evidence-based medicine (section 6). The paper concludes (section 7) by proposing that this more nuanced approach to SLRs be explored and adopted/adapted by IS researchers to help develop and share cumulative knowledge about information systems.

This paper contributes to the discourse about research methods in IS by: 1) explaining the EBP paradigm to those unfamiliar with it, 2) reviewing EBP-related publications in the IS literature, and 3) providing an overview of a newer approach to SLRs which developed in social policy research and which, it is argued, may prove a more useful research method for IS researchers than the conventional SLR approach as practised in evidence-based medicine. If more IS researchers undertake SLRs, we can start to develop the necessary knowledgebase to support evidence-based practice in IS.

2   Evidence-based Practice

Atkins and Louw (2000) argue that the volume of IS research publications is increasing, making it difficult for IS researchers to achieve and maintain an overview of the pertinent research in their subject. At the same time, they argue, IS practitioners often base their decisions on in-house expert opinion, gut feeling, or current fashion, without being aware of relevant academic research; if they do consult the academic literature they find it confusing, often contradictory, and hard to access. Evidence-based medicine developed from the early 1990's in response to a similar situation. Clinical practitioners were urged to move away from decision-making based on habit, prejudice, consultant's authority or imperfect knowledge of relevant research. Instead they should search the literature for the best available empirical evidence, critically appraise the study methods to evaluate the validity of the reported research results, and combine this evidence with the values and preferences of their patient to make the best possible decisions about the patient's treatment (Sackett et al, 1996). The prestigious *British Medical Journal* has listed evidence-based medicine as one of the 15 greatest medical

milestones since 1840 (Montori and Guyatt, 2008). Atkins & Louw (2000) argue that IS should also adopt an evidence-based approach to practice.

As EBP became established in medicine, it became apparent that it was necessary for researchers to develop a knowledgebase which contained the current state of knowledge on the most effective treatments for diseases and other health problems, and for that knowledge to be conveyed effectively to practitioners. This two-fold approach has been transferred to other disciplines, so that EBP has two main strands: systematic literature reviews (SLRs), using meta-analysis, to establish the current state of knowledge on a topic, and dissemination to researchers and practitioners in a readable form.

As researchers can readily observe, in many research articles it is not made explicit how the literature was searched for relevant previous work. The authors' literature search could have been extremely careful and detailed, with the use of appropriate keywords and metonyms and a wide range of databases, or it could have been more ad hoc. It is not clear to the readers how or why particular articles have been chosen for citation, nor whether all relevant articles have been examined. In an SLR, in contrast, the researchers develop and explain a review protocol so that the process is transparent, traceable and potentially repeatable by other researchers. The stages of an SLR are (Kitchenham, 2004):

1. Define a research question.

2. Define a strategy for searching the literature (e.g. search terms and databases to be used), which someone else could follow or repeat.

3. Search the literature for primary studies.

4. Decide which candidate articles to include or exclude, based on explicit selection criteria.

5. Assess the quality of the research studies found and hence the validity of their findings. (Evidence-based medicine has established a hierarchy of evidence quality, with randomised controlled trials at the top, and quality evaluation criteria have been developed for each research method.)

6. Extract and process the data from each high quality study (e.g. the intervention, size of population, findings).

7. Synthesise the studies, using statistical meta-analysis where possible.

8. Write report and disseminate.

In evidence-based medicine and healthcare much of the dissemination is via the Cochrane Collaboration (www.cochrane.org), a web-based knowledgebase which includes more than 3000 SLRs (Montori and Guyatt, 2008). and the idea of EBP has now spread to other disciplines, including software engineering (Dybå et al, 2005), social policy (Pawson, 2006), librarianship (Eldredge, 2000) and education (Petty, 2006). Web-based knowledgebases similar to the Cochrane Collaboration have also been established, for example, the Campbell Collaboration is concerned with SLRs in education, crime and justice and social welfare (www.campbellcollaboration.org), and a website for SLRs and evidence-based software engineering has recently been established (www.ebse.org.uk).

3   Evidence-based Practice and IS

To examine the take-up of EBP in IS, a search was carried out (25 November 2010) of the articles in the Association for Information Systems (AIS) eLibrary, looking for articles that mentioned EBP or SLR in their abstract. Table 1 shows the results.

Search 25 November 2010: "Abstract includes …"	No. of Articles	Articles
evidence-based information systems *or* evidence based information systems	1	Atkins and Louw, 2000
evidence-based practice *or* evidence based practice	1	Atkins and Sampson, 2002
evidence-based *or* evidence based	8	Atkins and Louw, 2000; Atkins and Sampson, 2002; Guah, 2007; Han, et al, 2004; Huda, et al, 2010; Hung et al, 2007; Hung et al, 2008; Mitsa, et al, 2007
systematic literature review	5	Childs et al 2009; Long, et al, 2005; Madlberger and Roztocki, 2009; Seyyedeh et al, 2009; Sridharan, et al, 2008

Table 1.   Searches of the AIS eLibrary

The search results suggest that, in contrast to EBP's growth in other disciplines, there has been little take-up of the evidence-based practice paradigm in the IS community. The only abstract containing the phrase "evidence-based information systems" is that of Atkins and Louw (2000), presented a decade ago at ECIS. In the paper the authors call for IS to learn from the evidence-based practices of medicine and healthcare. The equivalent of the Cochrane Collaboration should be developed for IS, that is, an easily accessible knowledgebase in the public domain which holds systematic literature reviews, with critical syntheses of both research publications and practitioner reports. They report that Massey University, New Zealand (Atkins' university at the time) will host a website for such a venture, and call for other interested researchers to work with them on developing this knowledgebase and the associated methodological practices. However, as at 25 November 2010 the URL they give for the website is not live, and searches of Massey University's website found no such webpages.

The only abstract containing the phrase "evidence-based practice" is that of Atkins and Sampson (2002). They start to address the methodological issues involved in EBP by proposing critical appraisal guidelines for case study research.

Six other papers use "evidence-based" or "evidence based" in their abstracts. One uses "evidence-based" as a synonym for "empirically-based" (Huda et al, 2010), and one uses the two words in a different context (which a comma woiuld make clearer) (Hung et al, 2007): "… gathering empirical evidence based on the Unified Theory of Acceptance ...". Three papers are concerned with health informatics and use the phrase only in discussing EBP approaches in medicine and healthcare (Han, et al, 2004; Hung et al, 2008; Mitsa, et al, 2007), and one uses the phrase "evidence based participatory quality improvement" without further explanation (Guah, 2007).

Five articles in the AIS eLibrary include the term 'systematic literature review" in their abstract. Only one of these five articles (Childs et al, 2009) refers to the EBP literature on SLRs. They report that they used a SLR to explore issues and practical strategies for accelerating positive change in electronic records management. However the authors only give an abstract model of a SLR without explaining their own review protocol. A URL is provided to a website where findings to date can be found, but on 14 Nov 2010 this page was not found. Details of the project were found on nearby webpages, but no full description of their SLR protocol was found there.

Long et al (2005) state that they used a SLR to examine factors impacting ISD (information systems development) performance. However, their paper does not meet EBP's standards of a SLR since there is no explanation of how they searched the literature for candidate papers, nor the number of papers found, nor any description of how they decided which papers to include or exclude, nor discussion of how they analysed and evaluated the selected papers. In short, there is no traceability or repeatability, and the review is a conventional literature review, not a SLR.

Seyyedeh et al (2009) investigate studies of factors influencing inter-organizational knowledge sharing. Their search description is vague – "*Certain keywords* [my italics] [were] used to search four databases (Inspec, Web of science, Sciencedirect, IEEE explorer, along with Google Scholar)" – the number of papers found is not stated, and again there is no discussion of inclusion/exclusion criteria or analysis and evaluation.

Bhavani et al (2009) aim to identify and evaluate the critical success factors for the successful and sustained adoption of e-learning. They give some details of their search process, such as the key words used in the search, but are vague about where they searched, e.g. they searched "various online educational journals such as *International Review of Research in Distance Education*" – it is not explained which other online educational journals they searched. Nor do the authors explain whether they applied inclusion/exclusion criteria to the 365 articles they found, or synthesised all of them or hust a subset, nor how they analysed and evaluated their selected articles.

Madlberger and Roztocki (2009) investigate digital collaboration in cross-organizational settings via a review of 80 research papers, published from 2000 to 2007, in six leading IS journals. They do not explain their search process for finding the 80 papers within the six journals, but they do explain how they then analysed and evaluated them.

It can be concluded that in the AIS eLibrary there is little discussion of EBP and no paper illustrates a properly-conducted SLR as EBP understands the term and as summarised in Section 2..

In addition to Atkins and Louw's call (2000) a decade ago, there have been a few other calls for IS to learn from medicine's evidence-based practice approach. Moody (2000) argues that closer links are needed between IS research and practice to improve knowledge transfer. He suggests that systematic literature reviews, as in the Cochrane Collaboration, should be used to synthesise research findings and support practitioners' decision-making. Moody (2003) outlines a project which will develop such a Cochrane Collaboration-type knowledgebase for IS, via a web-based system. Practitioners will be able to access the latest research and systematic reviews, and post their own policies and evaluations for sharing and peer review. This project is to be a joint venture between Monash University, Australia and the Australian Computer Society. As at 25 November 2010, the websites of both these organisations make no mention of this knowledgebase.

In 2001 a new section for literature reviews was added to *MIS Quarterly: MISQ Review*. The aim was to contribute to "the development of MIS as an academic discipline by synthesizing prior research and providing a conceptual foundation for future research" (Watson 2001), suggesting that the intended audience was IS researchers rather than practitioners. Watson and Webber (2002) give advice on how to conduct such reviews. They make no mention of the EBP paradigm, but they do outline a systematic approach to searching and studying the literature. Their definition of a review article encompasses all previous research publications on a topic, not just the empirical research which can help to provide the evidence to practitioners faced with deciding whether to adopt a particular information system or tool, again suggesting that the intended readers were researchers not practitioners. *MISQ Review* is now part of the *MIS Quarterly* Theory and Review Department. Its webpage currently lists the kinds of paper sought including "evidence-based information management", citing Rousseau (2006). However, a search (26 November 2010) of the MISQ archives for papers where the abstract or title included "evidence-based" returned no articles.

At a software engineering conference Darroch and Toleman (2005) discussed whether EBP could be adopted in IS. They suggested that IS could learn useful lessons by observing how EBP is adopted and grows in its sister discipline, software engineering. Evidence-based software engineering has developed from around 2004 (Kitchenham et al 2004, Dybå et al 2005, Jørgensen et al 2005). It explicitly draws upon the evidence-based medicine tradition and uses systematic literature reviews to aggregate empirical studies. A recent study (Kitchenham et al, 2010) has found that over the time period January 2004-June 2008, 53 SLRs were published in the software engineering literature, a remarkable contrast to IS (see above), especially considering IS has a much greater tradition of empirical research than software engineering (Glass et al 2004).

A more extensive literature search of the whole content of full papers rather than just the abstracts might reveal that additional IS researchers are interested in EBP but have not used either "evidence-based" or "systematic literature review" in their paper abstracts, but this seems unlikely if they want to position their work in the context of the EBP paradigm. (Note how making the whole literature search process explicit allows readers to reflect on whether it contains flaws or is incomplete.) In summary, in the decade since Atkins and Louw (2000) and Moody (2000) argued for IS to learn from medicine and healthcare and adopt EBP, only a few articles that explicitly place their work in the context of the EBP paradigm have been published in the conference and journal outlets indexed by the AIS eLibrary, despite EBP's growth in other disciplines.

4   Possible reasons for lack of interest in IS community

Evidence-based medicine grew from an idea shared by a few enthusiasts in the early 1990s to today's well-established approach for evaluating, synthesising and disseminating research, and ensuring that practitioners' decisions have a solid basis in peer-reviewed research findings. This section briefly reviews some possible reasons for the observed lack of take-up in IS.

It could be that the apparent lack of take-up is a misperception as the search of the AIS eLibrary did not use the appropriate search terms. However, it is hard to conceive how EBP papers would not include in their abstract at least one of the search terms used in Table 1, so the search terms do seem appropriate. Perhaps EBP papers in IS should have been sought in another database? But the AIS eLibrary does contain articles from the major IS research dissemination outlets and so is likely to contain work on EBP. It includes the ECIS archives – as that conference was the venue for presentation of Atkins and Louw's (2000) call for EBP in IS, it is quite likely that researchers responding to their call would also seek to present their work at ECIS.

Maybe IS researchers prefer to carry out primary studies and not secondary studies? Yet every PhD thesis and published research contains a literature review, a secondary analysis, and making the process less ad hoc and more visible, traceable and potentially repeatable would be appreciated by dissertation supervisors and examiners, and other IS scholars (Oates and Capper, 2009). Or perhaps IS researchers do not see the need for EBP and SLRs which synthesise the results of previous research? But there have been calls for research to be more relevant to the needs of practitioners, and for IS to develop a cumulative tradition (Culnan and Swanson 1986; Benbasat and Zmud, 1999; Steinbach and Knight, 2006) – which is what the EBP paradigm aims to do.

Finally, perhaps the EBP paradigm as practised in medicine and health care and subsequently adopted in other disciplines, is not appropriate for IS research? This possible reason is explored in more detail in the following section, which discusses the criticisms of EBP that have been made in the social sciences.

5   Criticisms of SLRs/EBP

Criticisms of EBP and SLRs centre on their simplistic, positivist underlying assumptions. A comprehensive critique is provided by Pawson (2006). He argues that the conventional EBP paradigm is focussed on "what works?" – whether some change or intervention brings about a successful outcome. For example:

- In software engineering: The effectiveness of pair programming (Hannay et al, 2009).
- In social policy: The effects of improved street lighting on crime (Farrington and Welsh, 2002, cited in Pawson 2006).

Such an approach has an underlying philosophy of positivism and seeks to identify causation: If X is applied then Y will occur. SLRs examine the family of studies in which such a hypothesis has been examined, and draw conclusions about whether it is true or false. In effect, the SLR is establishing

how often an experiment's results have been repeated successfully so that we can say whether or not X causes Y.

This is appropriate for medicine, where double blind randomised controlled trials occur of new drugs or medical interventions, and the results of individual trials can be combined and aggregated to see whether a new treatment does improve the patient outcome. However, Pawson argues that in his subject, social policy, it is not possible to establish such direct causal links between interventions and outcomes. For any social programme intervention there is unlikely to be a regular, consistent outcome; instead there will be a pattern of outcomes, including successful, unsuccessful and "a bit of both". This is because of different and dynamic contexts. Any social programme intervention is inserted into pre-existing conditions comprising people, perceptions, relationships, culture, organisations, politics and structures. The intervention changes the people, perceptions etc. At the same time, the intervention is shaped and modified by the people who implement it or who are affected by it. Hence trying to establish that "X causes Y to occur in multiple settings" is often too simplistic an approach.

Pawson's description of the nature of social programmes is analogous to the situation in IS. Medicine's "gold standard" of randomised controlled trials is rarely achievable in IS. True experiments with full control of all the variables are also difficult to achieve in IS. It has long been recognised by many IS researchers that any intervention involving information systems or tools is inserted into a socially-constructed context, and the intervention can be modified by the context in which it occurs. For example, nearly 20 years ago Orlikowski examined the introduction of CASE tools into two different organisations that experienced different outcomes, and showed how it was necessary "to consider the social context of systems development, the intentions and actions of the key players and the implementation process followed" (Orlikowski, 1993).

There has also been a turn in IS towards qualitative data (e.g. Kaplan et al, 2004), which is not amenable to meta-analysis using statistical techniques, and to an interpretive philosophy, which recognises that different people perceive the world differently, much of our world is socially constructed, and "what works" will have different meanings for different people. Adapting Pawson's (2006) criticisms of EBP for IS: any information system or tool is inserted into pre-existing conditions comprising people, perceptions, relationships, culture, organisations, politics and structures. The intervention changes the people, perceptions etc. At the same time, the intervention is shaped and modified by the people who implement it or who are affected by it. Hence trying to find out "what works", is too simplistic an approach. Instead we need to find out why an IS intervention sometimes is perceived as successful, sometimes unsuccessful and sometimes "a bit if both". The focus of an SLR should be on explanation and theory building, rather than just on the aggregation of data from multiple studies. If we are to develop a cumulative knowledgebase in IS, that can be shared with practitioners, then we need a richer and more nuanced approach to the evidence via SLRs than that used in evidence-based medicine.

6   A more nuanced SLR process

The purpose of a SLR is to synthesise previous empirical research, which, Pawson argues, should mean more than reportage and statistical summaries of previous research, leading to an arithmetical verdict on a particular type of intervention. Instead the aim should be to explain "what works for whom in what circumstances and in what respects?" (Pawson, 2006, p. 74). He argues that an SLR should not start with defining a research question; instead it should start with a tentative theory or model about how and why a particular intervention might work. Any relevant primary studies found in the literature are viewed as case studies which can test and modify the initial theory. For example, in IS the introduction of a CRM (customer relationship management) system might be based on the assumption that it will enable an organisation to acquire new customers, enhance the service it provides to existing customers and retain loyal customers. The reviewer then maps the different actors and factors which might affect the effective introduction and use of such a system in different situations, such as:

- Perceptions, reasoning and behaviour of the stakeholders – are there differences in different stakeholders' understanding of the intervention theory?
- Context – does this type of intervention work better with particular types of people, relationships, organisations or infrastructures?

This leads to a model which shows the underlying assumption(s) of the intervention and the elements which might affect the successful implementation. The SLR then tests, adapts and modifies this model or theory.

The process of searching and selecting the literature is still made transparent to the reader of an SLR, but also made visible is the process of testing, adapting and modifying the theory, based on each research paper studied, until a richer and more complete theory is obtained. Most of the stages of a conventional SLR (see section 2) can still be discerned, but the process is more iterative, with stages running in parallel and revisited as necessary as the evidence from each study is analysed for whether and how it affects the initial or emerging theory– and that process is made visible. Each stage is also more complex than in a conventional SLR (Pawson 2006, chapter 4):

- Identify the review questions: a preliminary search and study of the literature to establish initial questions and issues for the review, prioritizing the questions, formalising the model to be tested.
- Define and develop a strategy for searching the literature: define search terms and approaches for *each* element in the model and add new search terms or concepts as the literature is studied.
- Search the literature for primary studies, adding additional papers through "snowballing" (looking up references or authors by hand or via citation-tracking databases). The search process is a kind of purposive sampling: an initial search maps out the scope of the topic so that an initial theory can be developed, subsequent searches look for the empirical evidence to test the theory and a final search fine-tunes the emerging research synthesis.
- Decide which candidate articles to include or exclude: assess each study and part of study for its relevance to one or more parts of the emerging synthesised theory.
- Assess the quality of the research studies: assess each study for the rigour of the evidence it offers to support or contradict *parts* of the emerging theory. It might have strong evidence in one area and weak or no evidence in another; the individual study might be flawed overall, but it could still offer useful evidence in some sections.
- Analyse the data. Initial analysis concentrates on annotation, conceptualisation of topics discussed in each relevant paper, and abstraction. Later analyses look for which bits of data are pertinent to which parts of the emerging synthesised theory, and also which parts of the primary evidence will be included in the writing up of the review.
- Synthesise the studies. Instead of delivering a summative verdict, the SLR produces a refined theory or model which increases our understanding of how and in what circumstances an intervention may work (or not). More than one focus is possible; the focus is often one of four types: identifying the typical weak points and barriers in the implementations under review, adjudicating between two rival theories based on the evidence found for each, making sense of the contextual factors which indicate when an intervention is likely or unlikely to be effective, and comparing the official (e.g. managers' or vendors') intervention theory with what happens in practice.
- Write reports and disseminate. There is likely to be a long review paper for academic researchers, and a shorter "executive summary" for practitioners. The goal of the dissemination to practitioners is that they take account of the complex and inter-related elements that the review has discovered and can examine how they apply to their particular situation and practices.

The SLR as envisaged by Pawson (2006) is therefore explanatory rather than summative. Adapting his words (p. 102) for IS: The introduction of any information systems or tool has an underlying theory; primary research seeks the evidence for those theories; a systematic review draws together that evidence to refine the theories.

This model of a SLR is richer and more nuanced than in a conventional SLR and is more suited to the complexity of understanding information systems and their use by different people in different situations with different perceptions, assumptions and goals. It is also more suited to the qualitative, interpretive research that is increasingly common in the IS literature.

7   Conclusions

This paper has described a search for IS articles which address EBP. Even though it is now a decade since Atkins and Louw (2000) argued at *ECIS* for the concept of EBP in IS, the AIS eLibrary holds only a few EBP articles, despite EBP's growth in other disciplines. Further work could search other databases of IS research to see whether there are other EBP papers. Those papers which have been published in *MISQ Review* could also be analysed, to see whether they meet the accepted tenets of EBP even if they do not use the term. Those IS researchers who do address EBP are urged to ensure that their links to the EBP paradigm and/or use of SLRs are made clear through their papers' keywords and abstracts, so that subsequent searches for EBP-active researchers will find them.

Atkins and Louw (2000) and Moody (2000) separately called for EBP in IS and outlined plans to establish web-based knowledgebases to summarise the current state of empirical research on a topic, to improve knowledge transfer and to support practitioner decision-making. Further research could contact the authors to discover what response they received and what happened to their knowledgebase plans.

The paper briefly reviewed possible reasons for the lack of attention in IS to EBP, and suggested one possible reason is that the SLR as practised in evidence-based medicine is inappropriate for the complex interventions in complex situations studied by IS researchers. Recent developments in social policy (Pawson 2006), which deals with similar complex interventions, have re-defined the SLR and this newer approach could be more useful to IS researchers. Rather than attempting to answer the simplistic question "what works?" a SLR can aim for a model which helps to explain "what works for whom, in what circumstances and in what respects?". This enables a richer and more nuanced approach to SLRs and EBP.

A decade after the first calls for EBP in IS, it is hoped that IS researchers will now start to explore the EBP paradigm. It is hoped they will undertake SLRs of both the conventional type, where applicable, and also the newer, qualitative-oriented approach described in this paper. If they do, we can start to develop a cumulative knowledgebase in our discipline which synthesises what we know, and what we don't yet know, and which will be useful to both researchers and practitioners.

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