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System Evaluation for a Decision Support System

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Abstract: System evaluation is a necessary step in system development process to measure the successfulness of a system. However, this step has often been overlooked by system developers during the development process. This study aimed to discuss several system evaluations for Decision Support Systems (DSSs) and to explain the methodology used to evaluate a DSS model. In this study, a DSS model has been developed to assist decision makers to select an appropriate tree species to be planted for commercial tree planting. Based on few literatures, eight usability factors (efficiency, understandability, operability, attractiveness, error prevention, learnability, accuracy and effectiveness) have been identified for the evaluation process. The results present the usability level for each factor and indicated the tested DSS model is in the excellent level. It is anticipated that system developers can improve the DSS based on these findings as well as from the comments and suggestions made by the respondents.

Key words: System evaluation, usability testing, decision support system

INTRODUCTION

The concept of decision support system was introduced in the late 1960s (Tian *et al.,* 2007). Decision Support System (DSS) is a concept where computer-based systems are used to assist an organization and analyze information to support a decision making. Shim *et al.* (2002) noted that DSS is a computer technology solution that can be used to support complex decision making and problem solving. The applications of DSS have been used in many fields including medical, marketing, agriculture and forestry.

In order to verify and validate a successfulness of a DSS, it is crucial to conduct a system evaluation. However, according to Papamichail and French (2005) the process to evaluate a DSS is often omitted during the development of DSS. In spite of this, they stated that thorough examination of a DSS would allow the system developers to find out how well the system works, how sound its advice is and whether, it addresses the need of its users.

This study discussed the system evaluation for a DSS model being developed for Malaysian forest plantation management. The main purpose of developing the DSS model is to support the decision making process in selecting an appropriate tree species for commercial tree planting. This model has two modules which are Species Matching module and Economic module. The evaluation is important to indicate the deficiencies and to improve the DSS model in future. In this study, usability evaluation method is used to evaluate the DSS. The objectives of this study were: (1) to discuss several literatures on the system evaluation for DSSs (2) to explain the evaluating process for the DSS model and (3) to highlight the evaluation results and findings for the DSS model.

GENERAL REVIEW OF SYSTEM EVALUATION

Usability evaluation started becoming a favor in the middle of 1980s when the union of the mouse with the Macintosh graphical user interface opened the computer world to the public. The popularity of technology intended for public use is often directly related to its usability. For example, even though google search engine is popular with its superior functionality relative to other search engine, the simplicity of its interface makes it an attractive for even the most

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novice Internet user (Buzhart and Powell, 2005). Usability is one of the aspects that can be use to evaluate a DSS. The term usability was originally derived from the term user friendly (Folmer and Bosch, 2004). Five characteristics define usability testing: (1) that its goal is to improve a product usability, (2) that its participants represent real users, (3) that they do real test, (4) that the tester observe and record the participants and (5) that they then analyze the data and recommend changes to fix problems (Dumas and Redish, 1993; Dicks, 2002).

Many evaluation tools and techniques have been used by previous researchers to measure various usability key factors. Nonetheless, there are three general categories of evaluation method to analyze usability which were inspection, testing and inquiry (Gutierrez and Ritzie, 2000; Folmer and Bosch, 2004). An overview of each usability evaluation method type is as follows:

- **Inspection methods:** The usability inspection methods require specialists or other professionals to identify the potential usability problems that exist in user interface or proposed prototype. Inspection methods produce little or no quantitative data. The methods can be conducted faster and is less expensive than other evaluation methods
- **Inquiry methods:** The methods require users to express their opinions and preferences of system characteristics. Inquiry methods require quantitative data which is obtained of information about users likes, dislikes, needs and understanding of the system by talking to them, observation or questionnaires
- **Testing methods:** The methods ask the target audience to perform various tasks with the test material against the user requirements. Testing methods require both qualitative and quantitative data in obtaining information about the status of user interface or prototype towards the user needs

Folmer and Bosch (2004) listed the common usability evaluation method used by previous researchers (Table 1). Questionnaires are the inquiry methods widely used by researchers to gain quantitative data. The examples of usability questionnaires are shown in Table 2 (Perlman, 2002; Folmer and Bosch, 2004).

Besides evaluation methods, measurement factors are important to formulate and classify the questions. Folmer and Bosch (2004) have listed out factors that were considered from Shackel (1991), Nielsen (1993), ISO 9241-11 (1994) and ISO 9126 (1991) for usability evaluations, whereas, Parikh *et al.* (2001) has stated four measurement factors for DSS (Table 3). In this study, 8 usability factors were considered in the process to evaluate the DSS model. The factors are efficiency, understandability, operability, attractiveness, error prevention, learnability, accuracy and attractiveness. Table 4 shows the definition of each usability factors.

Table 1: Usability evaluation methods

Types	Methods
Inspection methods	Heuristic evaluation (Nielsen, 1994)
	Cognitive walkthrough (Wharton *et al.*, 1994; Rowley and Rhoades, 1992)
	Feature inspection (Nielsen, 1994)
	Pluralistic walkthrough
	Perspective-based inspection (Zhang *et al.*, 1998a; b)
	Standard inspection/guideline checklists (Wixon *et al.*, 1994)
Inquiry methods	Field observation (Nielsen, 1993)
	Interviews/focus groups (Nielsen, 1993)
	Survey (Alreck and Settle, 1994)
	Logging actual use (Nielsen, 1993)
	Logging actual use (Nielsen, 1993)
	Proactive field study (Nielsen, 1993)
Testing methods	Coaching method (Nielsen, 1993)
	Co-discovery learning (Nielsen, 1993; Dumas and Redish, 1993; Rubin, 1994)
	Performance measurement (Nielsen, 1993; Soken *et al.*, 1993)
	Question-asking protocol (Dumas and Redish, 1993)
	Remote testing (Hartson *et al.*, 1996)
	Retrospective testing (Nielsen, 1993)
	Teaching method (Vora and Helander, 1995)
	Thinking aloud protocol (Nielsen, 1993)

Table 2: Examples of questionnaires with references

Acronym	Questionnaires	References
QUIS	Questionnaires for user interface satisfaction	Chin *et al.* (1988)
PUEU	Perceived usefulness and ease of use	Davis (1989)
PSSUQ	Post-study system usability questionnaire	Lewis (1992)
NHE	Nielsen's heuristic evaluation	Nielsen (1993)
NAU	Nielsen's attribute of usability	Nielsen (1993)
EUCSI	End user satisfaction instrument	Doll *et al.* (1994)
CSUQ	Computer system usability questionnaire	Lewis (1995)
ASQ	After scenario questionnaire	Lewis (1995)
PUTQ	Purdue usability testing questionnaire	Lin *et al.* (1997)
PHUE	Practical heuristics for usability evaluation	Perlman (1997)
SUMI	Software usability measurement inventory	HFRG (2002)
MUMMS	Measurement of usability of multimedia software	HFRG (2002)
WAMMI	Website analysis and measurement inventory	HFRG (2002)

Table 3: Overview of usability factor

Shackel (1991)	Nielsen (1993)	ISO 9241-11	ISO 9126	Parikh *et al.* (2001)
Learnability-time to learn	Learnability	Effectiveness	Learnability	Quality
Learnability- retentation	Memorability	Efficiency	Operability	Satisfaction
Effectiveness- errors	Errors	Satisfaction	Understandability	Learning
Effectiveness- task time	Efficiency		Attractiveness	Efficiency
Flexibility	Satisfaction			
Attitude				

Table 4: Definitions of usability factors

Factor	Definition
Efficiency	System should be efficient to use (time)
Understandability	The capability of the system to enable the user to understand whether the software is suitable and how it can be used for particular tasks and conditions of use.
Operability	The capability of the system to enable the user to operate and control it.
Attractiveness	The capability of the software product to be attractive to user and pleasant to be used.
Error prevention	The systems should be low rate errors. User can do recovery if they make mistakes.
Learnability	The capability of the system to enable the user to learn its application
Accuracy	The correctness of the output information
Effectiveness	The capability of the system to archived the specified goals

PREVIOUS DSS MODEL EVALUATION

We have reviewed three DSSs to compare the consideration of usability factors in evaluating the DSS. The three DSSs are Hotel Advisory System (HAS), Project Analysis and Selection System (PASS) and The Land Use Model Metronamica (LUMM).

Hotel Advisory System (HAS) is a prototype system that has been design and develop to assists tourists in conducting hotel selection. Ngai and Wat (2003) formulated a formal questionnaire containing both closed and open ended to evaluate HAS. The evaluation is based on three parts which are: (a) demographic data, (b) effectiveness of prototype and (c) the usability of the prototype. HAS evaluation uses Likert scale with values ranging 1 to 5 (1 = strongly disagree; 2 = disagree; 3 = undecided; 4 = agree; 5 = strongly agree). The following is the HAS Evaluation Questionnaires:

- Help in selecting suitable hotels
- Provides clear information in selected hotels
- Provides new insight in selecting suitable hotels
- System is easy to use
- System is easy friendly
- Screen play is well designed
- Achieved stated objectives
- Response time in the system is acceptable
- System contains functions which user requires
- System commands are self-explanatory and easy to understand
- Likely to recommended to other users

Ghasemzadeh and Archer (2000) organized a framework for project portfolio selection through a DSS. The researchers have developed a set of hypotheses to evaluate Project Analysis and Selection System (PASS). For the system evaluation, these researchers divided the questionnaires into two parts which are: (a) perceived usefulness and (b) perceived ease of use. The questions use Likert scale values from 1 to 7. The researchers did not mention precisely the definitions of each of the scale values, however, they describe the values from strongly agree to strongly disagree. The following is the PASS Questionnaires:

- PASS helps to accomplish project portfolio selection more quickly
- PASS improves project portfolio selection decisions
- PASS makes it easier to accomplish project portfolio selection
- Overall, PASS is a useful tool for project selection
- It is easy to learn PASS
- It is easy to get PASS to do what I wanted to do
- PASS is clear and understandable
- PASS is flexible to interact with
- It would be easy for me to become skillful at using PASS
- Overall, PASS is easy to use

Land Use Model Metronamica (LUMM) is a GIS application. Wickramasuriya (2007) proposed a usability test to check user satisfaction and user's attitude towards the model. The questionnaires were also designed using Likert scale values 1 to 5 (1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree). The following is the questions to evaluate the usability of LUMM:

- The way the model works is sufficiently clear to me
- I agree with underlying principles and assumptions on which the model is based
- The outcomes of the model is reasonable
- The model has captured main processes of the real system
- The model helps to better understand the processes/problems of the real world situation
- The user interface of the model is attractive

Table 5: Comparison of HAS, PASS and LUMM towards the usability factors

	Evaluation		
Key factor	HAS	PASS	LUMM
Efficiency	-	✓	-
Learnability	✓	✓	✓
Understandability	✓	✓	✓
Operability	✓	✓	✓
Attractiveness	✓	-	✓
Error Prevention	-	-	-
Accuracy	✓	-	✓
Effectiveness	✓	✓	✓

- The organization of information on the model windows is clear and understandable
- This model is an easy to learn tool
- This system has all the functions that I expected it to have
- This system can have an added value to UDA's normal working procedures
- This model can help plan spatial policy decision in some way
- This model will be accepted in UDA
- I personally like to use the model in the future
- I think that someone else in UDA will find this model useful
- The model would improve the communication amongst peoples working in different disciplines
- Overall, we are satisfied with the model

Table 5 shows comparisons among HAS, PASS and LUMM evaluation towards the eight usability factors. Table 5 also indicated that the error prevention factor was not considered among those three DSS models during evaluation. However, in the case of evaluation in this study, error prevention factor was considered and adapted from SUMI and QUIS.

MATERIALS AND METHODS

The methodology in this study is shown in Fig. 1. Firstly, the issues related to usability especially focused on DSSs were identified. This includes the concept of usability and the evaluation methods. In this study, we decided to use the inquiry method as the main approach to evaluate the DSS model. In order to formulate the questionnaire and interview questions, evaluation measurement factors were identified through the comparison from HAS, PASS and LUMM evaluations and with the addition of error prevention factor from SUMI and QUIS (Table 5). Eight usability factors were proposed and carried out in this study that comprises efficiency, understandability, operability, attractiveness, error prevention, learnability, accuracy and effectiveness.

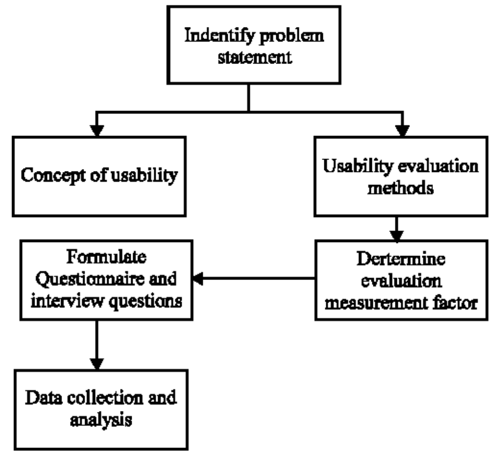

Fig. 1: Research methodology

A total of 37 questions was formulated based on the eight usability factors for the questionnaire. Likert scale with values 1-5 (1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, 5 = strongly agree) were used for the questionnaire to indicate the respondent's reaction toward each factor. Questions 1 to 15 were formulated to evaluate the whole of the DSS model and based on efficiency, understandability, operability, attractiveness and error prevention. However, questions 16 to 34 were formulated to evaluate each module in the DSS model separately and was based on three usability factors (learnability, accuracy and effectiveness). We also formulated questions 35 to 37 as a controller where the questions were designed to summarize the overall evaluations of the system. Moreover, interview questions were developed based on the same usability factors used for questionnaires. Each question was designed in the open-ended request format with the negative statement to recognize the weaknesses of the DSS model for any future improvements. Respondents express their opinion and recommendation at the end of the interview.

Prior to data collection process, selecting an appropriate number of respondents is a big issue. Bastien (2009) mentioned the aim of selecting an appropriate number of respondents is to find the most flaws of a user interface at the lowest possible cost. In 1990's, Nielsen (1993) recommended five respondents to evaluate a system because results of the evaluation are able to show 80-85% of the usability problems. On the other hand, Nielsen (2000) stated that the number of respondent could be more than five respondents depending on respondent type. Faulkner (2003) conducted an empirical research and the finding showed an increment number of 5 to 10 respondents improved data confidence. Further, Spiller (2005) recommended a sample size based from those

Table 6: Sample sizes for research

Research type	Method	Sample size (Respondents)
Corporate usability research	Survey (phone and web)	240 until more than 1000
	Focus groups	15 until 20 (depends on audience segments involved and goal study
	Usability testing	10 until 15
	Fields study	15 until 40
	Card sorting	15 until 30
Academic usability research		Samples are usually larger depending on size and scope and research objectives (e.g., 15 users per segment or 40-100 users in a usability test)

earlier studies conducted by Nielsen (2000) and Faulkner (2003) (Table 6). All these literatures are able to explain the suitable number of respondents required for an evaluation process.

The range from 10 to 15 respondents was considered because we conducted the system evaluation based on usability testing. The samples or respondents were chosen among forest managers, researchers, forest expertise and individual who have knowledge in forestry plantation. Besides, samples or respondents were also chosen from individual having a computer science background and focusing on decision support system fields to give their response, comment and opinion about the proposed prototype from a computer science view. Respondents for these categories of occupation and background were chosen as they are qualified and have knowledge as well as expertise in the particular field.

The data collection was conducted in 2007. The data collection phase involved both questionnaires and interviews. The evaluation was conducted individually because the respondents were from different agencies. Before conducting the evaluation process, the respondents were given a brief description regarding the purpose of the DSS. Training through demonstrations was facilitated on how to use the DSS model. The respondents were then asked to use all the functions in the DSS model. Questionnaires were later carried out and they were to be filled in and completed by the respondents (Appendix). An interview session was eventually conducted after the questionnaire session.

For the data analysis, the Likert scale values in questionnaires are interpreted to corresponding merit 0.00 until 1.00. Table 7 shows the interpretation from Likert scale values to the corresponding merit for questions 1 to 34 except for questions 2 and 13. Both questions 2 and 13 were designed in negative statement whereby these questions give a negative reaction upon the respondent agreeing with the question given (Table 8). Abdullah and Wei (2008) stated that this style of ordinal scale is easier to compile compared to any traditional point used in questionnaires.

Table 7: Data interpretation

Option	Strongly agree	Disagree	Not sure	Agree	Strongly agree
Likert scale	1	2	3	4	5
Corresponding merit	0.00	0.25	0.50	0.75	1.00

Table 8: Data interpretation process for negative statement

Option	Strongly agree	Disagree	Not sure	Agree	Strongly agree
Likert scale	1	2	3	4	5
Corresponding merit	1.00	0.75	0.50	0.25	0.00

Table 9: Usability average merit and usability level

Average Merit, A	Usability level
$0.00<=A<=0.20$	Bad
$0.20<A<=0.40$	Poor
$0.40<A<=0.60$	Moderate
$0.60<A<=0.80$	Good
$0.80<A<=1.00$	Excellent

The formula used in Bailey and Pearson (1983), Selamat and Rahim (1992) and Ribière *et al.* (1999) were modified with the formula in Chiew and Salim (2003) and Abdullah and Wei (2008) for this study to indicate the level of usability. Equation 1 shows the reaction of an individual to a given factor:

$$A = \frac{\sum R_{ij}}{nQ_j} \quad (1)$$

Where:

A = Average merit per factor
R_{ji} = The reaction to factor j by individual i
n = The No. of respondent
Q_j = The No. of question tested to factor j

For the total average of respondent's reaction is measured by the following Eq. 2:

$$TA = \sum_{j=1}^{8} \frac{\sum R_{ij}}{n \times Q_j} \quad (2)$$

Where:

TA = Total average merit for all factor

The results attained were interpreted using Chiew and Salim (2003) usability points as shown in Table 9. After completion of data analysis for all the factors, this method (Eq. 1 to 2) was repeated for questions 35 to 37 to summarize the overall evaluation on respondent perception towards the DSS.

RESULTS AND DISCUSSION

Eleven respondents took part in the evaluation of the DSS model. Table 10 shows the profile of the

Table 10: Background of the respondents

Respondent rank	Institution	Fields
Assistance director	Forest Plantation Unit, Department of Forestry Peninsular Malaysia	Forestmanagement
Assistance director	Forest Plantation Unit, Department of Forestry State of Perak	Forestmanagement
Forester	Forest Plantation Unit, Department of Forestry State of Negeri Sembilan and Melaka	Forestmanagement
Forester	Department of Forestry, District of Southern Johor	Forestmanagement
Forester	Forestry Department Sarawak	Geographical information system management
Lecturer	Faculty of Forestry, Universiti Putra Malaysia	Forest management
Lecturer	Faculty of Computer Science and Information Technology, Universiti Putra Malaysia	Decision support system
Tutor	Faculty of Forestry, Universiti Putra Malaysia	Forestmanagement
Tutor	Faculty of Forestry, Universiti Putra Malaysia	Forestmanagement
Research assistant	Faculty of Forestry, Universiti Putra Malaysia	Forestmanagement
Research assistant	Faculty of Forestry, Universiti Putra Malaysia	Forestmanagement

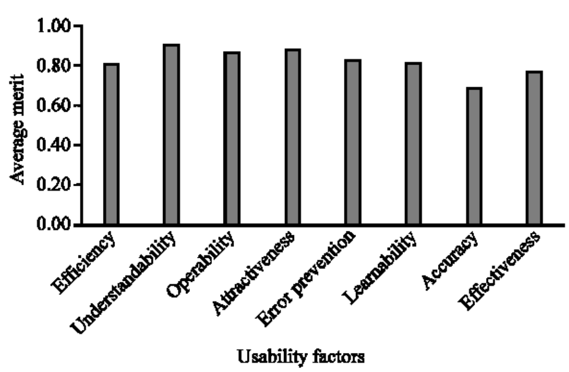

Fig. 2: The average merit for the eight-usability factor

respondents. Figure 2 shows the results from the questionnaire session. The highest average merit was scored by the understandability factor (0.90). This was followed by the factor of attractiveness (0.88), operability (0.86), error prevention (0.83), learnability (0.81), efficiency (0.80), effectiveness (0.77) and accuracy (0.69). The findings showed that seven usability factors are in the Excellent level except for the accuracy factor which was in the range of Good. The total average merit for all the eight-usability factor was 0.82 and this indicated that the tested DSS is in the range of excellent for the corresponding usability level.

It is important to identify the right measurement factors when formulating the questions. The definitions of each measurement factors should precisely be describe

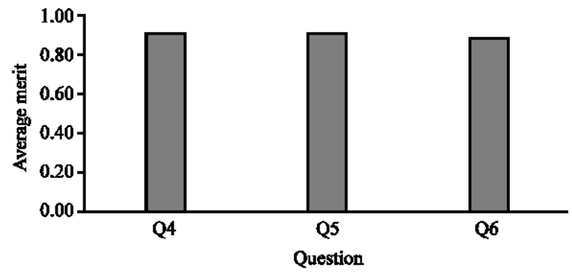

Fig. 3: The average merit of understandability factor

in order to formulate suitable questions. By using numerous questions to indicate a factor, it can reliably determine the deficiencies of the factor. For example, understandability factor scored the highest average merit because most of the respondent gave positive reaction towards all the three questions asked in the evaluation (Fig. 3), however, Question 6 pointed out that the system command could be modified to increase the understandability factors. Furthermore, findings gathered from the interview session were capable to identify the system command that is in need or require any modifications. This is due to during the interview session, one respondent suggested changing Forecasting button in the result form to another term like financial analysis.

Interview session was also able to identify the terms used throughout the tested DSS model with a more appropriate term of the respondents domain. As an example, the term concave and convex in the Species Matching form were suggested to be removed since, most of the foresters did not practice both terms when in need of describing their target planting site. In addition, respondents did propose to add in detail descriptions for the term used such as in the soil depth option.

Ngai and Wat (2003) stated that evaluation made by the domain experts help to determine the accuracy of the embedded knowledge. Through, our experiences, even though, respondents were chosen from within the domain field, yet, they still encountered the difficulties to assess accuracy factor. This situation leads to the accuracy factor score having the lowest average merit.

There were seven questions requiring the respondents to indicate their user satisfaction towards the accuracy for Species Matching module and Economic module. Question 22 required the respondents to indicate their satisfaction towards the selected tree species that were used as the data set in the tested DSS. Question 23 assessed on the accuracy for the results that was suggested in Species Matching module. Question 24 assessed on the sufficiency of the parameter used for making the decision which will affect the accuracy of the Species Matching module's result. Questions 25 and

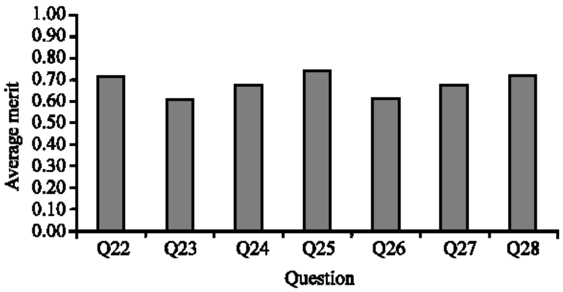

Fig. 4: The average merit for accuracy factor

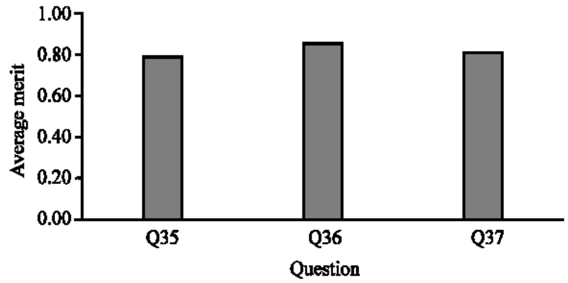

Fig. 5: The average merit for overall evaluation

26 assessed on the accuracy and sufficiency of the information provided in the tested DSS. Finally, questions 27 and 28 assessed on the sufficiency of the criteria and items provided in Economic module.

From Fig. 4, results showed average merit for each question was in Good range. Question 25 showed the accuracy on the information provided regarding the selected tree species for the tested DSS has the highest average merit (0.75). Even so, for the sufficiency level of that information, the average merit was only 0.61. This showed that additional information is needed to better improve the accuracy factor which included soil colour, soil texture, drainage, topographic elevation and tree disease all of which were suggested by the respondents.

The respondents lack of information of the quantitative data in the domain area through the interview session was founded as the main problem faced by the respondents themselves. This limitation affected the accuracy factor. Most of the respondents mentioned they experience difficulties to indicate the accuracy factor especially with respect to the result generated and from what was suggested by the Species Matching module. This is because they do not have sufficient data record, for testing on the accuracy of the result generated and suggested.

For example, the respondent from Forest Plantation Unit, Department of Forestry State of Negeri Sembilan and Melaka explained that since the forest plantation in Negeri Sembilan was privatized by the Menteri Besar Incorporation (MBI), therefore, the respondents did not have enough information to test the accuracy factor. The respondent from Bidor, Perak explained that though all four tree species are planted at their planting site but only the data for *Acacia mangium* and *Hevea brasiliensis* has ever been recorded. Whilst, the respondent from Department of Forestry of Peninsular Malaysia explained that they have very limited information for those 4 tree species and suggested to refer to Forest Research Institute of Malaysia (FRIM). For the Economic module, the respondent also from the Department of Forestry of Peninsular Malaysia explained that their agency referred to consultants to do their economic prediction.

As an addition, three questions were designed to assess the overall respondents opinion regarding the tested DSS model. Question 35 assessed on the respondents opinion regarding the ability of the DSS model to achieve its objectives in supporting decision making of selecting an appropriate tree species to be planted. Question 36 required the respondents to indicate whether they think the prototype is suitable to be recommended to other users. Question 37 was designed to assess the overall respondents satisfaction regarding the prototype.

Figure 5 shows the average merit for the overall evaluation. The results showed the average merit for question 35 (0.80), question 36 (0.86) and question 37 (0.82). The total average merit for these three questions was 0.83. Total average merit for these three questions acts as the control for evaluation on the previous eight-usability factor (questions 1 to 34). On the whole, the findings showed a consistency of the system evaluation for the DSS model. This is because total average merit for questions 1 to 34 and with questions 35 to 37 (control) were in the same range of corresponding usability level.

CONCLUSION

Measuring the successfulness of a DSS is important in identifying the deficiencies of a DSS. This study generally discussed the evaluation approaches. From those previous DSSs evaluation, similarities did exist for selection of the measurement factors to evaluate a DSS which were learnability, understandability, operability and effectiveness. These four factors are suggested to be the main factors for any evaluation of DSSs. The other four factors (efficiency, attractiveness, error prevention and accuracy) can be considered by the system developers when they intend to conduct the system evaluation. Moreover, this study discussed the method used for the evaluation including selecting the number of respondents, designing questionnaires and interview questions and the processes for data collection and analysis. From the questionnaire session, the findings showed that the tested DSS model was in the level of excellent. In spite of this, the respondents were able to highlight their suggestions and comments in order to improve the DSS model through the interview sessions. The findings, suggestions and comments can be considered by the system developers to improve the deficiencies of the tested DSS model. In future, it is also suggested that both the questionnaire and interview approaches should be implemented together for system evaluation due to their ability to verify and validate the successfulness of DSS in detailed as possible.

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APPENDIX

Key Factor 1: Efficiency
Instruction: Please tick (✓) the circle that best describes your perception towards the impact of Decision Support System (DSS) model for forests plantation management

		1	2	3	4	5	
1. Help to select appropriate tree species more quickly	Strongly disagree	O	O	O	O	O	Strongly agree
2. This system has at one time stopped unexpectedly	Strongly disagree	O	O	O	O	O	Strongly agree
3. Response time of the system is acceptable	Strongly disagree	O	O	O	O	O	Strongly agree

Key Factor 2: Understandability
Instruction: Please tick (✓) the circle that best describes your perception towards the impact of Decision Support System (DSS) model for forests plantation management

		1	2	3	4	5	
4. Sequence of screens is clear	Strongly disagree	O	O	O	O	O	Strongly agree
5. Term used throughout the system is simple	Strongly disagree	O	O	O	O	O	Strongly agree
6. System commands are easy to understand	Strongly disagree	O	O	O	O	O	Strongly agree

Key Factor 3: Operability
Instruction: Please tick (✓) the circle that best describes your perception towards the impact of Decision Support System (DSS) model for forests plantation management

		1	2	3	4	5	
7. Can stop using the system immediately	Strongly disagree	O	O	O	O	O	Strongly agree
8. System contains basic functions of system requirements	Strongly disagree	O	O	O	O	O	Strongly agree
9. DSS is easy to interact with	Strongly disagree	O	O	O	O	O	Strongly agree

Key Factor 4: Attractiveness
Instruction: Please tick (✓) the circle that best describes your perception towards the impact of Decision Support System (DSS) model for forests plantation management

		1	2	3	4	5	
10. Easy to read character on screen	Strongly disagree	O	O	O	O	O	strongly agree
11. Organization of information on screen is clear	Strongly disagree	O	O	O	O	O	Strongly agree
12. The user interface is attractive	Strongly disagree	O	O	O	O	O	strongly agree

Key Factor 5: Error Prevention
Instruction: Please tick (✓) the circle that best describes your perception towards the impact of Decision Support System (DSS) model for forests plantation management

		1	2	3	4	5	
13. Easy to make mistakes	Strongly disagree	O	O	O	O	O	Strongly agree
14. Error message is helpful	Strongly disagree	O	O	O	O	O	Strongly agree
15. Easy to correct the mistakes	Strongly disagree	O	O	O	O	O	Strongly agree

Key Factor 6: Learnability
Instruction: Please tick (✓) the circle that best describes your perception towards the impact of Decision Support System (DSS) model for forests plantation management

		1	2	3	4	5	
Species matching module							
16. Learning to use this module is easy	Strongly disagree	O	O	O	O	O	Strongly agree
17. Easy to remember names and use of commands	Strongly disagree	O	O	O	O	O	Strongly agree
18. Species matching module is easy to use	Strongly disagree	O	O	O	O	O	Strongly agree
Economic module							
19. Financial value form is easy to use	Strongly disagree	O	O	O	O	O	Strongly agree
20. Cash flow form is easy to use	Strongly disagree	O	O	O	O	O	Strongly agree
21. Learning to use this economic module is easy	Strongly disagree	O	O	O	O	O	Strongly agree

Key Factor 7: Accuracy
Instruction: Please tick (✓) the circle that best describes your perception towards the impact of decision support system (DSS) model for forests plantation management

		1	2	3	4	5	
Species matching module							
22. The tree species suggested is reasonable	Strongly disagree	O	O	O	O	O	Strongly agree
23. The result accuracy is high	Strongly disagree	O	O	O	O	O	Strongly agree
24. Parameter used to make decision is sufficient	Strongly disagree	O	O	O	O	O	strongly agree
25. The information of selected tree species is accurate	Strongly disagree	O	O	O	O	O	strongly agree
26. Information of selected tree species provided is sufficient	Strongly disagree	O	O	O	O	O	strongly agree
Economic module							
27. Criteria used in Financial Value Form is sufficient	Strongly disagree	O	O	O	O	O	Strongly agree
28. Item used in Cash Flow is sufficient	Strongly disagree	O	O	O	O	O	Strongly agree

Key Factor 8: Effectiveness

Instruction: Please tick (✓) the circle that best describes your perception towards the impact of Decision Support System (DSS) model for forests plantation management

		1	2	3	4	5	
Species matching module							
29. Help in selecting appropriate tree species	Strongly disagree	O	O	O	O	O	Strongly agree
30. Provides clear information for selected tree species	Strongly disagree	O	O	O	O	O	Strongly agree
31. Provides new insight in selecting appropriate tree species	Strongly disagree	O	O	O	O	O	Strongly agree
Economic module							
32. Help in supporting decision making for species matching	Strongly disagree	O	O	O	O	O	strongly agree
33. Help in doing economic calculation	Strongly disagree	O	O	O	O	O	Strongly agree
34. Provides new insight in doing economic calculation	Strongly disagree	O	O	O	O	O	strongly agree

Overall Evaluation

Instruction: Please tick (✓) the circle that best describes your perception towards the impact of decision support system (DSS) model for forests plantation management

		1	2	3	4	5	
35. Achieved the objectives to support the decision making on selecting appropriate tree species to be planted	Strongly disagree	O	O	O	O	O	Strongly agree
36. Likely recommended to other users	Strongly disagree	O	O	O	O	O	Strongly agree
37. Overall, I am satisfied with this system	Strongly disagree	O	O	O	O	O	Strongly agree

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