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**Multiple Criteria Decision Making: Method Selection
And Application To Three Contrasting Agricultural
Case Studies**

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Multiple Criteria Decision Making: Method Selection And Application To Three Contrasting Agricultural Case Studies

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Summary

Agribusiness, farm business and agricultural-environmental decisions which varied in their characteristics were used to evaluate multiple criteria decision making (MCDM) in an agricultural context. This paper discusses differences between the case studies, strengths and weaknesses of the methods used, and the success of the MCDM process based on participants' expectations and experiences. While MCDM can help identify the best decision, the main benefits identified in using MCDM included better understanding of their own and other's perspectives, a means to explain the decision and a structured way to work through the decision process. Key problem areas identified included time limitations, understanding and ownership.

Keywords:

Multiple criteria decision making, agriculture, decision making.

Introduction

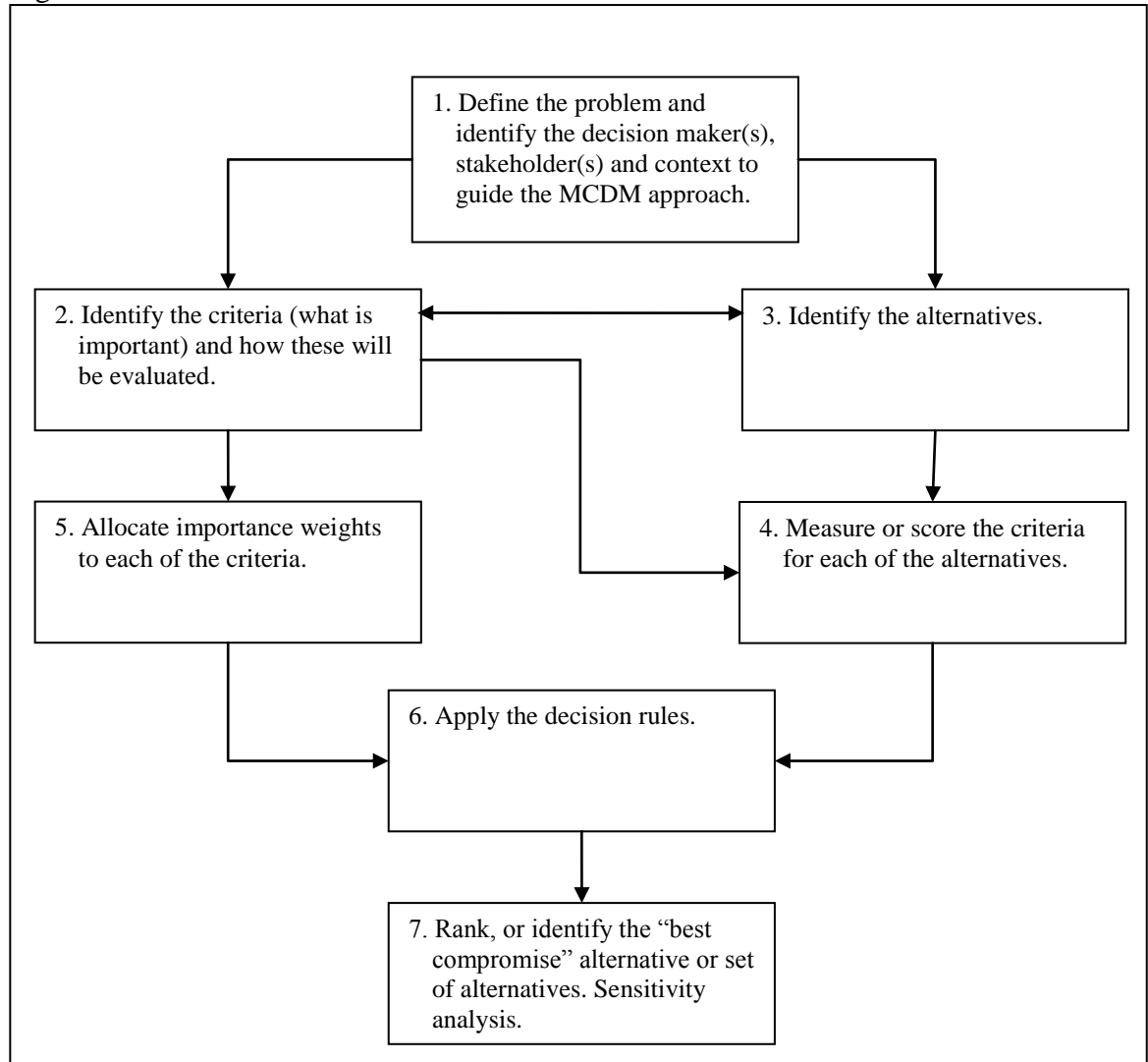
Multiple criteria decision making (MCDM) methods provide people with a quantitative means to assist with decision making where there are multiple and conflicting goals measured in different units. Other advantages of MCDM can include: making a decision more transparent to others, providing a means of problem structuring and working through the information, providing a focus for discussion, and helping people better understand a problem from their own and others' viewpoints. MCDM has been used at all levels of agricultural- and environmental-related decision making, ranging from farm-level decisions through to agricultural policy decision making. Environmental, economic, social and cultural considerations can be traded-off without converting all measures into the same units (RAC, 1992; Beinat, 2001). Although MCDM is increasingly used in Europe and USA, it has not been widely used in agricultural and environmental decision making in Australia and New Zealand (RAC, 1992).

There is considerable literature on MCDM techniques (mathematical analysis). However there is little on the application of MCDM, how to choose between approaches or techniques, or why a particular approach was chosen (Belton & Stewart, 2002; Belton, 2001; French, 2000, 1998). Roy (1999) suggests this lack of literature on real-life MCDM applications is because of the considerable work involved in describing a real decision process with all its complications and results which lack the characteristics required for many scientific journals. Belton and Stewart (2002) suggest MCDM requires: the development of an integrating framework for MCDM; greater integration between theory and practice with implementation research to explore the usefulness of the various processes or

techniques; and methodological research to identify weaknesses in MCDM models and extensions required to address these.

The MCDM process is generally similar for all approaches, but there are differences in the way the information on alternatives, criteria and relative significance of the criteria is elicited, specified and analysed (DTLR, 2001; Belton & Stewart 2002). The MCDM process consists of a series of stages from defining the problem to identifying the best alternatives (Figure 1).

Figure 1: The MCDM Process.



This research applied a MCDM approach to three different types of agricultural decisions: an agribusiness (AB) decision, farm business (FB) decisions and agricultural-environmental (AE) decisions. A descriptive framework was developed to help select the most appropriate MCDM approach and methods to use for different problem and decision maker requirements. This framework was then used to select the MCDM approach and methods for the three case studies. The effectiveness of the framework for selecting MCDM methods and the usefulness of MCDM for agricultural decision making was evaluated using these case studies. Other key issues that need to be considered when implementing MCDM were identified.

Method

Case Study Description

Case studies came from the agricultural sector and included:

- an agribusiness decision (meat company technology use – 3 individual, and a group decision),
- farm business decisions (cattle policy – 2 individual decisions), and
- agricultural-environmental decisions (farm systems for Lake Taupo catchment - 13 decisions).

Case study attributes are described in Table 1. The case studies were designed to work with participants making real decisions, or considering decisions they were likely to face in the future. These case studies represented combinations of different problem types and decision maker requirements, individual and group decisions, decision makers with similar or different objectives, and familiar versus new technologies.

Method Selection

MCDM methods were investigated leading to an understanding of the strengths, weaknesses, potential uses and restrictions associated with the predominant methods. A descriptive framework was then developed to assist in selecting the most appropriate MCDM approach and methods for a given problem, taking the problem attributes, the decision maker's requirements, and the method requirements and limitations into consideration. Method selection characteristics in the MCDM method selection framework are shown in Figure 2. The appropriate methods to use can become increasingly evident throughout the problem structuring and identification of alternatives and criteria stages. Therefore, method selection can be an on-going process.

The multi-attribute value theory (MAVT) approach with swing weightings was used for all case studies. Methods used for each of the stages are shown in Table 1. Key characteristics contributing to the selection of this method were similar for all case studies:

- alternatives in all case studies were discrete and required subjective judgements;
- there were limitations on time available, and this analysis method is relatively quick (requiring fewer comparisons than other MAVT methods e.g. AHP);
- it is relatively easy to use and understandable;
- alternatives are ranked, identifying the best alternative;
- it is transparent, which was an advantage particularly for the AB and AE case studies, although this was not specified as a requirement beforehand;
- software was available (AB) or readily developed (FB and AE).

MAVT is one of the most widely used MCDM approaches. It is also recognised as being suitable for groups and useful for facilitating learning. Its popularity may partly be the result of many decision method requirements having some of the above characteristics. However, the case studies differed in other respects e.g. group versus individual, understanding of the decision, willingness to be involved, decision maker objectives, and alternative and criteria identification (Table 1).

Figure 2: MCDM Method Selection Characteristics.

Method selection characteristics in this framework included:

- the objective of the analysis e.g. best alternative; ranking alternatives; a pareto-optimal set from a continuous decision space; a subset or grouping of alternatives, exploration of the problem, learning about others' judgements, communication between stakeholders, means to explain the decision, sense of ownership of the decision;
- the presence of a continuous or a discrete set of alternatives.
- whether subjective criteria can be used (discrete alternatives only);
- the requirement for, and availability of, a substantive model (for alternatives selected from a continuous decision space);
- the information available e.g. criteria and alternatives;
- time required and available (from clients perspective), ease of use, understandability, and soundness of the methods.
- the analytical skills and software available;
- the level of interaction the decision maker is prepared to have with the analyst e.g. iterative and MADM methods may require more decision maker-analyst interaction;
- whether decision makers are individuals or groups;
- whether group decision makers have similar/same or differing objectives e.g. a comparison or a compromise may be required;
- key participants and stakeholders. Stakeholders are those affected by the decision who may, or may not, be those making the decision. Key participants include decision makers, experts, facilitators and analysts.
- familiarity with the problem e.g. new technologies;
- whether risk or uncertainty has to be allowed for, and how e.g. as a criteria, a utility theory approach or sensitivity analysis.
- how the decision maker is most comfortable in defining criteria weights e.g. targets and constraints, partial-trade-offs, direct, subjective comparisons, concordance and discordance values. These differ between methods with some choice within some methods.

Evaluation

The framework was evaluated to identify whether it was effective in selecting the most appropriate method for the problem. As previously discussed, the MAVT approach was determined to be the most appropriate for all three cases. Therefore, in evaluating the framework the suitability of MAVT for the case study problems was assessed. Some methods within this approach differed for the three case studies e.g. identification of criteria, weighting.

Evaluation data were collected using written questionnaires (where time was limited), questioning of participants during the process, observation of the participants involvement in the process, and interviews (where more time was available) (Table 1). Written questionnaires required about 15 minutes to complete, and primarily consisted of questions requiring answers on a likert scale to enable collection of the maximum amount of data in a limited time.

Table 1: Description of the Problem.

Stage	Agribusiness	Farm business	Agricultural-environmental
Problem and context			
Problem	Identify strategies to adopt to best utilise objective carcass measurement technology	Identify the best beef policy for the farm (a beef cow and a finishing cattle case study)	Identify the best farm system for Lake Taupo catchment properties (with a nitrogen cap)
People	Operations managers (OM) for procurement, processing and marketing. Senior managers (SM) had input at an initial and final group meetings.	Mentor group assisted in identifying alternatives (during 2 meetings). Farm manager (cows) and partnership (finishing) completed the analysis.	4 Maori groups (trustee, manager and/or consultant). 3 individual farmers (couples or individuals). 4 researchers. 2 Environment Waikato staff
Context	Real decision. OM were told by SM to participate and come up with a strategy. OM were new in their positions.	Real decision associated with another beef project. Agreed to include MCDM in project. Farmers wanted to change.	Hypothetical example ensuring everyone used the same alternatives and criteria. Farmers facing similar decisions.
Time	Limited. Asked OM to put some time in outside meetings (limited success). 2 group meetings. 2 hour individual meetings with OM. Half hour evaluation.	Less restricted – mentor group aspects part of another project. Restricted to 2 hours for individual sessions, plus 1 hour for evaluation.	Limited. Half day group meeting to identify criteria. Restricted to 2 hours for individual sessions, including evaluation
Understanding	Problem and technology not clearly understood (not realised initially).	Problem and alternatives readily understood	Problem and alternatives readily understood
What was specified as wanted?	Identify the best strategy. OMs to take ownership of the problem/ decision (SM objective).	Select a policy or reinforce their decision. Explore decision and criteria. Evaluate quantitative decision making process.	Identify & evaluate alternative land uses. Understand what criteria are important. Understand MCDM process. Help out.
Identify alternatives	None pre-defined. Some group discussion. Identified by OM.	None pre-defined. Some identified by mentor group, some by farmer.	Pre-defined (14 alternatives) by Taupo researchers. Group suggestions included.
Identify criteria	Identified by OM. Value tree approach using revenue, cost and risk branches.	Identified by farmers (based in part on example given)	Defined at group meeting (14 criteria).
Score performance	Subjective scores	Some subjective scores. Gross margin measure provided.	Some subjective scores. Gross margin and N leaching measures provided.
Weight criteria	Various (swing weightings, trade-offs, point allocation, ranking)	Swing weightings	Swing weightings
Evaluation	Survey. Interview OM. Observations.	Interview or written response from managers. Observations.	Survey. Observations during process.

A few open-ended questions requiring written replies were asked (e.g. least liked aspect, best liked aspect, what was wanted). Interviews of half an hour to one hour were conducted with some AB participants, and a FB participant.

The approach selected was assessed relative to the participants' expectations of the process, or its usefulness in assisting them with their decision. Evaluation methods and questions asked were similar to those used in other MCDM and decision support comparisons and evaluations. Participants were asked for their opinions on: the appropriateness of MCDM for the decision; the importance of some of the benefits of MCDM methods; how well the process met what they considered important in evaluating their decision; other benefits they identified; their perceptions of each stage of the process (e.g. effectiveness, understandability, timeliness, and ease of use); the weighting methods used; and whether the decision arrived at was what was intuitively expected (Evans & Riha, 1989; Hobbs et al, 1992; Gundersen, 1994; Zapatero et al, 1997; Qureshi et al, 1999; Bell et al, 2001; Lai et al, 2002). The evaluation questions were similar to questions for evaluation of extension such as levels 4 (reactions) and 3 (knowledge, attitudes, skills and aspirations) of Bennett's hierarchy (Rockwell & Bennett, 2004); and learning aspects of extension (Lawrence et al, 2000). The method selected and the way the decision process unfolded guided some of the questions. Some questions were general to all case studies, others were method dependent and some were people specific.

Results

Evaluation Of The Process

The problem, technology and process were not clearly understood by the AB participants. Identification of criteria and alternatives was considered to be more difficult than the quantification stages of the process. The AB participants had to identify both the criteria and alternatives, and they disagreed or were neutral as to whether this was easy to do. The technology was new, and they had less time and help available to assist with this than the other case study participants. Managers who had put extra time into this found it easier. Most FB and AE participants found the information on the problem, process and alternatives (AE) to be adequate. They also considered identification of criteria and alternatives to be more difficult than the quantification stages of the process. FB decision makers had the assistance of a mentor group, an example beef decision with criteria available to work from, and more familiar technologies to consider. Even so, it still took considerable time and input to arrive at a set of alternatives and criteria, although one FB participant noted that it was still quicker than if they had done this themselves. The AE participants worked in groups to identify criteria, and most were neutral about whether this was easy to do (relative to agreeing other aspects of the process were easy).

Once participants understood the quantitative stages of the process, they had little hesitation about allocating weightings and scores and accepting the results. The most difficult aspect of the quantitative analysis was identified by participants as understanding the swings weighting method, and once it was explained, most agreed it was easy to use. The trade-off weighting method was also assessed by an AB participant but was considered more difficult than swing weighting. Where weighting and subjective scoring was done by people working together, they largely tended to agree on weights and scores and did not appear to have any difficulty coming to a

compromise when there was initial disagreement. Questions were not raised about the methods themselves, although there was discussion about the results and further analysis in most cases e.g. revision of the weights and scores.

Most case study participants would be prepared to use the process again, and 5 out of 14 AE decision makers said they preferred it to their current decision making process (8 were neutral and one disagreed). Case study participants felt the process could be useful for future decision making for themselves and other agricultural decision makers but commented that it would be necessary to have some guidance the first time it was used, particularly in weighting criteria. One participant commented that he thought the process was likely to be considered useful for farm decision making by about 50% of farmers i.e. those who were “strategic managers looking at farming as a business rather than a lifestyle”. Participants who were more willing to be involved were more positive. Some of the AB participants who had no choice about participating, and AE participants who were only “doing this to help” perceived it as being less useful or would not want to use this process to assist in future decision making.

Expectations And Outcomes

The decisions were regarded as suitable for MCDM i.e. participants agreed they had multiple conflicting goals. The outcomes wanted by the decision makers were varied (Table 1), and differed both between, and within case study types. These outcomes were achieved in some cases and most participants were relatively satisfied with the results. The AB case studies had still not reached a final outcome. Some AE participants had hoped to learn more about possible alternatives than was in the information provided. Participants identified benefits from working through the process other than those initially specified (Figure 3).

Figure 3: Benefits Participants Identified From Using The MCDM Process.

Unspecified benefits from working through the process which participants identified included:

- a greater understanding of their own decision making e.g. what was important to them in decision making;
- a better understanding of others’ perspectives;
- a structured, quantitative means to work through a decision;
- quantification which contributed to keeping the decision process objective;
- a means of documenting the decision;
- an objective decision process which provides a more transparent means to explain the decision or stimulate discussion of alternatives (e.g. to trustees, mentor group, senior managers);
- changing the way they thought about their decision making;
- validation that it was acceptable to consider non-profit criteria;
- a better understanding of where their area fits in, in the overall picture;
- getting together to discuss the decision, share ideas and come to an agreement;
- a better understanding of the decision or alternatives, sometimes as a result of identifying that more information was required and seeking that information.

The first three unspecified benefits were objectives for some participants, but were identified by others as unspecified benefits. The first two and the last one are a form of learning, and almost all case study participants indicated that they benefited from some aspect(s) of learning (e.g. the decision, criteria and their importance, others' perspectives), whether specified as an objective or not. Participants also considered a means of structuring the problem to be important. A structured decision making process that allowed them to make more thorough decisions, and identify what was important in their decision making was specified as a required outcome by some.

Ranking alternatives or identifying the best alternative was specified as an objective by the AB participants. This was less important in the FB and AE case studies, particularly the AE case where the decision was more futuristic and less tailored to their own farms or decisions. No-one appeared to perceive this process simply as a means to identify the correct decision and they were not concerned if the top ranked alternative differed from their intuitive expectations. Rather, an unexpected ranking led them to questioning their thinking on the decision, and exploring further to ensure whether their inputs really reflected their views i.e. decision makers were more focussed on the inputs (e.g. scores and weights) and how they affected the end result, rather than challenging the end result. Decision makers in the FB case studies accepted that the top ranked alternative was not their intuitive preference, agreeing after further exploration that the rankings and the analysis were correct. This led to one FB participant re-evaluating his current decision making process.

AB and AE case study participants were surveyed on the importance of possible benefits of MCDM in the decision being addressed (Table 2). All benefits were considered important by most people. Understanding which criteria have the biggest impact was most important for both case study types. AB participants considered ranking, understanding others' perspectives, understanding which criteria have the biggest impact and giving participants a sense of ownership of the decision more highly than the AE participants. AE participants ranked exploring what was important to them, identification of further information and reducing the chances of a decision being swayed, more highly. These results were not unexpected considering their objectives and case study characteristics (reaching a consensus group decision (AB) versus exploration of a pre-defined futuristic decision (AE)) (Table 1).

Table 2: The Importance Of Some Benefits Of MCDM (% respondents). NI=not important, I=important, VI=very important. These may not add to 100% as some specified "unsure".

Benefit	AB (n=9)			AE (n=13)		
	NI	I	VI	NI	I	VI
Ranking	0	33	67	7	64	29
Developing an understanding of others' perspectives	11	44	44	29	36	29
Exploring what is important to you in this decision	0	78	22	14	29	57
Understanding which criteria have the biggest impact	0	11	89	0	29	64
Identifying further information required	0	89	11	0	71	29
Making the decision clearly understood by others	11	44	33	14	57	29
Less chance of a result being swayed by individuals	22	33	33	23	23	46
Participants having a sense of ownership of a decision	0	44	56	29	21	50

Case Study Contrasts And Similarities

Differences existed between the case studies in the problem and context, and identification of alternatives and criteria (Table 1). The quantification and analysis stages of the process were similar for the case studies, particularly the FB and AE. Differences in planning and implementation, environment or circumstances, and people factors contributed to the way participants viewed the process. Some differences and similarities between the case studies which affected the success of the decision processes used are described in Figure 4. The case study types are shown in brackets with the case where this situation was more advantageous presented on the left.

Figure 4: Differences Between The Case Studies.

Environment or context
<ul style="list-style-type: none">• there were time limitations for all case studies, although some were less restrictive than others (FB>AE>AB);• the case studies were able to be incorporated within or alongside another project (FB>AE>AB);• the decision was an “individual” decision rather than a group decision requiring less co-operation between decision makers (FB=AE>AB);• greater flexibility was possible e.g. the decision maker was able to decide on some aspects of the process to best suit their way of thinking (FB>AE=AB);• the alternatives were easy for the participants to arrive at (AE>FB>AB);• the criteria were easy for the participants to arrive at (AE>FB>AB);
People
<ul style="list-style-type: none">• participants were willing to be involved, approached the process in a positive manner and wanted to make a change (FB>AE>AB);• the participants were easier to relate to (especially initially), making it easier to determine how best to implement the process (FB=AE>AB);• the decision makers were quantitative people making it easier for them to relate to this approach (AB>=FB=AE);• decision makers were accustomed to making decisions similar to the one they were evaluating ((FB=AE>AB);
Planning and implementation (some also relate to the context)
<ul style="list-style-type: none">• there was good understanding between those facilitating, which contributed to a more confident and effective delivery overall (FB=AE>AB);• the problem was understood by all those involved e.g. decision makers, facilitators (FB=AE>AB);• the technologies and alternatives were understood by all those involved (FB=AE>AB);• the process was understood by all those involved (FB=AE>AB);• the analysis process (and software) was interactive, and relatively straightforward to understand and use to help facilitate the process;• the outputs were planned to be easy for the decision makers to understand and included graphics to display the results.

Discussion

Benefits

Learning And Understanding

MCDM is perceived to be a decision making process or tool. Learning *per se*, is not generally seen to be the end purpose of an MCDM analysis, as it is in extension activities. However, Belton and Stewart (2002) suggest learning is the principal aim of a MCDM analysis. MCDM helps people understand a decision, and their own or others perspectives, thereby assisting them in identifying a preferred course of action. This is reflected in the terminology used by the case study participants and also in the MCDM literature where words such as learn, explore and understand are all used, often synonymously.

Learning, rather than the identification of a preferred course of action, can be the greatest benefit from using MCDM. Participants identified learning through being able to explore the decision as a key benefit, helping them understand the decision and technologies, what was important in making the decision, and factors affecting this. They were more interested in exploring the problem (e.g. reasons for the rankings and what criteria, scores or weightings impacted on these) than challenging the ranking.

Understanding others' perspectives was seen as more important in the AB case studies (Table 2) where a group consensus was required. The other case studies involved group comparison or individual decisions. People worked together during the process (e.g. discussions on technology capability, what was important, criteria weightings, scores) resulting in a greater understanding of the problem and each others perspectives. Even in the AE case study where consensus was not a requirement participants who sometimes worked in groups (to identify criteria, in the same room as others to complete the analysis) commented on their increased understanding of what was important to others. They found this stimulated their own thinking and enjoyed these aspects of the process.

Working through the MCDM process can identify gaps in peoples' knowledge, thereby prompting learning. This occurred in the AB case studies where the participants' realisation that they did not understand the technology prompted their learning about the technology.

The process used and presentation of results can assist with learning. Participants found the visual presentation of the analysis results (graphs) and the interactive approach helpful, and this would have contributed to their learning.

A Structured Process

Most participants liked the structured approach, finding it helped them to think through and understand the decision. The participants preferred a structured, or semi-structured decision making process and were accustomed to working with numeric data and this is likely to have affected their opinion. They found the structured approach gave the process some objectivity, and quantification (scores and weights) contributed to this. Belton and Stewart (2002) also considered that structuring a

problem is important, helping to ensure all criteria are accounted for, increasing confidence in the decision and minimising post-decision regret in complex decisions.

Most decision makers thought using a process that reduces the opportunity for the decision to be swayed by some individuals was important (Table 2), and some decision makers commented that the objectivity of the structured process was useful for this purpose. While still considering this to be important, an AB participant and 2 AE participants noted that sometimes it is necessary for an individual to step in and make the decision. Thus, while it is important in a group decision to have a decision making process where all can contribute, leadership is also required.

Complex and strategic decisions are most likely to benefit from a structured decision making process which provides greater understanding, objectivity and transparency. These decisions often involve more than one person. This was evident even in the more “individual” FB and AE farm decision making case studies where participants included: 3 couples; a manager answerable to a board of trustees; and corporate farm trustees, managers and consultants working either singly or together on the decision, none of whom would be responsible for making the decision on their own. A structured decision process can be used at one level of decision making with results referred to a higher level. Some participants from all case study types recognised this possibility.

Transparency

The objective and structured decision process provides a potentially transparent way to explain the decision to others. Participants who were accountable to others (AB managers, FB manager) and those who were involved in group decisions (some AE) recognised in hindsight that the process and results would be useful for explaining the decision to senior managers, trustees or mentor groups. This was not specified as an objective, probably because they were not aware of the usefulness of a structured decision process for this purpose initially. One person observed that results could be useful for documenting a decision.

Implementation Impacts And Difficulties

The problem context, people and implementation will all affect how smoothly any decision making process is likely to be. The AB case studies were more difficult than the FB and AE case studies. Key factors affecting this were: greater time pressure to complete the process; no pre-defined alternatives or criteria; poor understanding of the technology, problem and process; unfamiliar technology; and unwillingness of some participants to contribute. Many of these are inter-related. The main difficulties in the case studies were around time, understanding and ownership.

Time

The process requires a time commitment from decision makers and facilitators, both before (for planning) and during the decision process. The commitment to the decision and decision process needs to be not only at the level the decision is being made at, but also at higher levels within the company. The operation managers in the AB case study commented that senior managers should have recognised that operations managers needed more time made available to work on the decision. This would have resulted in them being more willing to participate and better results. It would be best not to proceed in facilitating a decision process unless a commitment

to using the process, including sufficient time allowed, is given. Schein (1999) recommends not getting involved in facilitating a decision unless the decision maker or their company makes a commitment up front, preferably during a paid meeting to ensure they are serious.

More time consuming methods may not be required to satisfy client expectations – and may in fact have the opposite effect. Time limitations were specified for all three case studies and were a key factor in deciding on the method. Time pressures can affect what process is used and how well this can be implemented. However, it also needs to be recognised that to the decision makers, “time is money”. More time may have allowed the MCDM process to have been conducted more thoroughly or more accurate methods and cross checking to be used. This could have resulted in slightly more accurate rankings, but other benefits (e.g. learning) which were seen as more useful outcomes are still likely to have occurred, particularly in the FB and AE case studies. More time in the AB case studies would have been beneficial.

Lack Of Understanding (Problem, Process, Technology)

It is critical to have sufficient discussion and background information on the problem and context in method planning and implementation. The problem, process and technologies need to be adequately explained to the participants. The assumption should not be made that all participants will understand the decision and technologies, even when they have been previously provided with information. Where technologies are new, more time will need to be allowed for discussing the decision and the alternatives.

Participants in the AB case study had difficulties in understanding the process, problem and technology. These problems were due in part to lack of time to explain these factors and the assumption that people understood the technology. The technology was new and its implementation was likely to have a significant impact on the system. While some information was available to the participants, not all had read or understood this, and further information was required. This affected participants’ ability to understand and assess the likely impacts of the technology.

In contrast, the FB and AE case studies were more successful. Factors contributing to this included: the decision process fitted more closely with on-going work on the decision; the process was explained more clearly than in the AB case study; more information and time was available to learn about the context and get to know those involved; and the participants were familiar with the alternatives, many of which would have required only incremental changes to the current system.

Differences between people need to be understood and allowed for in planning and implementing the process. Even working with a company decision such as in the AB case study where people had similar overall objectives, there were differences in their understanding, objectives and perspectives because of differing backgrounds, experiences, responsibility levels and personalities.

Ownership And Commitment

The operation managers in the AB case study were required to take some ownership of the consensus group decision, but were reluctant to be involved. These were busy people who were not committed, had no choice in participating, were unaccustomed

to this level of decision making, or saw no reason not to do things the old way. This made it more difficult getting them to participate in the process initially. The later realisation that they did not understand the technology sufficiently to make a decision resulted in these managers taking initiative between formal meetings to discuss the problem. Thus, the decision process and the need to be accountable acted as a catalyst, and most managers had a greater sense of ownership and commitment to the decision at the end of the process. This was an objective specified by senior management.

Trust And Facilitation

While trust and facilitation was not a problem in the case studies, the need for trust can affect methods used and facilitation. An outside facilitator, or analyst, may find it more difficult to understand the problem context in order to decide on the best decision process and work with the decision makers in implementing this process. This may be more likely with agribusiness decisions where information may be less readily available e.g. internal company information, people issues within the company. Case study identification, understanding of the problem context and the decision makers' trust was gained through working with AgResearch people who had established relationships with the company or decision makers. Methods used had to suit these people as well. However, the case studies would have taken considerably longer had they needed to be otherwise identified and the relationships with the decision makers developed.

Evaluation

Evaluation of the decision process and selection framework could be affected by: (1) whether the problem is suitable for MCDM; (2) the decision process selected; (3) the way the decision process is conducted; and (4) the personal preferences and objectives of those evaluating the decision process. The evaluation was further complicated by the fact that benefits were greater than the initially specified objectives which were used to assess the decision process selected.

Personal preferences and the willingness of the decision makers to be involved accounted for some of the variation in the decision makers' opinions of the decision process. Those who were more willing to participate were more positive. Some of the AB participants who had no choice about being involved and AE participants who were only "doing this to help" perceived it as being less useful, or would not use this process for future decision making.

The decision process was judged to be useful by most, but could have been better implemented. Most would be willing to use it again. This suggests that the MAVT decision process selected for the case studies was appropriate, and the framework for method selection could be considered to be useful. The planning and implementation could have been improved particularly for the AB case studies. As discussed, there were problems with time, understanding and ownership. These problems occurred in the initial stages of the process and the opinion was expressed that these were likely to have occurred with any formal or group decision making process. This concurs with Schein (1999), who notes that most "mistakes" in consultation tend to occur at the beginning. Similarly, many of the benefits would have resulted from any formal, structured decision making process, not just MCDM.

MCDM literature suggests people often raise issues relating to the quantitative analysis of the decision alternatives. However, this did not occur in these case studies. Participants found identifying alternatives and criteria more difficult. These aspects took considerable time which needs to be allowed for in planning.

Considerations For Future MCDM

Most problems encountered in the case studies occurred in the initial stages of the decision process and could apply to any formal decision process, particularly those involving groups. These included: insufficient time to complete the decision process properly; difficulty in understanding the problem, decision process, and technology (AB); and decision makers unwilling to take responsibility for the decision (AB) or not committed because they felt they had little to gain from participating (AB, AE). These problems were inter-related. While these issues are not discussed in much of the MCDM literature, they have been identified as being important in the wider decision making and consultancy literature.

Key points to consider in planning and implementing MCDM in future include:

- ensuring that decision makers or their company are prepared to invest time in a decision, particularly if it is important (which any decision requiring a structured process will be). Those involved should be informed of the extent of their involvement and have adequate information before the decision process commences. More time needs to be allowed if the technology is unfamiliar.
- understanding the problem context before the decision process is planned. This may be more difficult with agribusiness decisions where access to information may be more limited for facilitators or analysts.
- understanding as much as possible about the decision makers (attitudes, experience, skills, reason for participating) in the planning phase. This will be more difficult when dealing with groups or companies rather than individual decision makers.
- making sure at the beginning that the problem, decision process, technologies and any pre-defined decision alternatives are understood by all decision makers, and to some extent by facilitators and analysts. Do not assume these are understood.
- recognising the importance of establishing the trust of the decision makers (and company if applicable), working with contacts to ensure this if need be. This may require tradeoffs between working with those trusted by the decision makers, and the methods used and facilitator skills.
- considerable time and commitment may be required to identify criteria and alternatives, especially where these are not pre-defined or are dealing with unfamiliar technologies. Alternative and value focussed methods could be used to assist with this.
- be prepared to be flexible in implementation and revise the plan if required or is likely to be advantageous as some factors may not be understood or arise until the process is underway.
- realising that not everyone will necessarily be happy with the decision process and possibly the outcome because of differences in personality, background, objectives and expectations.

Conclusion

The case studies suggest that MCDM can be helpful for assisting with agricultural and agribusiness decision making. Most participants were happy with the outcome, would be prepared to use the process again and believed it would be useful for agricultural decision making. They identified learning about the decision and technologies; what was important to them; and others' perspectives as key benefits. The structured decision process provided an objective means to work through the problem, and a potentially transparent way to explain their decision to others. The process contributed to AB managers being more committed to the decision. Participants recognised many of these benefits only after being involved in the process.

MCDM is seen as a process or tool to help identify the best decision. It has the potential to do more than this, and the other benefits need to be promoted in advocating the use of MCDM. This may be difficult since these benefits may not be recognised until completion the process. Promotion of MCDM may best be achieved as part of other extension or consultation activities by someone who has used the process. The time and commitment required may deter people from considering a structured decision making process like MCDM. Simpler MCDM approaches are likely to be as effective in achieving many of the benefits (e.g. learning, stimulating thinking, objectivity) as more complex ones, and are more likely to be acceptable to decision makers given time constraints. There has been considerable research on MCDM methods. However, it is unclear why people use these methods, what would induce them to consider their use, and how they are best promoted or implemented to encourage people to use them. The opportunity exists for MCDM research in these areas.

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