

Sustainable Agriculture through ICT innovation

Evaluation of a Decision Support System for Socio-Economic Analysis of Biodiesel Projects in Latin America

Joélcio Cosme Carvalho Ervilha¹
Aziz Galvão da Silva Junior²
Luis Felipe Duhart Charles³
Ronaldo Perez⁴

1 Corresponding author. joelcio.carvalho@fao.org Bioenergy consultant, FAO-RLC, Chile

2 Associate Professor, Federal University of Viçosa, Brazil

3 National Bioenergy Officer, FAO-RLC, Chile

4 Associate Professor, Federal University of Viçosa, Brazil

ABSTRACT

The environmental concern and the oil price rising stimulate the implementation of policies to replace the fossil energy source. In this context, biofuels emerge as the most feasible alternative to attend this new demand. However, the potential impact of the biofuels production on the demand for agricultural products raises the question about the competition *biofuels versus food*. The investment analysis of projects and policies are complex, thus requiring tools to support the decision-making. The purpose of this paper is to evaluate the applicability and usability of a decision support system for the investment analysis on biodiesel projects, developed under an agreement signed by UFV (Federal University of Viçosa/Brazil) and FAO/RLC (Foods and Agriculture Organization - Regional Office for Latin America and the Caribbean). The normative ISO 25000 series (Software Product Quality Requirements and Evaluation) was the framework chose to evaluate the quality aspects. Additionally, the ISO 9241 (Ergonomics of Human System Interaction) was selected to evaluate the effectiveness, efficiency and satisfaction of the software by the user. The questionnaire applied on the evaluation consisted on quality attributes related to the normative ISO 25020/07 (Measurement Reference Model and Guide) and ISO 9241. The results obtained were treated descriptively and confirmed the software usability, especially related to efficiency and effectiveness.

Keywords: Bioenergy, Biodiesel, System Evaluation, Decision Support System, Latin America.

1. INTRODUCTION

In short and medium term, biofuels are the most feasible option to replace the fossil fuels, due to its relatively low production cost, energy density and the existing distribution infrastructure for liquid fuels. Biofuels policy can also contribute to the

Ervilha, J. "Evaluation of a Decision Support System for Socio-Economic Analysis of Biodiesel Projects in Latin America". EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation", Turin, Italy, 24-27 June 2013. The authors are solely responsible for the content of this technical presentation. The technical presentation does not necessarily reflect the official position of the International Commission of Agricultural and Biosystems Engineering (CIGR) and of the EFITA association, and its printing and distribution does not constitute an endorsement of views which may be expressed. Technical presentations are not subject to the formal peer review process by CIGR editorial committees; therefore, they are not to be presented as refereed publications.

Sustainable Agriculture through ICT innovation

development of rural areas, where 70% of poorest people live (FAO, 2012). The social development potential associated with a feasible energy option and environmental damages attenuator have turned biofuels programs into an interesting opportunity to developing countries. However, all the biofuels advantages involve criticism, in especial, regarding their sustainability and the competition for the land, on a so-called *food versus fuel* competition.

The links between bioenergy and food security are complex and multi-faceted (FAO, 2010). To tackle the increasing complexity of biodiesel investment projects, a decision support system (BiodieselFAO) was developed by the Federal University of Viçosa (UFV) in Brazil to the Food to the Agriculture Organization of the United Nations – Regional Office for Latin America and the Caribbean Office (FAO/RLC). This computational tool has been used by professionals from 17 countries for economical and social analysis of biodiesel projects considering several conditions, as different raw materials and industrial technologies. It was also used to analyze and design taxes and investment schemes.

The purpose of this paper is to evaluate the applicability and usability the BiodieselFAO using ISO standards as framework.

2. MATERIAL AND METHODS

The framework described in the normative ISO 25000 series (quality evaluation methodology of computational systems) had been chosen to evaluate the software BiodieselFAO. The ISO 25020/07, specifically, was the basis to define the quality attribute criteria used on the questionnaire. The ISO 9126 is the previous version of the ISO 25000 series and also was consulted to the methodology and to incorporate previous studies on this paper.

Besides the quality evaluation, the framework of the normative ISO 9241 was also used to describe the usability of the system, focusing on effectiveness, efficiency and satisfaction by the end users (Ehteshami, 2013).

The evaluation procedure was based on applying a web questionnaire, composed by external evaluations, internal evaluations and assessments of the software quality (Usabilitynet, 2013). Kanellopoulos (2010), Shafinah (2010) and Chua (2004), presented the following quality attributes:

- **Functionality** - A set of attributes that relate to the existence of functions and their properties. These functions are those related with stated satisfaction or implied needs.
- **Reliability** - A set of attributes related to the ability of the software to maintain its level of performance under stated conditions for a stated period.

C0283

Joélcio Ervilha. "Evaluation of a Decision Support System for Socio-Economic Analysis of Biodiesel Projects in Latin America". EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation", Turin, Italy, 24-27 June 2013.

Sustainable Agriculture through ICT innovation

- **Usability** - A set of attributes related to the effort needed to use and individual assessment of such use.
- **Efficiency** - A set of attributes associated with the relationship between the level of performance of the software and the amount of resources required under stated conditions.
- **Maintainability** - A set of attributes related to the easiness to extend, modify or correct errors in the software.
- **Portability** - A set of attributes relating to the ability of software to be transferred from one platform to another.

The evaluation procedure was based on the framework of ISO 25000 normative and was defined as the following.

2.1 Quality requirements definition

The quality requirements definition is the first step, which take as input a set of stated needs, relevant technical documentation and the ISO Standard itself and produces a quality requirement specification (Praxiom, 2013). The quality attributes are presented in the table 1.

2.2 Evaluation preparation

The second stage is the evaluation preparation, which involves the selection of appropriate metrics, a rating level definition and the definition of assessment criteria (Demirors, 2000). Metrics, in ISO 25000 series, typically give rise to quantifiable measures mapped on to scales. Since quality refers to needs, which vary from one evaluation to another, no general level for rating is possible. They must be defined for each evaluation.

A pre-test was applied to evaluate the criteria, to define the quality attributes and the rating level for each attribute, the information was organized as a questionnaire to be applied in the evaluation of the software BiodieselFAO.

2.3 Evaluation procedure

The last stage is the evaluation procedure, which is refined into three steps: measurement, rating and assessment. The selected metrics are applied to the software product and values on the scales obtained. Subsequently, for each measured value, the rating level is determined. Assessment is the final step, where a set of rated levels are summarized. The results will be analyzed as a summary of the software quality and treated descriptively.

The structured web questionnaire, composed by the quality attributes and the rating levels are presented below.

C0283

Joélcio Ervilha. "Evaluation of a Decision Support System for Socio-Economic Analysis of Biodiesel Projects in Latin America". EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation", Turin, Italy, 24-27 June 2013.

Sustainable Agriculture through ICT innovation

Table 1. ISO 25020/ISO9241 Questions for quality evaluation.

<i>Criteria</i>	<i>Details</i>	<i>Grade 1</i>	<i>Grade 5</i>
Suitability	Software attributes related to the presence of a set of functions necessary for economic and social evaluation of the project of vegetable oil and / or biodiesel	Few Suitable Functions	Fully Appropriate Functions
Accuracy	Attributes related software available to correct results are compared with other methods of evaluation (e.g. Excel spreadsheets)	Not Accurate	very Accurate
Interoperability	Attributes of software that relate to their ability to interact with specified systems (Excel, Word, etc.)	Not Interactive	very Interactive
Security	Software attributes related to their ability to prevent unauthorized access whether accidental or deliberate, to programs and data	unsafe	very Safe
Maturity	Attributes of software that relate to the frequency of faults in the software	High frequency of failures	Low Frequency of failures
Recoverability	Attributes of software that relate to the ability to reset their level of performance and recover the data directly affects in case of failure and the time and effort related to it	difficult Recovery	easy Recovery
Fault Tolerance	Attributes of software that relate to their ability to maintain a specified level of performance in cases of failures	Not Tolerant	very Tolerant
Learning	Attributes of software that relate to user effort to recognize the logical concept.	difficult Learning	easy Learning
Understanding	Attributes of software that relate to the effort of users to apply the system logical concept.	Not Comprehension	great Comprehension
Operability	Attributes of software that relate to the effort of the user to operate and control software.	Not Effort	great Effort
Attractiveness	Attributes of software that relate to the visual appearance, its design.	Not Attractive	very Attractive
Time response	Attributes of software that relate to the processing and response times	Plenty of time to answer	Short time to answer
Stability	Software attributes related to the risk of unexpected effects from modifications.	unstable	very Stable
Ease of analysis	Software attributes related to the effort required for the diagnosis and identification of parties to modify.	difficult Analysis	easy Analysis
Ease of change	Attributes related software effort needed for modification or correction of data inserted.	difficult Changes	easy Changes
Ease of testing	Software attributes related to the effort required to validate the modified data.	difficult Validation	easy Validation
Setup Capacity	Software attributes related to the effort required to install	Not Effort	much Effort
Capacity replacement	Attributes related software opportunity and effort of using software instead specified software	Few Capacity	Full Capacity
Adaptability	Related software attributes the opportunity to adapt to different topics specified without using other software considered. (Different types of raw materials or industrial processing technology for example)	Not Adaptable	Fully Adaptable
Compliance	Aspects of fitness to legislation concerning the country	Nonconforming	fully Compliant

C0283

Joélcio Ervilha. "Evaluation of a Decision Support System for Socio-Economic Analysis of Biodiesel Projects in Latin America". EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation", Turin, Italy, 24-27 June 2013.

3. RESULTS

The evaluation of a biodiesel project, especially in a complex theme as biodiesel, involves agricultural aspects and competition with food, to the land and supplements, which requires a tool to ease the analysis. In this context, the BiodieselFAO was evaluated as an alternative to ease the decision-making analysis on biodiesel projects.

3.1 Pre-Test

The pre-test was designed to verify the applicability of the quality criteria selected based on ISO 25000 series.

The evaluation process started with the application of the questionnaire to professionals who participated in the BiodieselFAO development and also used the software in evaluation projects of vegetable oil or biodiesel. In total, 9 professionals accepted participate and contributed with important information to structure better the criteria, rating level and also to organize the quality evaluation on the software.

These professional are from different areas as Engineering, Economics and Management, which also allowed analyze the effectiveness and usability on different areas on the evaluation. The pre-test results obtained are presented below.

Criteria Definition – Quality Attributes - As reported by the professionals consulted, the criteria defined are appropriate to evaluate the software on different aspects by their experience working with the software.

Evaluation of Attributes and rating levels - some changes were suggested to the initial settled for the terms that could cause misinterpretation. The term names were detailed for each attribute evaluated to avoid it.

3.2 Test

The test was proposed to 76 professionals from 17 countries in Latin America and the Caribbean. The professionals are involved on different areas on the biodiesel production chain including agriculture level, industry and policy development. These professionals were trained in an one week course coordinated by FAO/RLC and developed by the BiodieselFAO's developers and experts on decision-making process on biodiesel production chain from UFV.

The BiodieselFAO proposed test was emailed in an online survey shared on Google platform. From 76 professionals invited, 11 filled it up, which correspond around 15% of total.

C0283

Joélcio Ervilha. "Evaluation of a Decision Support System for Socio-Economic Analysis of Biodiesel Projects in Latin America". EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation", Turin, Italy, 24-27 June 2013.

Sustainable Agriculture through ICT innovation

In general the software fits the user needs, where their functionality, reliability and efficiency are the attributes that stood out, as can be observed on the Figure 1.

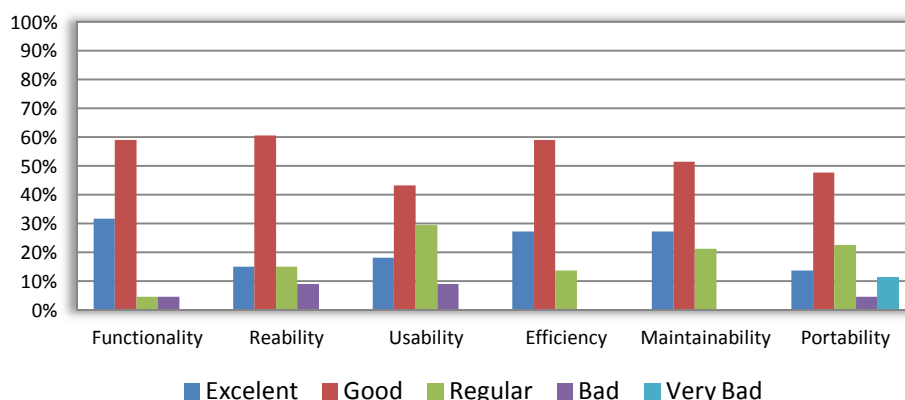


Figure 1. Test Final Results.

On a detailed analysis (Figure 2) of the quality attributes, the portability, usability and maintainability still need improvement.

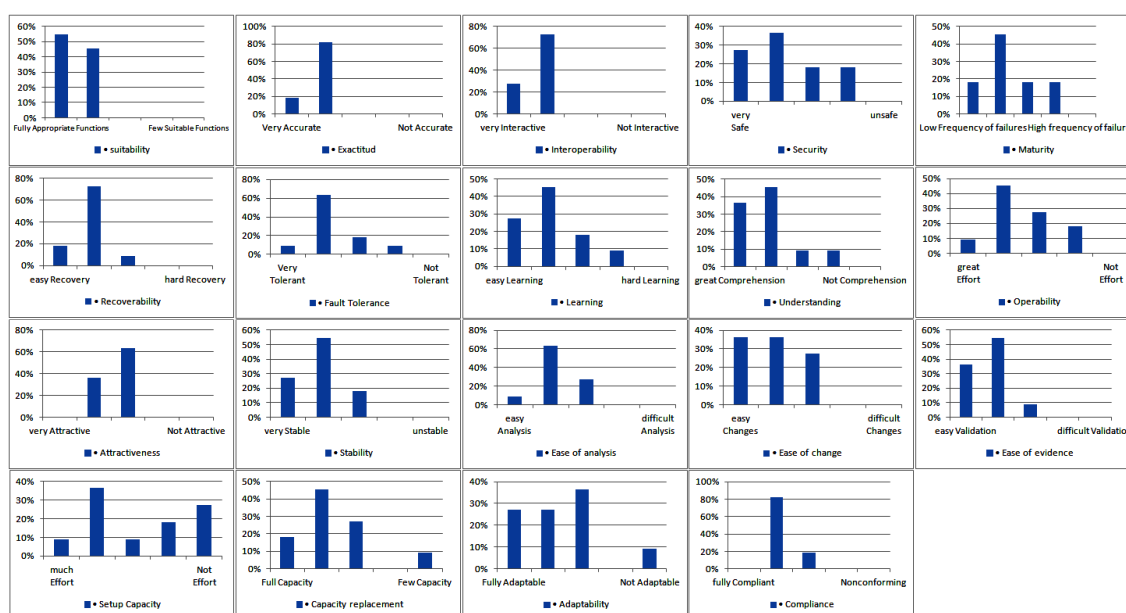


Figure 2. Test Detailed Results.

The users evaluated as a critical step on BiodieselFAO the insert data procedure, where great effort is required to complete all BiodieselFAO variable, which also affected the consideration about its aspect, it was not considered a friendly platform for all users.

When the specific quality attributes are analyzed, the evaluation concludes the following as need improvements: security, operability, adaptability and setup process. On the other hand, the results showed the potential of the software to ease the decision

C0283

Joélcio Ervilha. "Evaluation of a Decision Support System for Socio-Economic Analysis of Biodiesel Projects in Latin America". EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation", Turin, Italy, 24-27 June 2013.

Sustainable Agriculture through ICT innovation

analysis considering the positive answers related to accuracy, interactivity, low frequency of errors and great comprehension of the project data by the users.

In general, the attributes have at least 40% of good or excellent evaluation, except by the attractiveness of the BiodieselFAO design, it is evaluated as regular. Therefore, layout improvements can contribute to create a more logical and friendly interface, thus helping the data insertion procedure.

3. CONCLUSION

The software BiodieselFAO presents itself as an important tool for economic analysis of vegetable oil and biodiesel investment projects.

The test was important to confirm the applicability of the BiodieselFAO as a tool to ease the decision-making process, by providing a new ambient to develop the economical and social analysis. The software is a relevant tool to simulate different scenarios, through to ease the comprehension and the data changes, besides to be a safe and reliable tool to evaluate different variables.

These features are essential in biodiesel projects, due the complexity and the different players on this production chain. Additionally the software has proved useful in biodiesel policies analysis.

4. REFERENCES

Chua, B. B., Dyson, L. E., 2004, *Applying the ISO 9126 model to the evaluation of an e-learning system*. Proceedings of the 21st ASCILITE Conference. Perth, Australia.

Demirors, E., Demirors, O., 2000, *Evaluation Of Small Software Companies For Large Contracts*, EuroSPI 2000, Available on:
http://www.iscn.at/select_newspaper/small/bilgi.html.

Ehteshami, A., Sadoughi, F., Saeedbakhsh, S., Isfahani, M., *Assessment of Medical Records Module of Health Information System According to ISO 9241-10*, 2013, Acta Informatica Medica, PMC3612430, Bosnia and Herzegovina.

FAO, 2012, *Panorama de la Seguridad Alimentaria y Nutricional en América Latina y el Caribe 2012*, ISBN 978-92-5-307357-3, Food and Agriculture Organization of the United Nations - Latin America and the Caribbean Office, Santiago, Chile.

FAO, 2010, *Bioenergy and Food Security: The BEFS Analytical Framework*, ISSN 2071-0992, Food and Agriculture Organization of the United Nations, Rome, Italy.

C0283

Joélcio Ervilha. "Evaluation of a Decision Support System for Socio-Economic Analysis of Biodiesel Projects in Latin America". EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation", Turin, Italy, 24-27 June 2013.

Sustainable Agriculture through ICT innovation

ISO 9126, *International Standard ISO/IEC 9126. Information technology - Software product evaluation - Quality characteristics and guidelines for their use*, International Organization for Standardization, Geneva.

ISO 9241, *International Standard ISO/IEC 9241. Information technology - The Ergonomics of Human-system Interaction*, International Organization for Standardization, Geneva.

ISO 25000, *International Standard ISO/IEC 25000. Software engineering - Software product Quality Requirements and Evaluation (SQuaRE) - Guide to SQuaRE*, International Organization for Standardization, Geneva.

Kanellopoulos, Y., Panos, A., Dimitris, A., Christos, M., Evangelos, T., Christos, T., Nikos, T., 2010, *Code Quality Evaluation Methodology Using The ISO/IEC 9126 Standard*, International Journal of Software Engineering & Applications 01/2010.

PRAXIOM, 2013, *ISO Definition*. Available on: <http://www.praxiom.com/iso-definition.htm>

Shafinah K., Selamat M.H., Abdullah R., Nik Muhamad A.M. and A.G. Awang Noor, 2010. *System Evaluation for a Decision Support System*. Information Technology Journal, 9: 889-898.

Usability, 2013, *Quality methodologies*. Available on: <http://www.usabilitynet.org>

C0283

Joélcio Ervilha. "Evaluation of a Decision Support System for Socio-Economic Analysis of Biodiesel Projects in Latin America". EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation", Turin, Italy, 24-27 June 2013.