Decision Support Systems 54 (2012) 164–172

Contents lists available at SciVerse ScienceDirect

Decision Support Systems

journal homepage: www.elsevier.com/locate/dss

Effect of a participatory approach on the successful development of agricultural decision support systems: The case of Pigs2win

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ARTICLE INFO

Article history:
Received 2 August 2010
Received in revised form 2 March 2012
Accepted 9 May 2012
Available online 17 May 2012

Keywords:
Decision support system
Participatory approach
Pig farming
Critical success factors
Frontier analysis

ABSTRACT

This paper explores how a decision support system (DSS) can be developed that complies with the critical success factors of such systems. A participatory approach is used to develop Pigs2win, a DSS for Flemish pig farms. Pigs2win uses frontier analysis for comparative farm analysis. The participatory approach influences the selection of stakeholders, objective setting and evaluation of Pigs2win. Outcomes of the participatory approach result in features of Pigs2win that positively influence its compliance with critical success factors. Based on our experience with Pigs2win, we put forward points that need attention when a participatory approach is organized.

1. Introduction

Today's decision makers need to find good solutions to increasingly complex problems [49,65]. Farm decision making is no exception. Due to the intensification of agricultural production and concerns relating to environmental impacts, farmers are now required to deal with a wider range of issues [19,32,80]. As the complexity of decisions increases, managers increasingly lack the necessary expertise to make decisions that integrate the range of issues involved [80].

Decision support systems (DSSs) aim to help managers with their decision-making by offering information access, model analysis and supporting tools [27]. Multiple agricultural DSSs have been developed, addressing a variety of issues. These issues include measuring farm sustainability (e.g., [40,55,75,76]), improving manure management (see overview by [31]), simplifying livestock feeding decisions (e.g., [14,23,34,35]), improving crop production systems (e.g., [11,24, 30,66,70]) or subsystems like fertilizer use (e.g., [18,22,69]), pest management (e.g., [36,56]), irrigation (e.g., [39,71]), yield (e.g., [6,26,58]) and cultivar selection (e.g., [29,47]), improving pig production aspects like nutrition of growing pigs (e.g., [74]) and sows (e.g., [15]), sow productivity (e.g., [64]), disease control (e.g., [82]) and tail biting prevention (e.g., [2,3]).

Despite the wealth of available technologies, decision support has widely failed to fulfill expectations [43,45,53,57,80]. Many studies report on the poor uptake of agricultural DSSs (e.g., [10,19,20,25, 33,37,42,44,46,50–54,58,63,80]). Reasons for the low adoption rate include that the DSS is too complex, uses a terminology and logic unfamiliar to farmers, is not frequently updated, requires tedious data input, is irrelevant, unreliable and/or inflexible and is not easily accessible for users. The gap between science and practice is also often mentioned as a reason why DSSs are not implemented.

The objective of this paper is to explore how a DSS can be developed that complies with the critical success factors of such tools. Multiple authors emphasize the positive impact of participatory processes involving stakeholders on DSS' success (e.g., [5,16,33,38,44,57,61,63,72,80]). In this paper, a participatory approach is used to develop Pigs2win, a DSS for Flemish farrow-to-finish farms. Decision making in pig farming can be considered as a typical case of simultaneously trying to improve productivity and reduce environmental pressure, mainly caused by nutrient emissions.

Advice in pig farming is mainly based on the use of traditional key performance indicators (KPIs). Popular KPIs are feed conversion (kg feed per kg live weight gain), production costs (euro per kg produced live weight) and labor income (expressed per delivered pig, average finisher present, or labor unit). Traditional KPIs are easy to communicate but have shortcomings when assessing benchmarks for comparative farm analysis [73]. Compared to traditional KPIs, frontier analysis (see [8] for an introduction to frontier analysis) is more suitable for assessing farm-specific benchmarks and improvement paths [17,73]. Frontier methods measure technical, economic and/or environmental performance by positioning firms against a best practice frontier. Frontier methods are frequently used in management

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doi:10.1016/j.dss.2012.05.002

science, but they are currently not used in practice for pig farm advice, mainly because farmers and advisors are not familiar with these methods. A challenge for the participatory approach in this paper is the incorporation of frontier analysis in Pigs2win.

The paper is structured as follows: Section 2 puts forward critical success factors of DSSs that can be influenced during the development process. Section 3 presents the participatory approach that is used to design and evaluate Pigs2win. Section 4 describes how the participatory method resulted in features of Pigs2win that comply with the success factors of DSSs. This section also highlights the interference between frontier analysis and success factors. Section 5 concludes and provides advice on organizing a participatory approach for building DSSs.

2. Critical success factors of DSSs

Multiple authors (e.g., [5,12,13,21,41,42,51,68,80]) mention success factors of DSSs that can be influenced during the developing process. Based on a literature review, we distinguish between the following critical success factors: flexibility, perceived usefulness, accessibility, credibility, intended users and maintenance and adaptability.

Inflexible DSSs that address too small a part of a management task are unlikely to attain operational acceptance [81]. If users learn more about a certain decision problem, they may want to reduce decision uncertainty by analyzing the consequences of alternative scenarios [41,51,68]. Olsson et al. [61] indicate that the value of scenario modeling mainly lays in the possibility to compare the effect of different scenarios, not in providing exact quantifications. Power and Sharda [65] mention that spreadsheet packages are appropriate for analyzing scenarios. By changing cell values and having all cell values re-evaluated, effects of these changes can be analyzed.

Perceived usefulness, or user relevance, is not only required for adopting DSSs but also for the period after adoption. McCown [51] states that farmers cease to care about tools when they cannot see sufficient practical value for action resulting from the output. Agricultural DSSs are often developed using a different paradigm based on scientific knowledge and not practical knowledge as would be used by the farmer [10]. Furthermore, a DSS may become obsolete once users become familiar with the logic and are able to apply the system without using the tool itself [51,57]. Perceived usefulness requires that the objectives of the users correspond to the objectives of the DSS [46]. The relevance of an agricultural DSS increases when farmers can gain more profit by using it [37] and when the system can be adapted to farm-specific situations [33].

Accessibility, or ease of use, can be divided into conceptual (complexity of the DSS), technical (required technical resources and skills) and physical accessibility (location of the DSS). In general, conceptual inaccessibility is most difficult to solve [80]. Multiple DSSs are not implemented because they are too complex [10,37]. Kerr [33] states that users often do not understand the jargon used in DSSs and the variables needed for basic input. If DSSs expect prior knowledge, user acceptance will be lower [10,33].

DSSs may fail simply because users are not confident about the reliability of the system and its outputs [48,80]. Hochman et al. [25] identify the paradox between the purpose of a knowledge-based system, which is to make available expertise that is beyond that of the user, and the confidence in a system, which is a prerequisite for acceptance by users. Highly participatory approaches may help to install confidence in a DSS [25,46,80]. Kuhlmann and Brodersen [37] state that the credibility gap of users can be reduced through using simpler decision models to match the expertise of users. Nevertheless, models that are too simple may also become unreliable, especially when they represent complex systems.

Another success factor is the choice of intended users. Nelson [58] states that the role of intermediary advisors has received too little attention as developers of agricultural DSSs mainly consider farmers to be end-users. Nevertheless, intermediaries can serve as a key player in the dialog between farmers and computer-based DSSs. Based on results of DSSs, they can facilitate the exchange of ideas about management practices that are relevant to the farmers [5,58]. Cox [10] states that DSSs have more impact at farm level when the interaction between farmers and intermediaries is affected. Carberry [5] mentions that DSSs can be more complex if they are to be used by farm advisors.

Finally, successful DSSs should be easily maintained and adapted if new information becomes available [42,52]. In order to remain relevant, DSSs require up-to-date information. A frequent update of DSSs can be a major challenge [33].

3. Participatory development approach

Participatory approaches are used more and more to design and evaluate DSSs. Examples of agricultural DSSs based on a participatory approach can be found in literature (e.g., [4,5,58,77]). Carberry [5] mentions that participation of farmers and stakeholders improves results, since research activities and outcomes are well aligned with participants' expectations [5]. Nelson [58] states that a participatory approach allows for addressing problems that are relevant to decision-makers and structured for their specific circumstances. A participatory approach also has some disadvantages: time and resources are required [5,48,77], appropriate stakeholders have to be identified [48], conducting the participatory process requires appropriate skills [48,78] and different stakeholders must agree on the goals of the process [67,78].

Multiple authors mention key features of best practice participation. Reed [67] states that a participatory approach should enable learning both for researchers and stakeholders. Moreover, each stakeholder should have equal power to influence the participatory process. Central is the principle of involving stakeholders as active participants from the early stages of the research [28,67,79]. Stakeholder selection is usually an iterative process where stakeholders are added as the process continues [67]. A diverse group of stakeholders adds to the public acceptance and respect for the research results [79]. Methods for stakeholder participation should be selected and tailored to the decision-making context [67,79]. Voinov and Bousquet [78] give an overview of participatory methods, distinguishing between stakeholder-based modeling and other stakeholder-based methods. Common in stakeholder modeling are iterative modeling stages [5,48,78]. These stages involve identifying goals, selecting stakeholders, choosing modeling tools, collecting and processing data, discussing conceptual models and testing and improving models. The way in which stakeholders contribute to these stages (e.g. workshop, individual interview, group discussion) and the frequency of participation depend on the case [28,78].

In order to develop Pigs2win, the model developers put forward a general objective, being the identification of farm-specific benchmarks and improvement paths for economic and environmental performances and the identification of underlying factors that determine these performances. Based on this objective, the two model developers selected other stakeholders. The main intention behind the selection of stakeholders was the aim to develop a DSS that is scientifically sound, usable in practice and supported by the pig sector in Flanders. To ensure scientific soundness, three scientists were selected: one agricultural economist and two technical scientists, specialized in the field of animal sciences. Technical scientists were chosen because of their knowledge of technical aspects that influence economic and environmental performances. One of the technical scientists had to be specialized in animal nutrition, because of the significant share of feed costs in the total costs of Flemish pig farms. Also three pig farmers were selected, in order to find a balance between scientifically sound results and their practical value. Two representatives, one from a feed company and another from a veterinary company were also selected, as these companies provide important resources for pig farming. Also representatives of the two major organizations that protect the interests of famers were included. The stakeholder group