Technology Acceptance and the Uptake of Agricultural DSS

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Abstract

Despite their availability in a wide range of formats the take up of agricultural Decision Support Systems by farmers and agronomists, in the UK and in Europe as a whole is still disappointingly low. This paper sets out to examine the utility of a model widely used in mainstream IT development to explain the success or failure of technologies, the Technology Acceptance Model (Davis, 1989). It examines the models ability to account for the multiple factors for agricultural DSS failure identified by previous authors, in the light of the most recent discussions in our industry. It concludes that a combination of a user-centred design and support philosophy and a professional approach to marketing offers the best route to success.

Key words: DSS, Technology Acceptance Model, user-centred design.

1 Introduction

Decision support systems (DSS) of varying types have been produced for use within UK agriculture for over 10 years and yet still few farmers or agronomists make regular use of them. This failure of take up has been puzzling to DSS producers and the sponsors of DSS development because, on the face of it, the technology appears to offer the industry a practical and cost-effective way to incorporate the latest scientific knowledge in the management of pests, diseases, irrigation and nutrition, thereby increasing quality, reducing inputs and their impact on the environment. A number of papers have sought to explain the reasons for this apparent lack of interest on the part of the farmer and agronomist (e.g. Parker, 1999; Hayman & Easdown, 2002; McCown, 2002) and each has suggested a range of factors that may have had an impact on uptake. If the industry is right in believing in the ultimate utility of the DSS approach however, then identifying factors is not enough, we need to identify and use methods that ensure success.

2 Why do some technologies fail?

DSS are not alone in the world of obviously useful things that fail to be taken on by the people they are designed for. Trying to understand why people accept or reject technology is one of the most challenging issues in information systems research. The classic case in mainstream technology is Betamax versus VHS videos (Cusomano et al. 1992) where the company who hit the marketplace first, with the better product actually lost the race, contrary to all expectation.

The phenomenon of technology acceptance has been given serious attention by researchers in a number of discipline areas, and a number of theories proposed. In 1989, Davis introduced the technology acceptance model (TAM). TAM was created specifically to explain computer usage behaviour, using TRA (Theory of Reasoned Action; Ajzen and Fishbein, 1980) as a theoretical basis for specifying the causal linkages between five key constructs: perceived usefulness and perceived ease of use, and attitude toward use, behavioural intention to use, and actual system usage (Davis, 1989; Davis et al., 1989).
The Technology Acceptance Model proposes that the degree to which an IT system will be accepted is related to two key things, perceived usefulness (PU) and perceived ease of use (PEU). PU is defined as the users perception of the likelihood that the system will increase his or her job performance within an organisational context. PEU is defined as the degree to which a user expects a target system to be free of effort (Davis et al., 1989). Effort is the finite resource an individual allocates to the various activities for which he or she is responsible. When all other things are equal, an application that is perceived to be easier to use than another is more likely to be accepted by users. Two other TAM constructs are attitude towards use and behavioural intention to use. Attitude towards use is the user’s evaluation of the desirability of employing a particular application, while behavioural intention to use is the likelihood that a person will employ the application (Ajzen and Fishbein, 1980). This model and the two key variables within it has been widely adopted and validated (Doll et al., 1998; Subramanian, 1994).

3 Does the Technology Acceptance Model explain agricultural DSS failure?

A recent review of the literature (Parker, 2004) suggests that thirteen primary barriers to uptake have been identified. Brief outlines of each are given below.

3.1 Computer use and specification

The lack of computers on farms was one of the earliest perceived barriers to use (Gibbon, 1992) but many surveys (ADAS, 2000; Defra, 2001/2002) have shown this to no longer be the case in the UK. However, what has become apparent in the last few years is that the specification of user computers may have emerged as a new hurdle to overcome. User feedback within arable projects (Park & Parker, 2004; Pomfrett & Parker, 2000) suggests that a some problems users experience in relation to DSS use are due to the gap between the power and capability of their machines and that expected by the software.

3.2 Data requirements, particularly weather

Decision-making is a data hungry process and one of the perceived barriers to use is access to, and the cost of, up-to date and relevant data (Holdstock, 2004; Parker et al., 1994b). Agricultural DSS, particularly those based on simulation models, invariably need some level of weather or climate data to function. The more complex UK DSS e.g. WDM1, WMSS2 which support a range of their decision tasks including “what if” analysis, also need access to variety and product data plus crop, farm or field data.

3.3 Threat to the agronomist/consultant

There has been a perception (Parker et al., 1994a) that decision support tools are developed to take the place of the agronomist. This perception, where it exists, is likely to bring with it a reluctance on the part

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1 Wheat Disease Manager. MAFFarable LINK project No P174, Defra project AR0915, http://www.arableds.co.uk
2 Weed Management Support System. DEFRA LINK project No. LK0916, http://www.wmss.net
of some agronomists and some farmers to look seriously at the technology, and may even lead to an attempt to sabotage it if the threat is perceived to be great (Skarlicki & Folger, 1997). This is unlikely to take the form of agronomists smashing PC’s in the style of the Luddites, but negative comments in the popular farming press can be equally damaging.

3.4 Inappropriate models

Cox (1996) argued that one of the major reasons for the failure of early Australian DSS systems was the use within them of models more suited to research than to on-farm practice. This was certainly the case for many of the earlier UK DSS (e.g. Woodwards, 1995 cited in Parker, 1999) but should be less common now that a user-centred approach is being adopted in many developments. This approach should also help to reduce the probability that optimisation, which could interfere with the users chosen decision approach, is used inappropriately, a barrier suggested by McCown (2002).

3.5 Integration between systems

While many useful tools can exist in isolation, users have often bemoaned the fact that DSS do not share data (Phelps, 2004) and that they resent having to re-enter basic information about their business. While the main UK developers, both academic (e.g. Warwick-HRI, DESSAC consortia) and commercial (e.g. PlantSystems) use platforms within which data is common, links between these systems and the most commonly used farm data recording systems have yet to be developed. This may be seen as a barrier to use. It has however been suggested that in some cases, farmers and consultants are content to use example fields rather than individual areas (Meakin, 2003) and thus do not need to input large amounts of data.

3.6 Trust and understanding

Trust and understanding are key barriers to uptake and use of DSS and there seem to be three separate aspects to it in this context: understanding of the DSS concept, trust in specific models and trust in the software they are encapsulated within.

It is the author’s belief that users have to understand what a decision support system is and how it differs from other software systems in order to make the best use of it. However, despite localised distribution and workshops and training sessions in individual sectors, the number of people within the UK agricultural industry who know what a decision support system is, is still very low. Although hard data is not yet available, users who attended training for the recent release of the UK WDM software appeared to be more likely to see value in the system and be positive about it (Clarke et al., 2004).

Few people put their trust in strangers and yet in many ways that is what we seem to have expected the users of agricultural DSS to do. It takes time to build up a reputation, as most agronomists will confirm, and DSS and the models within them have to earn respect based on performance in the same way that individual experts do. This, it seems, has to be based on evidence rather than use by a few ‘early adopters’ (Moore, 1991).

Finally, while a lack of awareness of the potential and correct use of the technology and a lack of trust in the models they contain are major barriers to DSS use, lack of basic trust in the software itself must not be overlooked. A great deal of mistrust can be generated if new installations interfere with a user’s existing tools (e.g. accounting systems), or which crash frequently, or in a way which causes problems with other software (Pomfrett & Parker, 2000).

3.7 Support and training

Users have often cited support, or rather the lack of it, as a barrier to their continued use of UK DSS (Holdstock, 2004; Parker & Campion, 1997; Phelps, 2004). DSS users need support not only during installation and when learning how to use the basic functions of the software but also for the understanding and interpretation of the science they encounter within it.
3.8 Tailoring of systems

Any software package may have a number of target audiences. Where there are a range of users with differing requirements (e.g. Microsoft Word™) methods have to be found to accommodate the most demanding, while keeping things simple for the novice and occasional user, or this will constitute a barrier to use.

3.9 User interface design

The ease with which a user can interact with a system has been mooted as a key component of its success by a large number of authors, from within the DSS development community (Sankar et al., 1995) and from the wider technology acceptance research sphere (Davis, 1989) and the design of the user interface is a part of the ease of use of any system. Some of the most frequent complaints the author has encountered in relation to UK DSS user interfaces are: lack of adherence to expected standards, generally Microsoft, (e.g. tabbing through data fields), inconsistencies (e.g. similarly named functions doing different things), over-complicated navigation (e.g. a number of related functions on separate dialogs) and use of colour (e.g. red and green for coding without other differentiation such as saturation).

3.9 Time commitment

The time it takes to use computer based DSS has been cited as a major barrier to their uptake (Lay, 1997). This is true in other time pressed domains such as medicine (Short et al., 2004). Farmers and consultants have increasingly been asking for more tailored approaches to information delivery which would cut down on the time taken to use them e.g. automatic running of systems and information delivery via PDA, email and mobile phone (Parker, 2001c; Phelps, 2004).

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3.10 User focus (user centred design and task fit)

The author has argued in earlier papers that ensuring that a system is developed with a user focus would help to prevent many of the previously listed issues from becoming barriers to uptake. A truly user-centred design approach would go a long way to ensuring that a DSS: had demonstrable cost-benefits, used appropriate models, employed accessible data, had usable interfaces, was developed for appropriate platforms, integrated with appropriate systems, incorporated appropriate training and support and eased agronomist fears by involvement. The close involvement of users in the development should also help to generate a feeling of trust.

4 Mapping the reasons for failure to TAM

The concepts of PEU and PU accommodate all of the barriers listed earlier in as figure 2 shows. Those under ‘ease of use’ all relate to the effort a user may expect to have to employ in relation to the DSS, those under ‘usefulness’ relate to the DSS potential to increase a users job performance. User focus is an over-arching issue and relates to both PU and PEU.

4.1 The importance of social aspects

It has previously been the author’s contention that the adoption of a user-centred approach would address and resolve the majority of the issues leading to failure to adopt. This belief is supported by the research represented by the TAM. However the author’s recent experiences in DSS related projects have strongly
suggested that social aspects also play a key role in the take up and use of agricultural DSS. A belief which is mirrored in the more recent versions of the TAM (e.g. Konana & Balasubramanian, 2004).

Publicity and awareness are critical to commercial system success (Di Benedetto, 1999). Publicity for DSS developments and releases is however generally low key and this may in itself lead to a lack of demand or user pull. Trust is another socially influenced factor, particularly trust in the model outputs. Unless mainstream users obtain evidence of the models usefulness, either from trials data in credible and accessible literature or from other mainstream users, uptake is likely to be limited to ‘early adopters’. External drivers such as regulation can also drive DSS uptake by increasing the value of the system, as long as the system is seen as useful support and not part of the regulation. A degree of social pressure could also drive DSS uptake as producers look to justify their inputs in the face of public concern.

![Fig 2. Barriers to UK DSS use as seen within Technology Acceptance Model categories](image)

5. Conclusions

Despite the best efforts of developers, DSS still remain on the fringes of agricultural technology and have not yet served their intended purpose as mainstream knowledge transfer tools, or as innovative aids to more effective decision-making. The authors previous contention that a more user-focused approach would alleviate this problem is supported by the TAM approach but both it and recent UK experience suggest that social factors such as trust and public awareness play a much more important role than previously thought. This would suggest that a combination of a user-centred design and support philosophy and a professional approach to publicity and marketing would offer the best route to success.

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