



INNOVATIVE: Journal Of Social Science Research

Volume 4 Nomor 2 Tahun 2024 Page 5241-5254

E-ISSN 2807-4238 and P-ISSN 2807-4246

Website: <https://j-innovative.org/index.php/Innovative>

Selecting File Management Service Based on Multi Criteria Decision

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Abstrak

Pengambilan keputusan mempunyai tantangan tersendiri baik dalam evaluasi yang melibatkan berbagai aspek maupun elemen yang berkontribusi terhadap suatu keputusan secara keseluruhan. Dalam pengambilan keputusan studi kasus pada tulisan ini menggunakan software MACBETH dimana metode yang digunakan adalah evaluasi multi kriteria. Perangkat lunak MACBETH memberikan kerangka kerja untuk membangun model evaluasi berbasis preferensi yang kompleks tidak hanya itu MACBETH juga memberikan keuntungan dalam proses pengambilan keputusan karena membantu mengatasi kompleksitas dan subjektivitas serta memfasilitasi penetapan prioritas serta memungkinkan alternatif yang sistematis dan transparan berdasarkan informasi yang konsisten. Dalam mengevaluasi alternatif untuk memilih penyedia jasa yang terbaik bagi kebutuhan perusahaan dengan menentukan kriteria penilaian yang relevan dan memberikan bobot pada setiap kriteria untuk menilai alternatif berdasarkan informasi yang diberikan dari beberapa alternatif penyedia jasa. Informasi yang diperoleh seperti kualitas layanan, fasilitas yang ditawarkan dan biaya digunakan sebagai kriteria evaluasi yang relevan sehingga dengan mengintegrasikan faktor-faktor kunci dan preferensi dengan bantuan perangkat lunak MACBETH dapat mengoptimalkan pengambilan keputusan strategis. Hasilnya dapat dilihat secara visual dengan grafik dan matriks preferensi untuk memudahkan pemahaman dan interpretasi data.

Kata Kunci: *MACBETH, Analisis Keputusan Multi Kriteria, Pembobotan Multi Kriteria*

Abstract

Deciding has its own challenges both in evaluation which involves various aspects and elements that contribute to an overall decision. In making case study decisions in this paper using MACBETH software where the method used is multi-criteria evaluation. MACBETH software provides a framework for building complex preference-based evaluation models not only that MACBETH also provides advantages in the decision-making process because it helps overcome complexity and subjectivity and facilitates setting priorities as well as enabling systematic and transparent alternatives based on consistent information. In evaluating alternatives to choose the best service provider for company needs by determining the relevant assessment criteria and giving weight to each criterion to assess alternatives based on information provided from several alternative service providers. Information obtained such as service quality, facilities offered and costs are used as relevant evaluation criteria so that by integrating key factors and preferences with the help of MACBETH software it optimizes the strategic decision making. The results can be seen visually with graphs and preference matrices to facilitate understanding and interpretation of the data.

Keywords: *MACBETH, Multi Criteria Decision Analysis, Multi Criteria Weighting*

INTRODUCTION

Decision analysis is a formalized approach to making optimal choices under conditions of uncertainty [1]. Decision analysis is a normative method for selecting among actions that have uncertain outcomes. This outcome uncertainty can be characterized by probability distributions for variables that represent the key consequences of the considered actions [2].

Decision analysis is a systematic approach to decisions that have to be made in the face of uncertainty [3,4,5]. It is systematic for three reasons. It requires an explicit formulation of the problem, including alternative choices that are available to the decision maker and important specific outcomes. This formulation is often represented by a figure called a decision tree. Second, it requires the explicit quantitative representation of uncertainty in the form of probabilities. Third, it requires the explicit quantitative representation of preferences in the form of utilities. Multi-Criteria Decision Analysis (MCDA), also known as Multi-Criteria Decision-Making (MCDM), is about making decisions when multiple criteria or objectives need to be considered together in order to rank or choose between alternatives. MCDA is a vast field of research, with its scientific community and its specialized journals, as well as a large and growing number of real-world applications. Multiple Criteria Decision Analysis (MCDA) is a scientific process aiming to frame Decision-Making Problems (DMPs) and develop a comprehensive assessment of alternatives [6,7,8].

An MCDA sets and recommends decision rules on how to evaluate the overall environmental, technical, and socioeconomic performance of a set of alternatives and how to choose among them [9]. Over the last few decades, the number of MCDA methods has grown steadily [10], and an analyst can find it challenging to select the most suitable method.

RESEARCH METHOD

MCDA methods consist of four steps:

1. Creating a set of criteria relevant to the decision at hand;
2. Defining the preference parameters of the model (criteria weights, thresholds, etc.);
3. Measuring the performance of each alternative with respect to each criterion on possibly heterogeneous scales; and
4. Aggregating the information defined in Steps 1–3 to solve the question at hand: to choose the best alternative, to rank the alternatives, or to sort them into pre-defined categories [11].

Figure 1 summarizes the decision-analysis process. As can be seen, the process begins with the identification of the decision context and the understanding of its objectives. These objectives should be [12]:

- Essential, considering the motivations and concerns of the decision problem;
- Understandable, with clear and unambiguous meaning;
- Operational, allowing the quantification and evaluation of performances;
- Concise, considering as few goals as possible;
- Preferably independent, which means that the performance evaluation in one objective does not depend on the assessments in the other.

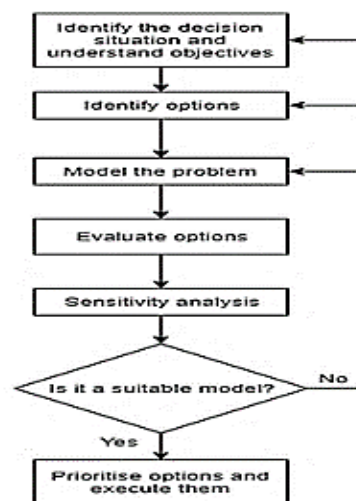


Figure 1. Decision analysis process (adapted from Clemen and Relly, 2011)

Decision analysis helps organizations improve the quality, speed, and accountability of its decisions and includes a variety of procedures, methods, and tools for identifying, clearly representing, and formally assessing the important inputs and steps to decision making. The decision analysis process is important because it helps to ensure that all of the relevant information is considered when deciding. It also helps to identify the best possible solution, given the constraints and available resources.

MACBETH is an approach that helps a decision-maker to quantify the attractiveness of different options based on qualitative judgments about differences of attractiveness [13].

The MACBETH approach is applicable to additive value models; accordingly, it can be used to define value functions and to determine weights [14]. The purpose of this study is to understand a problem in making a strategic decision where the socio-technical approach in decision analysis refers to a perspective that involves the interaction between social and technical factors when analyzing and evaluating decisions from multiple criteria. Where human and technological aspects are considered, in this case using MACBETH software when analyzing and evaluating decisions to be taken. The socio-technical approach can consider factors such as communication patterns, individual preferences, organizational culture apart from technical considerations such as efficiency. In this paper, the financial manager at petroleum company opens a tender to select a record management service provider to manage.

RESULT AND DISCUSSION

Structuring of The Problem

The purpose of this study is to understand a problem in making a strategic decision where the socio-technical approach in decision analysis refers to a perspective that involves the interaction between social and technical factors when analyzing and evaluating decisions with multiple criteria in this case using MACBETH software with analyzing and evaluating decisions to be taken.

1. Characterization of the Context

The first step in good decision making involves defining what question or problem is being addressed and why, identifying who needs to be involved and how, establishing scope and bounds for the decision, and clarifying the roles and responsibilities of the decision team. To clarify the decision context, we consider five main aspects. The aspects are:

- 1.1. Define what decision is made and why? We have a client at petroleum company in Indonesia and we should select the best managed service provider company (MSP) in record management. The strategy is to improve the operational and productive

efficiency of the enterprise.

- 1.2. Define what risks are being ranked if there are, and why? If the decision maker chooses the wrong objectivities bias will affect with the outcomes for instance the decision maker only focuses on cost and prefers to have the highest rank to service provider give the cheapest price but the cheapest one cannot be the best alternative.
- 1.3. Identify how will the information use in future decisions?
- 1.4. what are the key drivers of the change and what are the underlying policy objectives?
- 1.5. Identify the constraints within which the decision will be made. In this paper, for the constraint will be discussed on part F. Reflective chapter.

2. Identification of Actor or Decision Maker(s)

In this paper, financial manager as an extension of the company records management service providers in managing document and current problem is about accumulation of documents from departments and it needs more space. The management prefers to use record management service to organize the documents safely so the archive room can be useful to extension the workspace. The type evaluation model is framework used to assess and comparing the different record management service providers based on the criterions, requirements using multi criteria decision analysis (MCDA).

3. Definition of decision support process

The term Decision Support (DS) is used often and in a variety of contexts related to decision making. [15]

“DS means helping you to make good decisions by understanding the effects of all the alternatives. It allows you to answer the question, ‘What will happen if...?’, for a whole range of scenarios” [16]. “DS is utilizing computer-based systems that facilitate the use of data, models, and structured decision processes in decision making. Some key words associated with DSS are such as: Decision Theory, Decision Analysis, Operations Research, Management Science, and Artificial Intelligence. Or maybe this will help: Neural Networks, SAS Programming, and Expert Systems” [17].

Inevitably, DS is a part of decision-making processes. A decision is defined as the choice of one among a number of alternatives, and Decision Making refers to the whole process of making the choice, which includes:

- Assessing the problem,
- Collecting and verifying information,
- Identifying alternatives,
- Anticipating consequences of decisions,

- Making the choice using sound and logical judgement based on available information,
- Informing others of decision and rationale,
- Evaluating decisions.

According to Simon [18], the decision-making process consists of three main stages:

1. Intelligence: Fact finding, problem and opportunity sensing, analysis, and exploration.
2. Design: Formulation of solutions, generation of alternatives, modeling and simulation.
3. Choice: Goal maximization, alternative selection, decision making, and implementation.

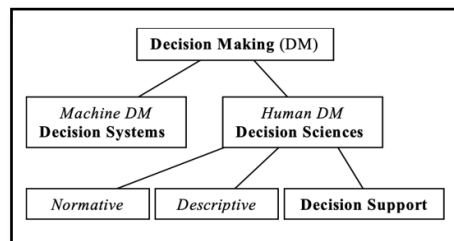


Figure 2. The role of DS in Decision Making

The term DS contains the word "support", which refers to supporting people in making decisions. Thus, DS is concerned with human decision making. Therefore, we explicitly differentiate between machine and human decision making and associate DS only with the latter (Figure 1). The two disciplines that closely correspond to this distinction are Decision Systems, which (primarily) deals with computer-based programs and technologies intended to make routine decisions, monitor and control processes [19], and Decision Sciences, a broad discipline concerned with human decision making. Decision Support Systems (DSS) are defined as interactive computer-based systems intended to help decision makers utilize data and models in order to identify and solve problems and make decisions.

Their major characteristics are:

- DSS incorporate both data and models;
- they are designed to assist managers in semi-structured or unstructured decision-making processes;
- DSS support, rather than replace, managerial judgment;
- they are aimed at improving the effectiveness—rather than efficiency—of decisions.

4. Type of Evaluation Model to be Constructed

The evaluation of models formed based on information gathered from decision maker including:

- Identifying criteria, in this case the decision maker prefers the rules in screening process using bidding criterion.
- Weighting the criteria based on the interest of the company preferences.

The next rank is organization, decision maker expects the strong capabilities in their internal organization including the efficient process they offer and how effective their communication to the customers with provide smooth record management operations and flexibility. The next is total customer as the indicator of the service provider's reputation and their best performances gain trust from customers. The accessibility offering the efficient retrieval processes and user-friendly access to records through online and searching the functionalities, it relates with the location in terms record retrieval and physical access. Insurance and the certification are also considered for this case the decision maker wants the service providers to have at least 4 types of certifications. ISO 9001, ISO 15489, ISO 27001, NAID AA.

Structuring The Model

1. Screening Criteria

At the drafting stage, the process of selecting a record management service provider, in this company, is appointed as the manager of the financial manager archives who is responsible for managing the company's physical records. In making decision, several important things to consider in choosing record management service providers include:

- Accessibility
- Security
- Optimization of space
- A strategic location will make it easier to retrieve documents and return them.
- Technological and infrastructure facilities
- Policy on document retention and destruction
- Cost

2. Fundamental Points of View/Criteria

The characteristics can be defined as a point of view because they have a relationship with aspects that are considered relevant to decisions from the evaluation results (Bana e Costa et al, 1998).

Area of concern	Fundamental points of view
Management Feasibility	Experience Organization Service Performance Total Customer
Range of Service	Record Services Accessibility Packaging
Facilities and Location	Security Insurance Location
Certification	ISO 9001:2015 ISO 15489-1:2016 ISO 27001:2013 NAID AAA

Table 1.

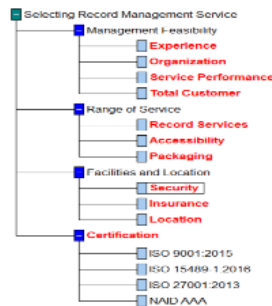


Figure 3. Value Tree

In table 1. The decision maker has four area of concern which divided into several fundamental points of view that can give the perspective of best service provider should be chosen.

3. Descriptors

Descriptors are used to evaluate as well as for comparison of several options based on certain criteria or objectives. In the process of decision analysis, descriptors are attributes or characteristics that describe the various options or alternatives considered. Descriptors can be both quantitative and qualitative and they provide a basis for assessing the attributes of each option. The decision makers can evaluate options quantitatively and qualitatively against certain criteria or objectives.

To construct the descriptors, we discussed with decision maker to define the level of criterion.

Table 2.

Fundamental Point of View	Descriptor	Impact Range	
		Not acceptable	/
Expense	Expense per annum	8089	
Experience	Five level qualitative scale	Table 3	
Service Performance	Accuracy, Error, Compliance	90	
Organization	Five level qualitative scale	Table 4	
Total customer	Five level qualitative scale	Table 5	
Record service	Five level qualitative scale	Table 6	
Accessibility	Five level qualitative scale	Table 7	
Packaging	Five level qualitative scale	Table 8	
Security	Five level qualitative scale	Table 9	
Insurance	Five level qualitative scale	Table 10	
Location	Distance from office to storage	26	

Table 5.

Total Customer		
Impact Level	Descriptor	Reference Level
L5	More than 20	Excellent
L4	16-20	Good
L3	11-15	Adequate
L2	6-10	Low
L1	1-5	Very Low

Table 3.

Experience		
Impact Level	Descriptor	Reference Level
L5	More than 12 years	Excellent
L4	10 to 12 years	Good
L3	7 to 9 years	Adequate
L2	4 to 6 years	Low
L1	1 to 3 years	Very Low

Table 4.

Organization		
Impact Level	Descriptor	Reference Level
L5	Organization chart, roles, responsibility, experiences, achievement	Excellent
L4	Organization chart, roles, responsibility, experiences	Good
L3	Organization chart, roles, responsibility	Adequate
L2	Organization chart and roles	Low
L1	Organization chart	Very Low

Table 6.

Record Service		
Impact Level	Descriptor	Reference Level
L5	Consultancy, Storage options, Retention schedules, Training, Assist issues relates service, Easy communication channel, Provide access in a timely manner, Record retrieval, Reporting, Provide transparent payment and offer assistance related	Excellent
L4	Consultancy, Storage options, Retention schedules, Training, Assist issues relates service, Easy communication channel, Provide access in a timely manner, Record Consultancy, Storage options, Retention schedules, Training, Assist issues relates service, Record retrieval, Reporting	Good
L3	Consultancy, Storage options, Retention schedules, Training, Assist issues relates service, Record retrieval, Reporting	Adequate
L2	Consultancy, Storage options, Retention schedules, Training, Record retrieval	Low
L1	Consultancy, Storage options, Retention schedules, record retrieval	Very Low

Table 7.

Accessibility		
Impact Level	Descriptor	Reference Level
L5	Mission ID user access to electronic records through the creation of records through the platform using efficient and timely registration, digital, video and audio, provide disaster recovery plan and disaster recovery scenarios, records reporting and analytics	Excellent
L4	Mission ID user access to electronic records through the creation of records through the platform using efficient and timely registration, digital, video and audio, disaster recovery plan and disaster recovery scenarios	Good
L3	Mission ID user access to electronic records through the creation of records through the platform using efficient and timely registration, digital, video and audio	Adequate
L2	Mission ID user access to electronic records through the creation of records through the platform	Low
L1	Mission ID user access to electronic records through the creation of records through the platform	Very Low

Table 8.

Packaging		
Impact Level	Descriptor	Reference Level
L5	Standard box, Media storage boxes, Archive box, Transfer cases, Spo	Excellent
L4	Standard box, Media storage boxes, Archive box, Transfer cases	Good
L3	Standard box, media storage boxes, Archive box	Adequate
L2	Standard box, media storage boxes	Low
L1	Standard box	Very Low

Table 9.

Security		
Impact Level	Descriptor	Ref
L5	Design safe media transport, GPS, CCTV, Access log, fire detection system, utilizing firewalls, data encryption technique, document tracking system, biometric authentication	
L4	Design safe media transport, GPS, fire detection system, utilizing firewalls, data encryption technique, CCTV, Access log, electronic key cards	
L3	Design safe media transport, GPS, CCTV, equipped fire detection system, Access log, utilizing firewalls, data encryption technique	
L2	Design safe media transport, GPS, CCTV, equipped fire detection system, Dehumidifier, Iron Box	
L1	Design safe media transport, CCTV, equipped fire detection system	

Table 10.

Insurance		
Impact Level	Descriptor	Ref
L5	Coverage errors in providing services in financial losses from customers	
L4	Coverage from expenses from unauthorized access to sensitive records, credit monitoring service after data breach	
L3	Coverage financial losses due to disruption and cyber threats	
L2	Coverage financial losses due to disruption and coverage physical records due to natural disasters	
L1	Coverage physical record, storage facilities against losses from fire, vandalism, natural disaster	

As the result from MACBETH the twelve-profile combination, ten profiles were considered by decision maker. For the profile combination as shown tables, with the variety of descriptors the decision maker can be easily to see the result based on the gathered information from service providers. The Fundamental point of view in certification is defined by acceptable and not acceptable. Refers to Bana e Costa and Beinat (2005), the several references can impact the profiles can be used to develop the constructed descriptor.

4. Options

The discussion about options of which service providers offering services fit with decision maker needs. From 8 service providers the decision makers chose by screening at beginning based on the criterion experience which minimum adequate level is 7 to 9 years as preference and 5 options of service provider can be accepted.

- 1st option is Crown
- 2nd Option Lane
- 3rd option is Santa Fe
- 4th option is Prime
- 5th option is AG

5. Performance profile of the options

Table 11

Options	EXP	O	SP	TC	RS	ACS	P	SC	INS	LOC
Crown	Excellent	Excellent	98	Excellent	Excellent	Excellent	Excellent	Excellent	Good	26
Lane	Good	Excellent	95	Good	Excellent	Good	Excellent	Good	Good	24.5
Santa Fe	Excellent	Excellent	98	Excellent	Excellent	Excellent	Excellent	Excellent	Good	10
Prime	Adequate	Good	95	Good	Good	Good	Good	Good	Adequate	12.5
AG	Good	Excellent	98	Good	Excellent	Excellent	Good	Good	Good	9.5

Table 11 presents the profile of the option by collaborating each of service providers with impact level of each descriptor after the descriptors for all fundamental points of view and options are known.

Constructing of an Additive Evaluation Model Using Macbeth Methodology

1. Value Function/Preference Scales

Using the MACBETH approach, it is possible to define value functions that measure the attractiveness of each performance level. These numeric functions result from qualitative judgments on the differences in attractiveness reported by the decisionmaker. To define the value functions, we use five performance levels: Excellent, Good, Adequate, Low, very low and an arbitrary value of 0 and 100, respectively, should be assigned to these five performance levels. The value functions should be validated by the decisionmaker. The

decision maker decided the judgements with fill the matrix for fundamental under analysis. The qualitative judgement matrices and the interval scales showed after no inconsistency was detected in any judgement matrices, the validation is approved by the decision maker. The value function was constructed to each service provider to see the attractiveness. In Figure 2 shows in the form of overall thermometer the value function is shown for fundamental points of view which descriptors were qualitative and constructed.

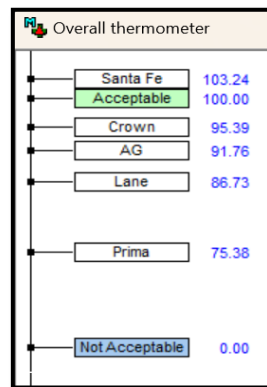


Figure 4.

In figure 2 as the value scores 0 and 100 were assigned to the neutral and good reference level, impact level acceptable and not acceptable. For the result of the service providers, none has the score below zero which means negative score and the decision maker will not accept the service provider which has negative score. The decision maker concerns about the quality performances and facilitates can be offered by the service provider and the budget is not an issue as long his company can get the best price in comparable and reasonable with the quality they will pay for. The decision maker has preference to choose at least from five service provider options into two best options and comparing the price after.

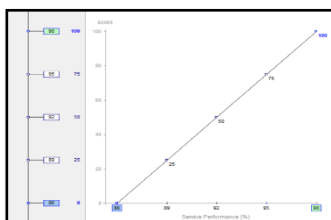


Figure 5. Service performance score.



Figure 6. Value function of experience, organization, total customer

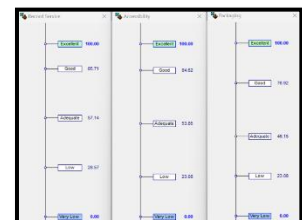


Figure 7. Record service, Accessibility, Packaging

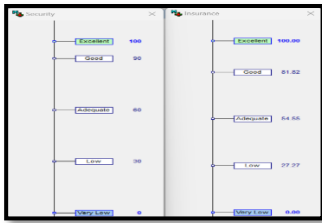


Figure 8. Security and Insurance

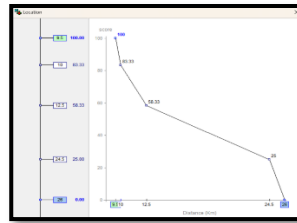


Figure 9. Location

After the score is given and there is no inconsistent judgment in matrices for experience and organization were validated, even not in all process to fill the judgment always smooth. This judgment score was achieved after the decision maker reviewed the 1st result which was the organization value was higher if comparing with experience. From the place of important factors to selecting service provider, the experience is supposed to be higher than the organization because is often considered that it directly relates to the track record of company about reputation and credibility.

2. Weighting Coefficients

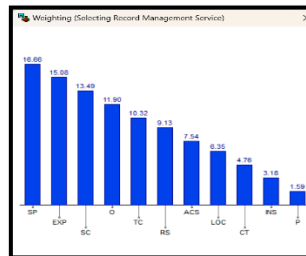


Figure 10. Weight of each fundamental point of view

The numerical value assigned to each factor or element in a set of that that present its contribution. The sum of all weights is equal 100. The weighting of each factor depends on the judgement and expectation from the decision maker.

Application of The Additive Model

1. Computation of the Global Attractiveness of Each Option

The global attractiveness is determined by combining the performance values which the decision maker chose the criteria and weighted the criteria. Performance value can be rated with numerical and qualitative assessments. We combined the criteria assessments and highest value is considered as the most attractive option.

2. Sensitivity Analysis

On the evaluation in sensitivity analysis based on accessibility which presents in figure 10. Comparing to the score, the highest rank showed Santa Fe among other 2 competitors, Crown and AG which can provide excellent accessibility.

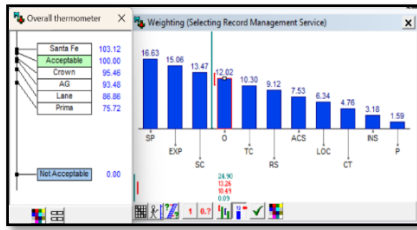


Figure 11. a

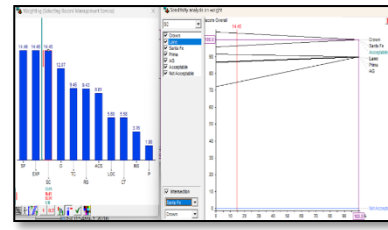


Figure 11.b

This figure presents that the current weight of horizontal axis of "security" 13.49, when the weight of security increases, the global score on vertical axis of Santa Fe increases and the score can be adjusted depends on the preference score needs by the decision maker.

3. Robustness Analysis

The results of the robust analysis are supported by the MACBETH system features, based on the assumption that the ordinal column only provides instructions for the dominating service provider. When all columns ordinal, cardinal and global information are filled in, Santa Fe dominates from all options.



Figure 12. Robust analysis

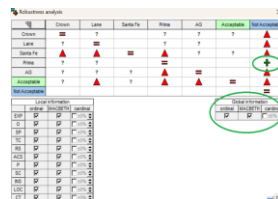


Figure 13. Robust analysis

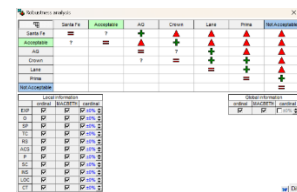


Figure 14. Robust analysis global comparisons

In the table of global comparison of the figure 12, it can be seen that when the selected preference information pre-cardinal MACBETH information for the eleven criteria (local information) and ordinal information for comparison of reference profiles in the (global information), then AG is no longer globally more attractive than other service providers.

However, if we consider pre-cardinal information not only for the local information but also for the global information see the (figure 13) it is sufficient for AG, to be globally more attractive than Prima. It is also possible with the table of global comparison to see the effect of considering uncertainty on the action impacts. Figure 14 presents that when considering

the uncertainty, Santa Fe is globally more attractive than other providers if we selected the cardinal information under the eleven criteria. The result of this study shows that MACBETH can help the decision maker sees clear based on the result of which selected service provider is supposed to be chosen and the selected one based on what decision maker's (company) needs. Furthermore, future research might explore the application of MACBETH approach to other larger decision problems.

CONCLUSION

From the decision support process with using MACBETH can assess the various aspects with multi criteria and evaluating with the various steps with identification the decision criteria, and assess the decision objectivities with the decision maker(s) and identification any assumptions or limitation that caused biases which might influenced the decision making process and this made the process took time as well as gathering the data that relevant information, the completeness of data from the service provider to screening the candidates and identify the any potential gaps or limitation in the data collected. From the result that Santa Fe has the highest score comparing to other competitors which not only considered in 2 criteria which most decision makers might select from service provider. High service performance in affordable price, but not only based on those two factors, we assessed which the best one effectively relevant with company objectives, goal and constraints.

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