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Design of a Multi Model Decision Support Software Tool for Multi Criteria Group Decision Making in Software Product Selection

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ABSTRACT: *The design of a cloud based multi model software product selection and decision support software tool incorporating three Multi Criteria Decision Making (MCDM) models: Weighted Sum Method, ViseKriterijumsaOptimizacija I KompromisnoResenje (VIKOR) in Serbian; meaning Multi Criteria Optimization and Compromise Solution and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) has been presented. Existing systems rely one or a hybrid MCDM model for the evaluation which can produce erroneous results. The proposed software tool considers the ranking results from all three models when making a decision. The DSS tool was implemented using freely available Google Cloud technologies: Sheets, Drive, Sites, for easier collaborative decision making. The cloud based software tool was employed in a software product selection problem. The results show that the tool effectively produced the ranking from the models for the evaluation and selection with ease.*

Keywords*: Decision Support Systems, MCDM, Google Sheets, TOPSIS, VIKOR, WSM.*

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I. Introduction

Decision Support Systems (DSS) guide individuals, businesses and organization make effective and transparent decisions. DSS are influenced by factors such as the skills and requirementsof its users,the technological development, the expected result, etc. Shibl, et. at. (2013); power and Phillip-Wren (2011). A DSS provides three basic components: the database component, a model base, and a user interface component Jun and Jun, (2011). The database keeps both the data and information of the system. The model(s) provide the means of analysing available options and the user interface provides a user friendly environment for users to enter data and also view results.Cloud computing services are rapidly increasing. Nouh et al (2013) With a promise of reduced maintenance and operational cost, and increased computation and processing power; organizations are moving to the cloud. Decision makers have used spreadsheets as tools for decision making in the last two decades Decision Support with Spreadsheets have advanced to the point of providing powerful, general-purpose functionality and are among the most widely used decision-support tools in business today.

1.1 Aim and Objective.

In this paper we present the design of a cloud based multi model decision support software tool with the objective of: (1) incorporating three Multi Criteria Decision Making models: Weighted Sum Method, VisekriterijumsaOptimizacija I KompromisnoResenje (VIKOR) in Serbian; meaning Multi Criteria Optimization and Compromise Solution and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for collaborative decision making, (2) implementing same using freely available Google Cloud technologies and (3) applying the software tool in a software product selection problem.

II. Literature Review

Software selection problems have been solved by mathematical programming methods, Lengacher and Cammarata (2012);Kokangul, (2009); Freitas and Souza (2011), artificial Intelligence methods Guo et al. (2011); Kaur and Singh (2014), multi criteria decision making methods such as AHP, WSM, TOPSIS, VIKOR, PROMETHEE, ELECTRE, etc. Malik et al. (2016); Aouadni, et al., 2017, Eldrandaly, (2007) and integrated multi criteria decision making models, several of which are combinations of AHP and other methods Hanine et al (2016); Zaidan et al, (2015); Jadhav and Sonar (2009). In Multi Criteria Decision Making (MCDM) problems there are characteristics and sub characteristics that are often conflicting with high uncertainty. Different users of the software product also have differing perspectives and multiple interests, therefore extending the MCDM problem into a Multi Criteria Group Decision Making Problem (MCGDM) where two or more experts are involved in the evaluation process. Kara and Cheikhrouhou (2014); Efe (2016).

2.1Related work

TOPSIS4BIM decision support for Building Information Modelling software selection. They applied cloud based technology in the deployment but applied only one MCDM model: Fuzzy TOPSIS model. Radu et al, (2014) presented iDS, a system designed to become a collaborative and cloud-based Group Decision Support System. The use of MCDM models were not mentioned in this work. The proposed system was to be made available as a Business as a Service cloud model. Abdelhakim and Shirmohammadi (2014) proposed a knowledge driven, web-based group decision support system for the selection and evaluation of educational multimedia based on knowledge of intelligence, design, choice, implementation, and evaluation.

With the amount of software products in the market today and the importance attached to selecting the most appropriate software product, there is need for decision support systems that will automate the processed of software product selection problem. Software product selection activities have often relied on one or a hybridMCDMmodel for the evaluation. Relying on only one model for the selection may result in recommending the wrong software product. Also, available decision support tools are proprietary and require the user to have installed software programs on their systems for the evaluation. In this work, a Multi Criteria Decision Making software tool, incooporating the WSM, TOPSIS and VIKOR as seperate decison making models is designed and developed applying Rapid Application Development (RAD) methodology using Google cloud based tools and technologies.

III. Design of the Proposed Cloud Based Decision Support Software Tool

The proposed cloud based, multi model driven decision support software tool was made to ease data entry from decision makers, automate the ranking processes by the three Multi Criteria Decision Making models and generate results. Figure 1 shows the architecture of the system. The tool consists of the user interface, the database and the model management components.

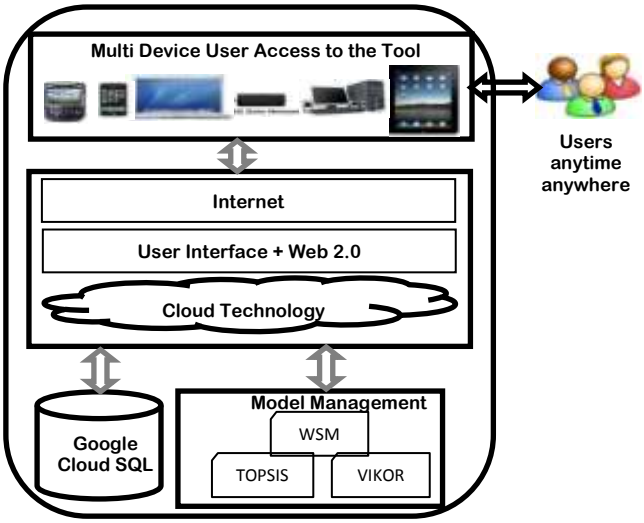

Figure 1: Architecture of the Proposed Software Tool

3.1 The User Interface Component

Users access the software application through Google Sites and may or may not have the permission to access its functions on Google Sheets; a cloud based spreadsheet platform provided by Google. Figure 2 shows the users and their use cases.

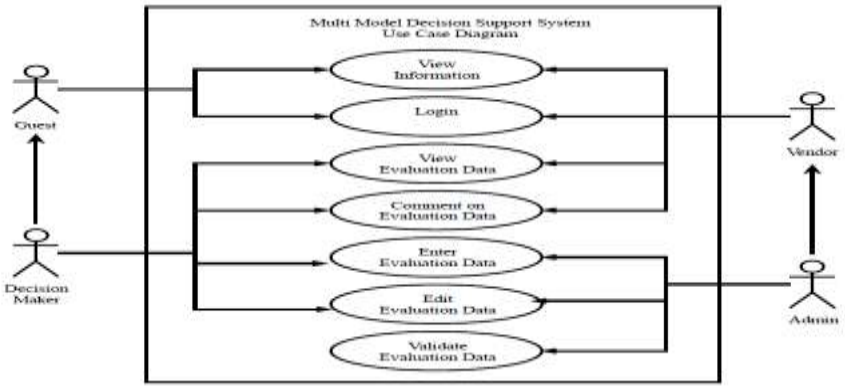

Figure 2: Use Case diagram of the proposed Multi Model Decision Support SoftwareTool

3.2 The Database Component

The Relational Schema for the database is shown in Figure 3.

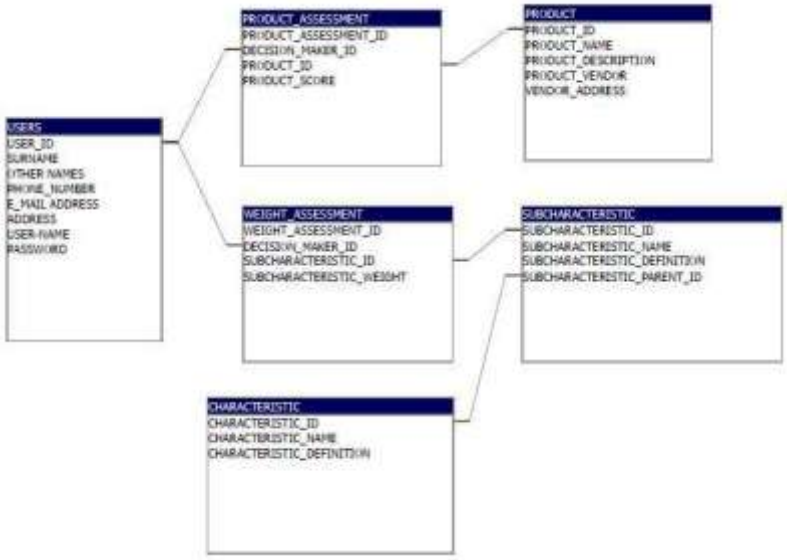

Figure 3: Relational Schema for the database Tables

3.3 The Model Management Component

Three Multi Criteria Decision Making Models: Weighted Sum Method (WSM), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Vise KriterijumsaOptimizacija I KompromisnoResenje(VIKOR) meaning Multi Criteria Optimization and Compromise Solutionare included in the model management component of the Multi Model Decision Making software tool.The detailed explanations of the algorithms outlining the operations of each of these models have been given by several researchers including Odokuma and Asagba, (2017);Zaidan et. al., (2015); Mardani et. al., (2015). The evaluation process is summarized in Figure 4.

IV. Implementation Tools and Technologies

The following technologies and tools were employed in the implementation.

1. Google Sheets
2. Google Drive
3. Google Sites

Google Sheets-Google Sheets is a free, functional, cloud base spreadsheet application that can be used by individuals or groups for collaboration anytime, anywhere. Multiple people can work on the same spreadsheet at the same time and all their contributions will be effected, making it suitable for group decision making. Sheets offers cloud storage, which ensures that the spreadsheet is editable from any web enabled device. Sheets provided both the user interface for the decision maker and the model management in the proposed application.

Google Drive – Data storage and retrieval was provided by Google Drive. Drive makes Sheets spreadsheets available anytime and anywhere.

Google Sites – Provided the means of creating the web pages for the cloud based application. The spreadsheets created in Google sheets were stored in Google drive and accessed through Google Sites.

V. Evaluation and Results from the Multi Model DSS Software Tool

To evaluate its effectiveness and usability the developed cloud based DSS software tool was employed in a software selection problem. Figures 5 to 18 show sample screens from the evaluation of five software products by four decision makers. Figure 17 shows Product B as the best alternative from all three MCM models employed in the research.

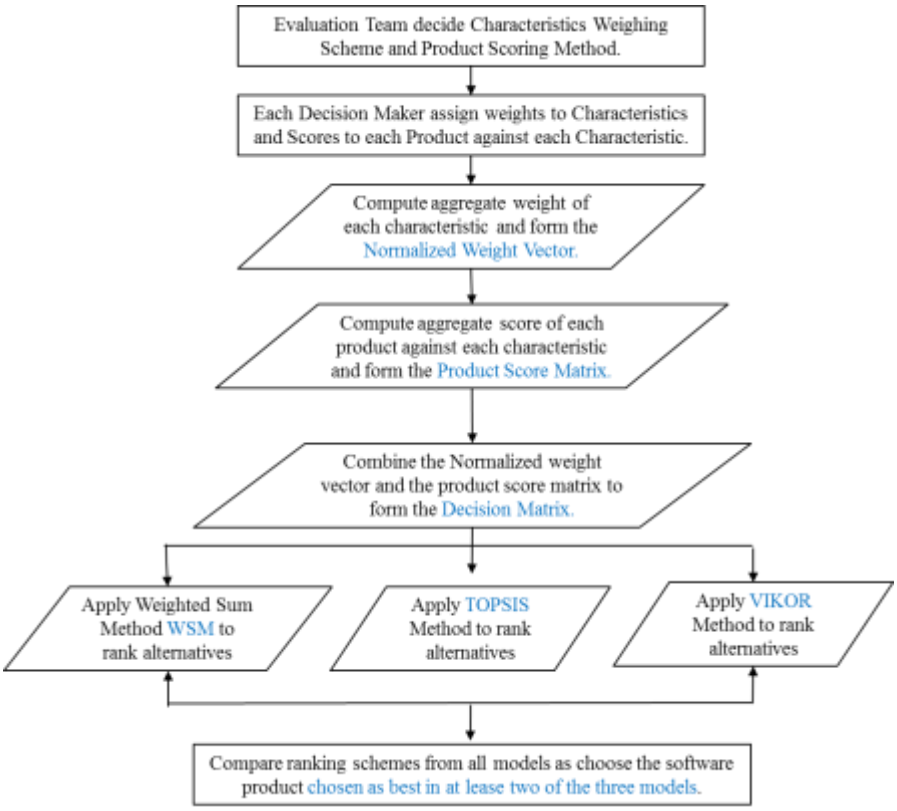

Figure 4: Summary of the Evaluation Process

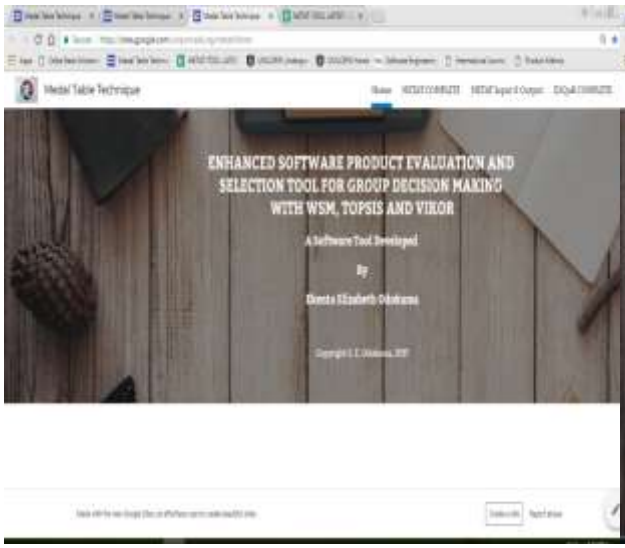

Figure 5: Application Dashboard

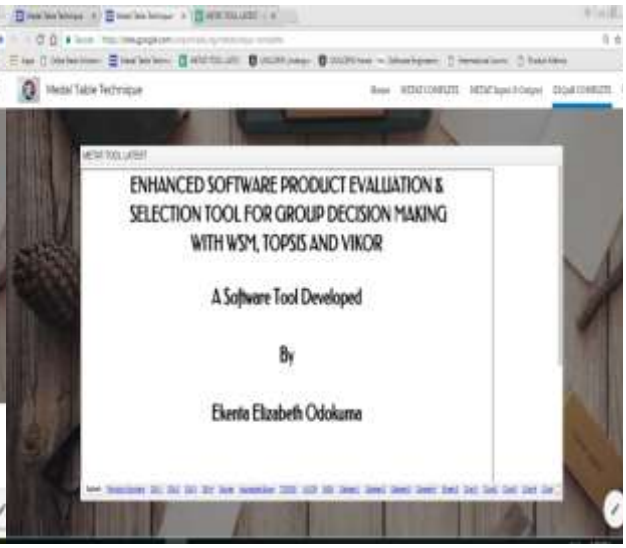

Figure 6: Thirty-three worksheets and several functions and formulae work in the background. Some worksheet names appear in blue.

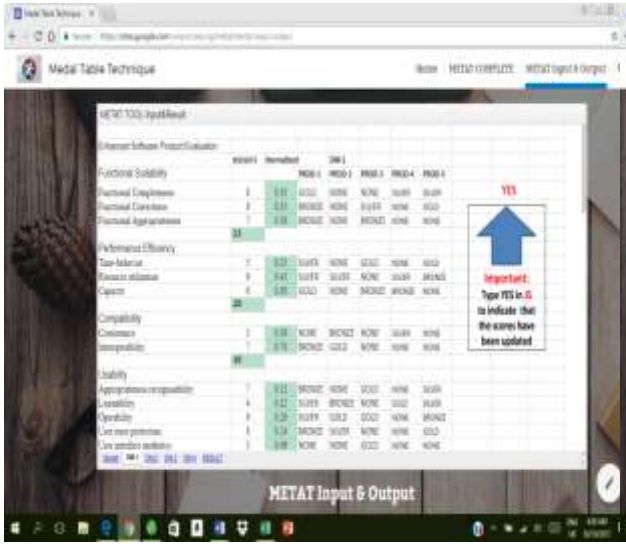

Figure 7: The screen for decision maker input. Cells shaded green contain formula and cannot be altered

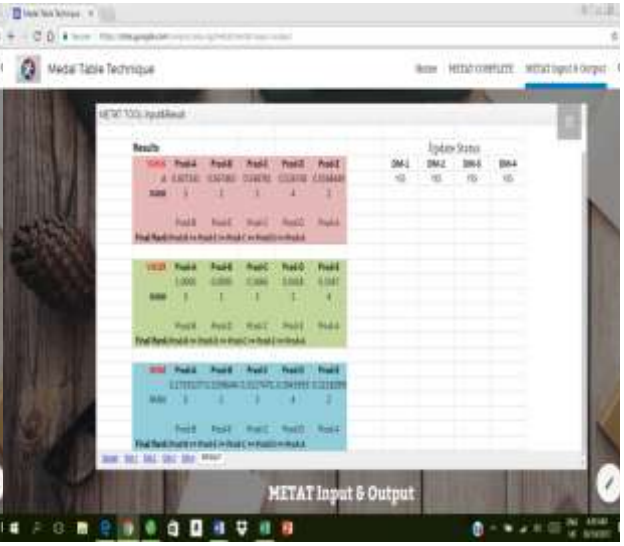

Figure 8: The result sheet after all decision makers have entered their weights and ratings

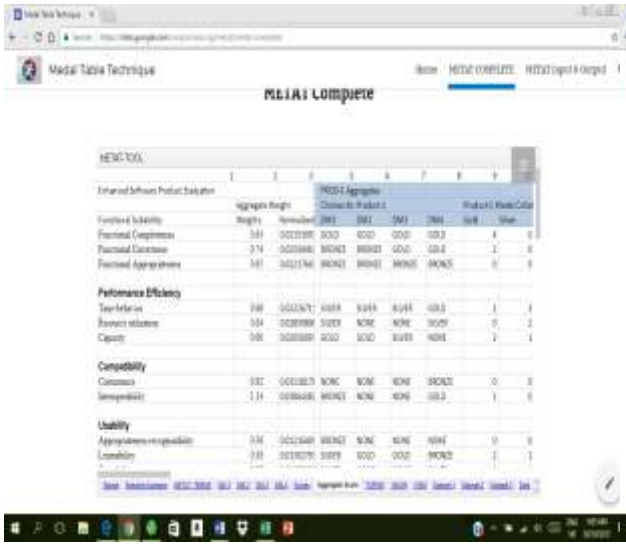

Figure 9: Showing the worksheet where a set of data is collated from all decision makers for use by all the three models.

Figure 10: The Final result from all the ranking methods end the worksheet

Figure 11: First page of the TOPSIS method

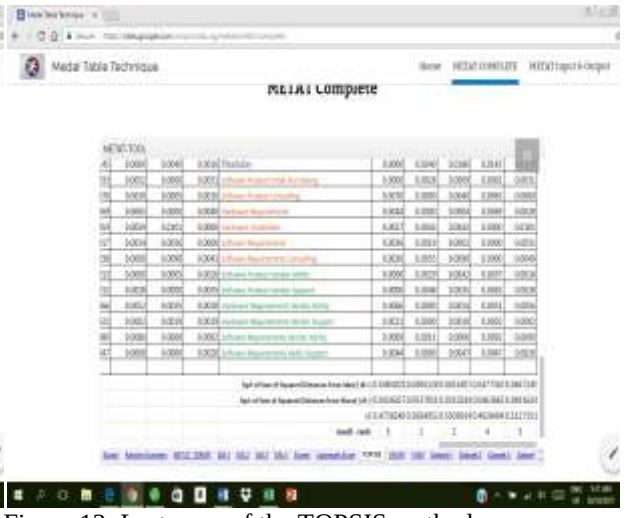

Figure 12: Last page of the TOPSIS method

Figure 13: First page of the VIKOR method

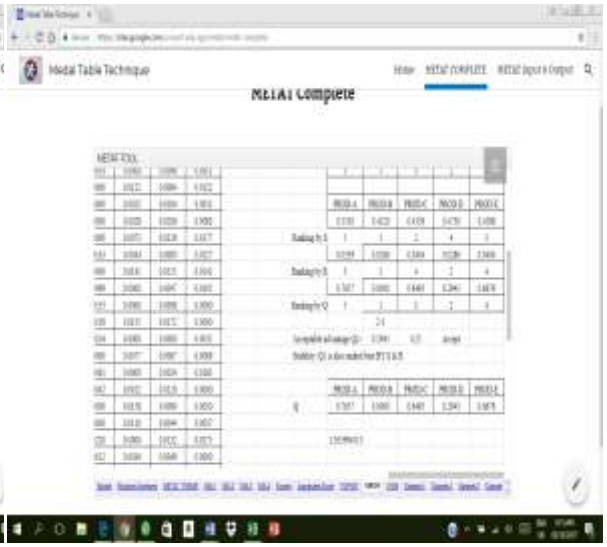

Figure 14 Last page of the VIKOR method

Figure 15: First page of the Weighted Sum Method (WSM)

Figure 16: Last page of the Weighted Sum Method (WSM)

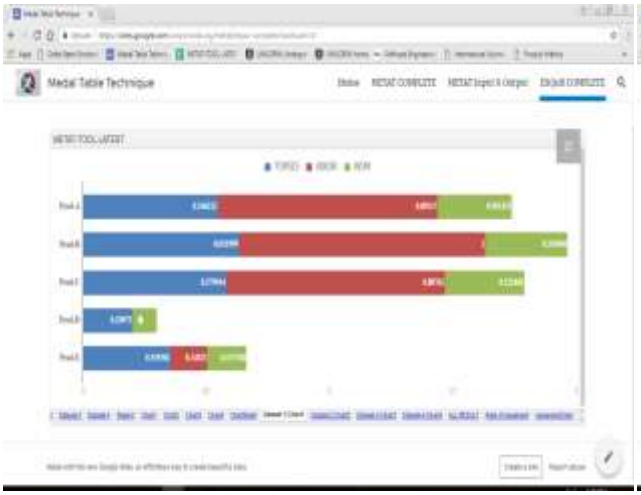

Figure 17: Chart showing result from a set of decision makers' Inputs. Product B is seen as the best.

Figure 18: Chart showing the rate of agreement among the models.

VI. Conclusion and Future Work

The proposed system has many advantages when compared to the existing systems:
(1) the ranking results from three different models are simultaneously obtained, making it easier to select the best software product if all the models point to the same.
(2) The decision maker is more confident about his choice since there are three opinions.
(3) The cloud based software tool is easy to use and can be employed at no extra cost to the evaluation process.
Researchers may add more models to the proposed cloud based tool. The tool may be adapted to solve other multi criteria decision making problems.

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