Decision support system design for determining brown sugar quality with weighted product method

I Taufik1*, A Saleh1, C Slamet1, D S Maylawati1,2, M A Ramdhani1 and B A Muhammad1

1Department of Informatics, UIN Sunan Gunung Djati, Bandung, Indonesia
2Department of Informatics, Sekolah Tinggi Teknologi Garut, Garut, Indonesia

*Corresponding author’s email: ichsan@uinsgd.ac.id

Abstract. Brown sugar is the result of processing the coconut juice with a distinctive taste, so that its use cannot be replaced by other types of sugar. The purpose of this research is to design of Decision Support System (DSS) using a Multi Attribute Decision Making (MADM) model by applying Weighted Product (WP) method to determine the quality of brown sugar. WP method was chosen because the problem in this research is a ranking problem. The WP method is able to select the best alternative from a number of alternatives and its superiority in weighting technique. This system is designed by using PHP and MySQL as the database programming language. This system can rank the brown sugar by calculating the criteria weight. The weight value is searched for each attribute, then conduct the ranking process to determine the optimal alternative, which is the best brown sugar and decent in terms of ranking. Based on the tests performed, a system capable to produce the best ranking in accordance with the calculations used, so that the system this can be speed up the selection of brown sugar.

1. Introduction

The development of information technology is developing along with globalization in various sectors [1-2]. Information technology is also required to obtain more specific and measurable information [3]. Information technology development has an important role. Those important role is also has a negative impacts and the positive impact of the technology including the ease of obtaining various information such as goods and services. In addition to the positive impact of technology, the negative impact of current technology is on fraud in the sale and purchase of brown sugar. In this case there is many frauds about the quality of brown sugar and its sales, which result in a drastic drop in selling prices.

The quality of goods is one of the factors that determining the price of an item. The price of an item, especially the price of brown sugar, often changes over time and with the quality of the brown sugar. In this case, it is possible for unscrupulous brown sugar sellers to cheat. Today many consumers feel confused in choosing the quality of brown sugar on the market. Determination of choosing the quality of brown sugar has many aspects and factors as considerations such as color, texture, taste, aroma and pH level [4].

Weighted Product (WP) method requires a normalization process because this method multiplies the results of the assessment of each attribute. The multiplication results have not been meaningful if they have not been compared (shared) with the standard values. The weight for benefit attributes serves as a positive rank in the multiplication process, while the cost weight functions as a negative rank [5].

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd
Similar research that uses WP as a method in decision analysis, among others: Implementation of the WP Method on Decision Support Systems for Credit Provision in Rural Banks [5]; initial draft of CSE-UCLA evaluation model based on WP in order to optimize digital library services in computer college in Bali [6]; Implementation of Weighted Aggregated Sum Product Assessment (WASPAS) Method in the Best Wood Determination for Guitar Materials [7]; Implementation of the WP Method for Employee Recruitment at PT. Krakatau Argo Logistics [8]; and Decision Support System to Determine the Best Quality of Rambutan Fruit Using the WP Method [9]. Whereas, this study focused on designing decision support systems using the WP method for determining the quality of brown sugar.

2. Methods
The application design method that used in this research is the waterfall software development life cycle. Waterfall is often called the classic life cycle (classic life cycle), where it describes a systematic and sequential approach to software development, starting with the user and software requirements elicitation, then going through the stages of planning (analysis), modelling (design), construction (implementation), testing, and system submission to customers or deployment, which ends with support for the complete software produced [10]. Waterfall software development life cycle process is described in Figure 1 and flowchart of weighted product calculation process shown in figure 2.

![Figure 1. Waterfall Software Development Life Cycle [10]](image)
![Figure 2. Flowchart of Weighted Product Calculation Process [5].](image)

3. Results and Discussion
The combination of information technology and the activities of people that use computerized technology is called information system [12], which is generally used to support operations and management [13]. Information systems process the data organically [14], which are designed based on user needs [15]. Information systems have a flexibility that allows to be developed into a better systems [16]. Information system is also capable to solve complex data processing problems [17]. One information system that intended to support decision making is the Decision Support System (DSS) [18]. Many previous research, information systems have advantages in terms of: good data accessibility [19], efficient in processing time [20], accurate [21], support the decision precisely [22], economical [23], widely used [24], enhance user understanding [25], increase productivity [26], present the data and information well [27], and data store medium [28]. This article presents a decision support system design for determining brown sugar quality with weighted product method.
3.1. Weighted Product Method

The weighted product method uses multiplication to connect the attribute rating, where the rating of each attribute must be raised first with the corresponding weight. This process is the same as the normalization process [5]. Preferences for alternative of S, follow equation (1).

\[ S_i = \prod_{j=1}^{n} x_{ij}^{w_j} \]  

(1)

Where:
- \( S \) = Alternative preference which is analogous as vector \( S \);
- \( i \) = Alternative \( i \);
- \( X \) = Criteria value;
- \( j \) = Criteria \( j \);
- \( W \) = Criteria weight;
- \( \eta \) = Number of Criteria

\[ \sum W_j = 1 \], where \( W_j \) is positive for attribute profit and negative value for loss.

Next, the alternative reference vector is determined by following equation (2).

\[ V_i = \frac{\prod_{j=1}^{n} x_{ij} w_j}{\prod_{j=1}^{n} x_{ij}} \]  

(2)

Where:
- \( V \) = Alternative preference which is analogous as vector \( V \);
- \( i \) = Alternative \( i \);
- \( X \) = Criteria value;
- \( j \) = Criteria \( j \);
- \( W \) = Criteria weight;
- \( \eta \) = Number of Criteria

The process of calculating the weighted product is described with flowchart in Figure 2., with the steps of the weighted product method, are as follows:

a. Multiplying all attributes for an alternative with the weight as a positive rank for the attribute of benefits and the weight of the function as a negative rank in the attribute of cost.
b. Multiplication results are summed to produce values for each alternative.
c. Look for alternative values by doing the same first steps, but using the highest value for each attribute of benefit and the lowest for value the attribute of cost.
d. Divide the value of \( v \) for each alternative with the standard value (\( V(A^*) \)) that produces R.
e. The best alternative order will be found.

Implementation of WP method for application as admin is presented in Figure 3.

![Flowchart of Weighted Product](image-url)

**Figure 3.** Flowchart of Weighted Product for: (a) Master Admin and (b) Admin.
3.2. System Design
The model of analysis and design system is described with structured software analysis and design using Data Flow Diagram (DFD) and Entity Relation Diagram as logical data model of application. Context Diagram as DFD level 0 on the implementation of the WP method to determine the quality of brown sugar, designed for two users, namely: master admin and admin (Figure 4). Whereas for Entity Relational Diagram (ERD) is presented in Figure 5.

![Figure 4. Context Diagram (DFD Level 0)](image-url)

![Figure 5. Entity Relational Diagram](image-url)

3.3. User Interface Implementation
Interface implementation is a part of implementation processing that presented to users [29]. Display of interface on this application is designed to facilitate users in using this application easily. The user interfaces of this research are among others:

a. Login page. This login page is addressed to the master admin and the regular admin to access their page with the username and password correctly, after entering the username and password, then the next page will be shown depend on the user who log in (Figure 6);

b. Master Admin Main Page. On this page the master admin can see graphs and information of ranking results and any stages in ranking process (Figure 7);

c. Value page. On this page the master admin can input the information about the value and number of values (Figure 8);

d. Criteria page. The master admin can input the criteria data and the type of criteria (Figure 9);
e. Weight page. The master admin can add the weight of criteria and weight values (Figure 10);
f. Alternative page. The master admin can add new alternative names and can delete existing old alternative data (Figure 11);
g. Ranking page. On this page is shown all of the data and the information results of the ranking where the value will automatically appear after entering the criterion data then generate the final value. The final value uses in the ranking process. This ranking produces an alternative with the best quality of brown sugar (Figure 12);
h. Report page. This page present about ranking report, which can also print the report (Figure 13).

Figure 6. Login Page.

Figure 7. Main Page.

Figure 8. Page of Value.

Figure 9. Page of Criteria.

Figure 10. Page of Weight.

Figure 11. Page of Alternatives.
3.4. System Testing

Basically, testing is a process for finding and removing bugs (errors) in the system / software. Reliability of the system in this research used: analytical, logical, conceptual, and operational verification [11]. The method that used in testing the functionality of application is the Black-Box Testing method. Based on the results of black-box testing, with some hypothetical cases, it can be concluded that all of function and process of application have been run well and 100% successful.

4. Conclusions

The system is built using the weighted product method that capable in calculating and ranking the data of brown sugar by inputting alternative data and criteria. Furthermore, the data is processed by the system until provide a decision in the form of the best alternative ranking. The performance of the weighted product method can be said successful overall when viewed in terms of the system and testing that has been done.

5. References

[1] Irfan M and Restu M 2014 Implementasi Compute Based Instruction Model Instructional Games pada Pembelajaran Interaktif ISTEK 8 162–176
[2] Gerhana Y A, Irfan M and Slamet C 2017 Implementasi Technology Acceptance Model untuk Mengukur Penerimaan Guru Inovasi Pembelajaran (Studi Kasus Model Pembelajaran CBR di SMK) ISTEK 11 1–18
[3] Irfan M 2015 Analisa Pola Asosiasi Jalur Masuk terhadap Kelulusan Mahasiswa dengan Menggunakan Metode Fold-Growth (Studi Kasus Fakultas Sains dan Teknologi ISTEK 9 2 172–190
[4] Zuliana C, Widyastuti E and Susanto W H 2015 Pembuatan Gula Semut Kelapa: Kajian pH Gula Kelapa dan Konsentrasi Natrium Bikarbonat J. Pangan dan Agroindustri 4 1 109–119
[5] Jayanti L D 2014 Implementasi Metode Weighted Product pada Sistem Pendukung Keputusan Pemberian Kredit pada BPR BKK Karanganyar Kab. Pekalongan menggunakan metode weighted product. Semarang: Universitas Dian Nuswantoro
[6] Divayana D G H, Adiarta A and Abadi I 2018 Initial draft of CSE-UCLA evaluation model based on weighted product in order to optimize digital library services in computer college in Bali IOP Conference Series: Materials Science and Engineering 296 1 12003
[7] Simanjuntak P, Irma I, Kurniasih N, Mesran M and Simarmata J 2018 Implementasi Metode Weighted Aggregated Sum Product Assessment (WASPAS) dalam Penentuan Kayu Terbaik untuk Bahan Gitar J. Ris. Komput. 5 1 35–42
[8] Krisnaningsih E and Kurniawan R A 2017 Penerapan Metode Weighted Product Untuk Rekrutmen Karyawan PT. Krakatau Argo Logistics PROSISKO J. Pengemb. Ris. dan Obs. Sist. Komput. 4 1 30–36
[9] Zai Y, Mesran M and Buulolo E 2017 Sistem Pendukung Keputusan untuk Menentukan Buah Rambutan dengan Kualitas Terbaik Menggunakan Metode Weighted Product (WP) Media Inform. Budidarma 1 1 8–12
[10] Pressman R S 2012 Rekayasa Perangkat Lunak: Pendekatan Praktis (Yogyakarta: Andi)
[11] Suhendi H Y, Ramdhani M A and Irwansyah F S 2018 Verification Concept of Assessment for Physics Education Student Learning Outcome Int. J. Eng. Technol. 7 3.21 321–325
[12] Pamoragung A, Suryadi K and Ramdhani M A 2006 Enhancing the implementation of e-Government in Indonesia through the high-quality of virtual community and knowledge portal Proceedings of the European Conference on e-Government, ECEG 341–348
[13] Ramdhani M A 2013 Metodologi Penelitian untuk Riset Teknologi Informasi. (Bandung: UIN Sunan Gunung Djati)
[14] Maylawati D S, Darmalaksana W and Ramdhani M A 2018 Systematic Design of Expert System Using Unified Modelling Language IOP Conf. Ser. Mater. Sci. Eng. 288 1 012047
[15] Ramdhani M A, Maylawati D S, Amin A S and Aulawi H 2018 Requirements Elicitation in Software Engineering Int. J. Eng. Technol. 7 2.29 772–775
[16] Aulawi H, Ramdhani M A, Slamet C, Ainissyifa H and Darmalaksana W 2017 Functional Need Analysis of Knowledge Portal Design in Higher Education Institution Int. Soft Comput. 12 2 132–141
[17] Darmalaksana W, Ramdhani M A, Cahyana R and Amin A S 2018 Strategic Design of Information System Implementation at University Int. J. Eng. Technol. 7 2.29 787–791
[18] Suryadi K and Ramdhani M A 2002 Sistem Pendukung Keputusan (Bandung: Remaja Rosdakarya)
[19] Maylawati D S, Ramdhani M A and Amin A S 2018 Tracing the Linkage of Several Unified Modelling Language Diagrams in Software Modelling Based on Best Practices Int. J. Eng. Technol. 7 2.29 776–780
[20] Slamet C, Rahmain A, Sutedi A, Darmalaksana W, Ramdhani M A and Maylawati D S 2018 Social Media-Based Identifier for Natural Disaster IOP Conf. Ser. Mater. Sci. Eng. 288 1 012039
[21] Slamet C, Andrian R, Maylawati D S, Darmalaksana W and Ramdhani M A 2018 Web Scraping and Naïve Bayes Classification for Job Search Engine IOP Conf. Ser.: Mater. Sci. Eng. 288 1 1–7
[22] Gerhana Y A, Zulfikar W B, Ramdani A H and Ramdhani M A 2018 Implementation of Nearest Neighbor using HSV to Identify Skin Disease IOP Conf. Ser. Mater. Sci. Eng. 288 1 012153
[23] Rahman C, Slamet C, Darmalaksana W, Gerhana Y A and Ramdhani M A 2018 Expert System for Deciding a Solution of Mechanical Failure in a Car using Case-based Reasoning IOP Conf. Ser. Mater. Sci. Eng. 288 1 012011
[24] Slamet C, Rahmain A, Ramdhani M A and Darmalaksana W 2016 Clustering the Verses of the Holy Qur’an Using K-Means Algorithm Asian J. Inf. Technol. 15 24 5159–5162
[25] Maylawati D S, Ramdhani M A, Zulfikar W B, Taufik I and Darmalaksana W 2017 Expert system for predicting the early pregnancy with disorders using artificial neural network 2017 5th Int. Conf. Cyber IT Serv. Manag. CITSM 2017
[26] Zulfikar W B, Jumadi, Prasetyo P K and Ramdhani M A 2018 Implementation of Mamdani Fuzzy Method in Employee Promotion System IOP Conf. Ser. Mater. Sci. Eng. 288 1 01214
[27] Maylawati D S, Ramdhani M A, Rahman A and Darmalaksana W 2017 Incremental technique with set of frequent word item sets for mining large Indonesian text data2017 5th Int. Conf. Cyber IT Serv. Manag. CITSM 2017 1–6.
[28] Taufik A, Ismail N, Gerhana Y A, Komarujaman K and Ramdhani M A 2018 Design of Smart System to Detect Ripeness of Tomato and Chili with New Approach in Data Acquisition IOP Conference Series: Materials Science and Engineering 288 1 012018
[29] Ayuningtias L P, Irfan M and Jumadi 2017 Analisa Perbandingan Logic Fuzzy Metode Tsukamoto, Sugeno, dan Mamdani (Studi Kasus: Prediksi Jumlah Pendanaftar Mahasiswa Baru Fakultas Sains Dan Teknologi Universitas Islam Negeri Sunan Gunung Djati Bandung) J. Tek. Inform. 10 1 9–16
Acknowledgments
The authors expressed the appreciation and thank you to the Research and Publishing Centre of UIN Sunan Gunung Djati Bandung, which has provided funding support for the publication of this article.