

JURNAL

ILMU PENGETAHUAN & TEKNOLOGI KOMPUTER

Vol. 8. No. 1 August 2022

ISSN: 2685-8223 (Printed)

ISSN: 2527-4864 (Online)



Publisher:

Lembaga Penelitian dan Pengabdian Masyarakat Universitas Nusa Mandiri
Jl. Jatiwaringin Raya No. 02 RT 08 RW 013 Kelurahan
Cipinang Melayu Kecamatan Makassar Jakarta Timur 13620
Phone: 021 28534471
<http://ejournal.nusamandiri.ac.id/index.php/jitk/index>

EDITORIAL BOARD

- Advisors : Chairman of Universitas Nusa Mandiri
- Responsible Person : Chairman of LPPM Universitas Nusa Mandiri
- Editor In Chief : Ruhul Amin, M.Kom
Profile: ID Scopus: 57224841038 | Universitas Nusa Mandiri
- Associate Editors : Daning Nur Sulistyowati, M.Kom
Profile: Scopus ID: 57208283626 | Universitas Nusa Mandiri
- Nurajijah, M.Kom
Profile: ID Scopus: 57208282684 | Universitas Nusa Mandiri
- Board of Editors : Dr. Raimon Efendi,S.A.B,M.Kom
Profile: Scopus ID: 57208861363 | Universitas Dharmas Indonesia
- Alfa Saleh, M.Kom
Profile: Scopus ID: 57200210551 | Universitas Potensi Utama
- Dinar Ajeng Kristiyanti, M.Kom
Profile: Scopus ID: 57191189495 | Universitas Bina Sarana Informatika
- Ninuk Wiliani, M.Kom
Profile: Scopus ID: 57212350451 | Institut Teknologi & Bisnis BRI
- Anggi Oktaviani, M.Kom
Profile: Scopus ID : 57205210550 | Universitas Nusa Mandiri
- Eni Irfiani, M. Kom
Profile: Scopus ID : 57210461376 | Universitas Bina Sarana Informatika
- Esron Rikardo Nainggolan, M.Kom
Profile: Scopus ID : 57208281339 | Universitas Nusa Mandiri
- Ari Pambudi, M.Kom
Profile : Univ. Indonusa Esa Unggul
- Ummu Radiyah, S.Kom., M.Eng.
Profile : Universitas Nusa Mandiri
- Taufik Hidayatulloh, M.Kom
Profile : Universitas Bina Sarana Informatika
- Reviewers : Prof. Dr. Dwiza Riana, S.Si, MM, M.Kom
Profile: ID Scopus: 56242366200 | Universitas Nusa Mandiri
- Dr. Didi Rosiyadi, M.Kom
Profile: ID Scopus: 55355563700 | Pusat Penelitian Informatika LIPI

Dr. Windu Gata, M.Kom

Profile: Scopus ID: 57193213766 | Universitas Nusa Mandiri

Dr Hilman Ferdinandus Pardede, S.T, MEICT

Profile: ID Scopus: 55351397700 | Pusat Penelitian Informatika LIPI

Dr. Foni Agus Setiawan, M.Kom

Profile: ID Scopus: 56669695700 | Universitas Ibn Khaldun Bogor,
Indonesia

Adil Setiawan, M.Kom

Profile: ID Scopus: 57200211356 | Universitas potensi utama

Agung Wibowo, M.Kom

Profile: ID Scopus: 57203100012 | Universitas Bina Sarana Informatika

Taufik Baidawi, M.Kom

Profile: ID Scopus: 57200216518 | Universitas Bina Sarana Informatika

Sopiyan Dalis, M.Kom

Profile: ID Scopus: 57208282541 | Universitas Bina Sarana Informatika

Sukmawati Anggraeni Putri, M.Kom

Profile: ID Scopus: 57200216199 | Universitas Nusa Mandiri

Nurmalasari, M.Kom

Profile: ID Scopus: - | Universitas Nusa Mandiri

Bambang Krismono Triwijoyo, M.Kom

Profile: ID Scopus: 57193868829 | STMIK Bumi Gora Mataram

Sri Hadiani, M.Kom

Profile: Universitas Nusa Mandiri

Bahtiar Imran, S.ST., M.TI

Profile: ID Scopus: 57198810908 | Universitas Teknologi Mataram

Dimas Sasongko, S.Kom., M.Eng.

Profile: ID Scopus: 57193503355 | Universitas Muhammadiyah Magelang

Rohmat Gunawan, M.T.

Profile: ID Scopus: 57211267688 | Universitas Siliwangi

Rohmat Indra Borman, M.Kom.

Profile: ID Scopus: 57205615323 | Universitas Teknokrat Indonesia

Prensa Perdana Surya Saputra, ST., MT.

Profile: ID Scopus: 57210972475 | Universitas Muhammadiyah Gresik

Galih Abdul Fatah Maulani, S.Kom., M.Kom.
Profile: ID Scopus: 57202308014 | Universitas Garut

Ardhin Primadewi, S. Si, M. TI
Profile: ID Scopus: 57210971067 | Universitas Muhammadiyah Magelang

Editorial Address : Kampus Universitas Nusa Mandiri Tower Jatiwaringin
Jl. Jatiwaringin Raya No. 02 RT 08 RW 013 Kelurahan Cipinang Melayu
Kecamatan Makassar Jakarta Timur 13620

Website : <http://ejournal.nusamandiri.ac.id/index.php/jitk>

Editorial Email : redaksi.jitk@nusamandiri.ac.id or jurnal.jitk@gmail.com

PREFACE

Editor of JITK (Jurnal Ilmu Pengetahuan dan Teknologi Komputer), said praise and gratitude to the presence of Allah S.W.T, creator of the universe who mastered knowledge as wide as heaven and earth, for the abundance of grace and gifts that have been given to JITK editors to publish JITK Vol. 8, No. 1 August 2022, which is used by lecturers, researching, and professionals as a medium or media to publish publications on the findings of research conducted in each semester.

JITK is published 1 (one) year for 2 (two) times at the end of each semester, JITK editors receive scientific articles from the results of research, reports / case studies, information technology studies, and information systems, which are oriented to the latest in science and information technology in order to be a source of scientific information that is able to contribute to the increasingly complex development of information technology.

The editor invited fellow researchers, scientists from various tertiary institutions to make scientific contributions, both in the form of research results and scientific studies in the fields of management, education, and information technology. The editors really expect input from readers, information technology professionals, or those related to publishing, for the sake of increasing the quality of journals as we all hope.

The editor hopes that the scientific articles contained in the JITK scientific journal will be useful for academics and professionals working in the world of management, education, and information technology

Chief Editor

TABLE OF CONTENTS

FRONT MATTER	i
EDITORIAL BOARD.....	iii
PREFACE	vi
TABLE OF CONTENTS	viii
1. DECISION SUPPORT SYSTEM USING FUCOM-MARCOS FOR AIRLINE SELECTION IN INDONESIA Gede Surya Mahendra	1-9
DOI : https://doi.org/10.33480/jitk.v8i1.2219	
2. IDENTIFY CHOLESTEROL DISEASE RISK LEVELS USING MULTIPLE LINEAR REGRESSION ALGORITHMS Deny Haryadi, Dewi Marini Umi Atmaja	10-17
DOI : https://doi.org/10.33480/jitk.v8i1.3328	
3. IMPROVING THE PERFORMANCE OF SUPPORT VECTOR MACHINE WITH FORWARD SELECTION FOR PREDICTION OF CHRONIC KIDNEY DISEASE Esty Purwaningsih	18-24
DOI : https://doi.org/10.33480/jitk.v8i1.3327	
4. IMPLEMENTATION OF ARAS ALGORITHM ON DECISION SUPPORT SYSTEM TO DETERMINE THE BEST LECTURER Supriatin Supriatin, Alex Rizky Saputra, Budy Satria	25-32
DOI : https://doi.org/10.33480/jitk.v8i1.3152	
5. EVALUATING USER ENGAGEMENT AND READING BEHAVIOR ASPECTS OF WEB VISITORS BY ANALYZING INDICATORS ON GOOGLE ANALYTICS DATA Shumaya Resty Ramadhani.....	33-39
DOI : https://doi.org/10.33480/jitk.v8i1.2996	
6. SI/IT STRATEGIC PLANNING USING WARD AND PEPPARD METHODS (CASE STUDY: PT. XY) Rediva Kezia Wijanarko.....	40-45
DOI : https://doi.org/10.33480/jitk.v8i1.2979	
7. 3D ANIMATION DESIGN "SCIENCE, LANTERNS TO HEAVEN" USING THE POSE-TO-POSE METHOD Desy Apriliyanti, Juniardi Nur Fadila, Fresy Nugroho	46-55
DOI : https://doi.org/10.33480/jitk.v8i1.2231	
8. PACKAGE RECEIVER BOX BASED ON IOT USING FUZZY MAMDANI AND MOBILE APPLICATION Ilham Firman Firman Ashari, Arimbi Ayuningtyas	56-64
DOI : https://doi.org/10.33480/jitk.v8i1.2982	
9. SENTIMENT ANALYSIS ON THE PERMENDIKBUD CONCERN PREVENTION AND TREATMENT OF SEXUAL VIOLENCE IN HIGHER EDUCATIONAL ENVIRONMENTS USING SUPPORT VECTOR MACHINE (SVM) Reinhard Alfaries Saemani, Nina Setiyawati	65-71
DOI : https://doi.org/10.33480/jitk.v8i1.2807	

DECISION SUPPORT SYSTEM USING FUCOM-MARCOS FOR AIRLINE SELECTION IN INDONESIA

Gede Surya Mahendra

Program Studi Teknik Informatika
STMIK STIKOM Indonesia
www.stiki-indonesia.ac.id
gede.mahendra@stiki-indonesia.ac.id

Abstract— Since deregulation in 1999, the development of the Indonesian aviation industry has continued to develop. However, many airlines still face various problems before and during flights. Problems in the plane, ranging from engine problems, technical problems, tire damage, cockpit problems to air pressure problems. Airlines customers have personal considerations and preferences when choosing an airline. The many choices and many considerations of airlines often confuse customers. To solve this problem, a decision support system (DSS) can be used to provide advice in selecting airlines based on customer preferences. This study uses the FUCOM-MARCOS method, using 8 criteria and 6 testing alternatives. When using FUCOM to calculate criterion weights, it appears that the factor price (C5) is the factor that counts most. Calculations using FUCOM-MARCOS show that Garuda Indonesia is the favorite airline in Indonesia with a preference value of 0.7390, followed by Citilink in second place, and Batik Air in third. Testing using consistency analysis shows that Garuda Indonesia remains stable and is the first choice by being ranked first 15 times out of 17 tests, with an average ranking distribution reaching 1.23466.

Keywords: FUCOM, MARCOS, DSS, Airlines, Indonesia

Intisari— Sejak deregulasi pada 1999, perkembangan industri penerbangan Indonesia semakin berkembang. Namun, banyak maskapai penerbangan yang masih menghadapi berbagai masalah sebelum dan selama penerbangan. Terdapat masalah di pesawat, mulai dari masalah mesin, masalah teknis, kerusakan ban, masalah kokpit hingga masalah tekanan udara. Pelanggan maskapai penerbangan memiliki pertimbangan dan preferensi pribadi saat memilih maskapai. Banyaknya pilihan dan banyaknya pertimbangan maskapai seringkali membingungkan pelanggan. Untuk mengatasi masalah tersebut, dapat digunakan sistem pendukung keputusan (SPK) untuk memberikan saran dalam memilih maskapai penerbangan berdasarkan preferensi pelanggan. Penelitian ini menggunakan metode FUCOM-MARCOS, menggunakan 8 kriteria dan 6 alternatif untuk dilakukan pengujian. Ketika menggunakan FUCOM untuk menghitung bobot kriteria, terlihat bahwa faktor harga (C5) adalah faktor yang paling diperhitungkan. Perhitungan menggunakan FUCOM-MARCOS menunjukkan bahwa Garuda Indonesia merupakan maskapai terfavorit di Indonesia dengan nilai preferensi 0,7390, disusul Citilink, sebagai peringkat kedua, dan Batik Air menduduki peringkat ketiga. Pengujian menggunakan analisis konsistensi menunjukkan bahwa Garuda Indonesia tetap stabil dan menjadi pilihan pertama, menduduki peringkat pertama sebanyak 15 kali dari 17 pengujian, dengan rata-rata sebaran peringkat mencapai 1.23466.

Kata Kunci: FUCOM, MARCOS, SPK, Maskapai, Indonesia

INTRODUCTION

Since the issuance of a series of deregulation steps in 1999, the development of the Indonesian aviation service industry has continued to develop. The large number of airlines operating in Indonesia directly brings stiff competition. However, it turns out that there are still many airlines that experience various problems before and during the flight. In 2021 alone, various problems will occur in aircraft, ranging from engine problems, technical problems, tire damage, cockpit problems to air pressure

problems[1]. The COVID-19 situation has also hampered the business conditions of airlines. Aircraft manufacturer Airbus announced that as a result of the pandemic, the losses amounted to 18.8 trillion IDR[2]. Not only affects companies, but as many as 25 million people are unemployed due to COVID-19, and this number continues to increase after the pandemic duration chart[3]. Airline service levels have continued to improve, especially during times of pandemics. One of them is by providing free rapid antigen testing services through Garuda



Indonesia, Lion Air, Batik Air, NAM Air and Sriwijaya Air[4].

The better the service quality standard of the selected airline, the greater the interest of potential passengers to use its services[5]. TripAdvisor is one of the websites that make online reservations and provides information about various accommodations in various parts of the world[6]. TripAdvisor customers have a tool that allows them to rate the accommodations used online. All parties can use this level to influence the improvement of service quality and provide information related to accommodation with characteristics. However, airlines customers have personal considerations and preferences when choosing their travel agency. The many choices and many considerations of airlines often confuse customers. To solve this problem, a decision support system (DSS) can be used to provide advice in selecting airlines based on customer preferences. A DSS is an effective system that uses decision rules, analysis models, comprehensive databases and decision maker knowledge to help make complex decisions[7]–[9]. In this research, the method used was the FUCOM-MARCOS combination. This method combination was chosen because FUCOM has the following advantages: the algorithm is simpler, the standard result weights are more reliable, the comparison between standards is less, and the predefined integer, decimal, or decimal values are allowed, so it is better than AHP More flexible or BWM[10]–[14]. When considering parameters in an uncertain environment, MARCOS will give good results, and considering the relationship between ideal and anti-ideal solutions can have a positive impact on effective decision making[15]–[21]. However, for consistency analysis, there has not been a comprehensive analysis of how several decision makers with different weights and method combinations that test how to use consistency analysis are compared. Therefore, this study aims to calculate the combination of the FUCOM-MARCOS method and analyze the consistency of the combination of these methods. The urgency of this research, if not realized, will hamper the development of the DSS method which can only reach the calculation and design stages manually so that it can hinder innovation in the DSS field.

MATERIALS AND METHODS

The research method used in this study follows the various stages of the Cross-Industry Data Mining Standard Process (CRISP-DM) model[22]–[26]. This framework is expected to analyze business problems and current conditions, provide appropriate data transformation, and provide a model that can assess effectiveness and

record the results obtained[22]. The stages of the CRISP-DM process model are shown in Figure 1.

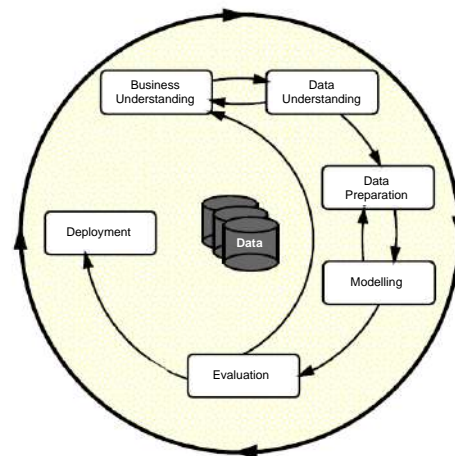


Figure 1. CRISP-DM Model

The first stage is the stage of understanding the business, which is used to determine business goals, analyze business conditions, and determine the objectives of the DSS. This stage analyzes the results of observations, interviews, and supporting documents to achieve the objectives and research results. Aviation business entity or air transportation is an air transportation business entity that is a state-owned company, regional business entity, or Indonesian legal entity in the form of a limited liability company whose main activity is to operate aircraft in accordance with the provisions of laws and regulations. Regulation of the Minister of Transportation (No. 77 PM, 2011) Article 1, paragraph 5[27], is used to transport passengers, cargo and / or post offices. Regular commercial air transportation is commercial air transportation that is carried out on fixed and scheduled routes and flight schedules with certain and published prices[28]. Indonesian scheduled airlines include Aviastar, Batik Air, Citilink, Garuda Indonesia, Indonesia AirAsia, Indonesia Metro Aviation, Kalstar Aviation, Lion Air, NAM Air, Sriwijaya Air, Susi Air, TransNusa, Wings Air, and Xpress Air.

TripAdvisor is a site that provides reviews of travel and travel accommodation, one of which is a review of Indonesia Airlines. On TripAdvisor, only exposure to value is provided, regardless of consumer preferences. Every customer has their own considerations, many airlines in Indonesia have similar policies and service quality standards, which often confuses consumers. This study will use data from TripAdvisor as substitute data and will use 3 sources to select airlines. An example of airline reviews on TripAdvisor can be seen in Figure 2.

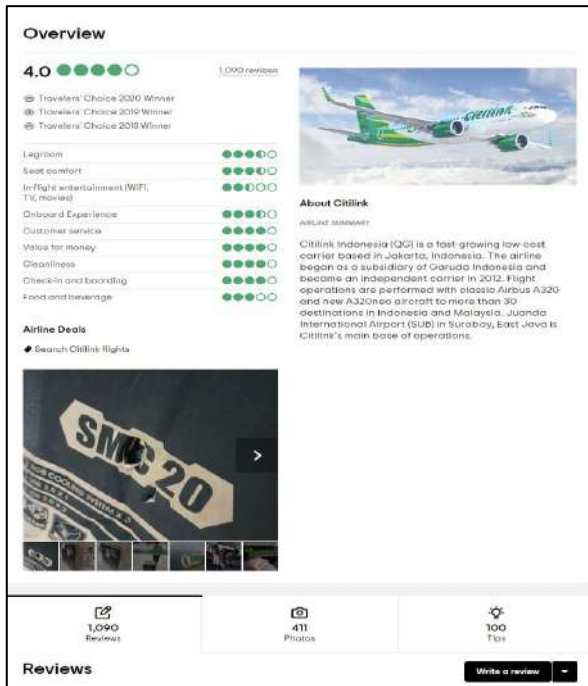


Figure 2. Airline Reviews On Tripadvisor

In addition, there are stages of understanding data for data collection, followed by data analysis and evaluation of the quality of the data used in the study. In order to provide recommendations to consumers, appropriate standards and alternative data must be obtained. The criteria used in this study include leg and chair comfort (C1), in-flight entertainment (C2), in-flight experience (C3), customer service (C4), price (C5), cleanliness (C6), check-in and boarding (C7) and food and beverage (C8). Criteria with cost condition is price (C5) while others are criteria with benefit condition. The alternative airlines used are Indonesian scheduled commercial airlines, which consists of 6 airlines, namely Batik Airlines, Citilink, Garuda Indonesia, AirAsia Indonesia, Lion Air and NAM Air.

The next stage is the data preparation stage, this stage includes selecting the data to be used and the data to be published for inclusion in the DSS calculation. At this stage, data cleaning will also be carried out to repair, remove or ignore noise in the data. Three Decision makers will use FUCOM to weight the criteria. Instead, airline data will be evaluated based on predetermined criteria. At the business understanding stage, tools, techniques or methods have been selected to be used in this research, namely FUCOM-MARCOS to determine the most popular airlines in Indonesia. At this modeling stage, the process of using this method will be explained. Before proceeding, you can use provisional data to test your design to prove that this method works. The flowchart of the method is shown in Figure 3.

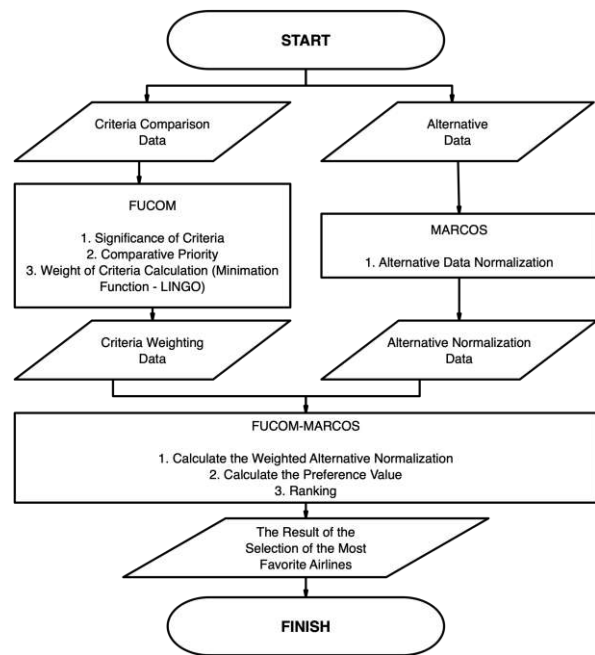


Figure 3. Flowchart Of Using The Fucom-Marcos Method

The first step is to prepare to compare the criteria provided by the decision maker as a resource with substitute data for airline data on TripAdvisor. By using the FUCOM method, standard weight data were determined starting from providing standardized significance levels, comparing priorities, and using LINGO to use minimization functions to calculate standard weight coefficients. In addition, the MARCOS method is used to normalize surrogate data to produce surrogate normalized data. Standard weighting data using the FUCOM method and alternative data normalized by the MARCOS method will be weighted and normalized to calculate and calculate the preference value, and a preference value will be generated which can be ranked to determine the favorite airlines in Indonesia. A higher priority value is a better airline recommendation. The evaluation phase will be tested based on the results of the DSS recommendations and the performance of the methods used. Consistency analysis was used to obtain the consistency of the FUCOM-MARCOS method and the lowest possible conditions. The final stage is implementation, where the implementation plan is carried out based on previous evaluations. If the test results show good results, further implementation can be planned. Apart from deployment planning, monitoring and maintenance plans can also be planned to produce final reports and scientific publications regarding research results.

RESULTS AND DISCUSSION

To be able to perform calculations using the FUCOM-MARCOS method, previously weighting the criteria for determining favorite airlines based on questionnaire data from decision makers who already understand well about active use of airlines, which is transformed in the FUCOM method as a comparison between criteria and airline data is used as alternative data. The number of decision makers (DM) used to compare between standards to produce standard weights is 3, which will be called the Decision Maker 1 (DM1), Decision Maker 2 (DM2), and Decision Maker 3 (DM3). The number of airlines used is 6 airlines company. Using the FUCOM method, these three decision makers providers provide a weighted standardized evaluation by providing a standardized level of importance, and calculation of mathematical coefficient and transitivity ratios. The decision maker chooses the most preferred standard and assigns a value of 1, which is the same as the previous value, or adds an ordinal or decimal value at the end before the next standard of choice, so the lower the weight, the better. Table 1 lists the weights of the three decision maker on each criterion.

Table 1. Weighted Criteria Based on the Three Decision Makers

Criteria	C1	C2	C3	C4	C5	C6	C7	C8
DM1 Weighting	1,5	1,1	1,9	2,4	1,0	1,7	1,3	2,1
DM2 Weighting	1,1	1,9	1,5	1,6	1,0	1,4	2,1	2,5
DM3 Weighting	1,0	2,0	1,8	1,4	1,2	1,6	2,2	2,5

In addition, calculations are focused on decision maker 1 (DM1), and calculations from other sources will follow computations of DM1. Carry out the DM1 weighting from the smallest to the largest weight. In addition, the value of comparison priority calculation is the calculation of the weight coefficient ratio, and mathematical transitive calculations are also carried out based on the ratio of the weight coefficient. Table 2 shows the standard weighted rating of DM1.

Table 2. Weighted Criteria Based on the Decision Makers 1

Criteria	C5	C2	C7	C1	C6	C3	C8	C4
DM1 Weighting	1	1,1	1,3	1,5	1,7	1,9	2,1	2,4

Comparative priority calculation and weight coefficient ratio on DM1, calculated using the following formula.

$$\frac{w_k}{w_{k+1}} = \varphi_{k \over k+1}$$

Calculation of mathematical transivity from the calculation of the weight coefficient ratio on DM1, calculated using the following formula.

$$\frac{w_k}{w_{k+2}} = \varphi_{k/(k+1)} \times \varphi_{(k+1)/(k+2)}$$

The final results of mathematical modeling to determine the evaluation criteria weight coefficient for informant 1 are as follows.

$$\begin{aligned} & \min \chi \\ & \text{s. t.} \\ & \left| \frac{w_5}{w_2} - 1,10000 \right| \leq \chi, \left| \frac{w_2}{w_7} - 1,18182 \right| \leq \chi, \left| \frac{w_7}{w_1} - 1,15385 \right| \leq \chi, \left| \frac{w_1}{w_6} - 1,13333 \right| \leq \chi, \left| \frac{w_6}{w_3} - 1,11765 \right| \leq \chi, \left| \frac{w_3}{w_8} - 1,10526 \right| \leq \chi, \left| \frac{w_8}{w_4} - 1,14286 \right| \leq \chi, \\ & \left| \frac{w_5}{w_7} - 1,30000 \right| \leq \chi, \left| \frac{w_2}{w_1} - 1,36364 \right| \leq \chi, \left| \frac{w_7}{w_6} - 1,30769 \right| \leq \chi, \left| \frac{w_1}{w_3} - 1,26667 \right| \leq \chi, \left| \frac{w_6}{w_8} - 1,23529 \right| \leq \chi, \left| \frac{w_3}{w_4} - 1,26316 \right| \leq \chi, \\ & \sum_{j=1}^8 w_j = 1 \\ & w_j \geq 0, \forall j \end{aligned}$$

Then the mathematical modeling obtained is solved using the help of the LINGO application program to perform the minimization function. The notation and results of the minimization function to find the weight coefficient of the FUCOM evaluation criteria using LINGO can be seen in Figure 4.

To find the weighted average of all decision makers, the geometric mean (GeoMean) calculation is carried out based on the weighting of the criteria for all decision maker, are presented in table 3. The weighting to be used is the normalization result of GeoMean from all decision maker, are presented in table 4. Based on the weighting of the criteria from all Decision maker, it was determined that the price factor (C5) which reached 17% was a factor that became the main focus of airline selection followed by comfort (C1) which reached 16%, and the cleanliness factor (C6) and customer service (C4) became the next biggest factor which reached around 12%.

```

1 MIN=epsilon;
2 @ABS (w5/w2-1.20000)=epsilon;
3 @ABS (w2/w7-1.08333)=epsilon;
4 @ABS (w7/w1-1.07692)=epsilon;
5 @ABS (w1/w6-1.14286)=epsilon;
6 @ABS (w6/w4-1.06250)=epsilon;
7 @ABS (w4/w3-1.11765)=epsilon;
8 @ABS (w3/w8-1.05263)=epsilon;
9
10 @ABS (w5/w7-1.30000)=epsilon;
11 @ABS (w2/w1-1.16667)=epsilon;
12 @ABS (w7/w6-1.23077)=epsilon;
13 @ABS (w1/w4-1.21429)=epsilon;
14 @ABS (w6/w3-1.18750)=epsilon;
15 @ABS (w4/w8-1.17647)=epsilon;
16
17 w1+w2+w3+w4+w5+w6+w7+w8=1;
18 w1>=0;w2>=0;w3>=0;w4>=0;w5>=0;w6>=0;w7>=0;w8>=0;

```

Variable	Value	Reduced Cost
EPSILON	0.3245436E-05	0.000000
W5	0.1799723	0.000000
W2	0.1499773	0.000000
W7	0.1384406	0.000000
W1	0.1285520	0.000000
W6	0.1124826	0.000000
W4	0.1058662	0.000000
W3	0.9472246E-01	0.000000
W8	0.8998659E-01	0.000000

Figure 4. Notation and Minimization Function Results to Find the Weight Coefficient of FUCOM Evaluation Criteria Using LINGO

Table 3. The Weight Coefficient of Evaluation Criteria for the Three Decision Makers

Weighted Criteria	DM1	DM2	DM3
W1	0,12855	0,17096	0,17997
W2	0,14998	0,09898	0,10587
W3	0,09472	0,12537	0,11248
W4	0,10587	0,11754	0,13844
W5	0,17997	0,18806	0,14998
W6	0,11248	0,13433	0,12855
W7	0,13844	0,08955	0,09472
W8	0,08999	0,07522	0,08999
SUM	1	1	1

Table 4. The Weight Coefficient of Evaluation Criteria for the Three Decision Makers in Geometric Mean

Weighted Criteria	GeoMean	GeoMean (Normalized)
W1	0,15815	0,15953
W2	0,11626	0,11728
W3	0,11013	0,1111
W4	0,11988	0,12093
W5	0,17186	0,17337
W6	0,12477	0,12586
W7	0,1055	0,10643
W8	0,08477	0,08551
SUM	0,99132	1

After getting the weighted criteria using FUCOM, then you can calculate the preference value using MARCOS. In general, in calculating the preference value starting from the alternative value normalization, the weighted alternative normalization calculation, calculating the preference value and ranking. The alternatives used are Batik Air (A1), Citilink (A2), Garuda Indonesia (A3), Indonesia AirAsia (A4), Lion Air (A5), and

NAM Air (A6). Airlines alternative data used in this calculation is shown in Table 5.

Table 5. Airlines Alternative Data

Alternative	C1	C2	C3	C4	C5	C6	C7	C8
A1	80	35	35	35	624.645	35	35	30
A2	70	25	35	40	512.152	40	40	30
A3	80	40	40	40	851.212	45	40	40
A4	65	20	30	35	421.969	40	40	30
A5	60	20	25	30	449.352	30	30	20
A6	60	15	25	35	430.914	35	40	35

Based on predetermined alternative data, the following calculation shows an example of calculating the normalized value for the Batik Air alternative using MARCOS. For the next alternative, use the same formula to produce the alternative normalized values shown in Table 6. Criteria with benefit condition using this formula.

$$n_{ij} = \frac{x_{ij}}{x_{ai}}$$

Criteria with cost condition using this formula

$$n_{ij} = \frac{x_{ij}}{x_{aai}}$$

$$n_{15} = \frac{624.645}{\min(624.645;512.152;851.212;421.969;449.352;430.914)} = \frac{624.645}{421.969} = 0,6755$$

Table 6. Airlines Normalized Alternative Data

Alternative	A1	A2	A3	A4	A5	A6
C1	1,0000	0,8750	1,0000	0,8125	0,7500	0,7500
C2	0,8750	0,6250	1,0000	0,5000	0,5000	0,3750
C3	0,8750	0,8750	1,0000	0,7500	0,6250	0,6250
C4	0,8750	1,0000	1,0000	0,8750	0,7500	0,8750
C5	0,6755	0,8239	0,4957	1,0000	0,9391	0,9792
C6	0,7778	0,8889	1,0000	0,8889	0,6667	0,7778
C7	0,8750	1,0000	1,0000	1,0000	0,7500	1,0000
C8	0,7500	0,7500	1,0000	0,7500	0,5000	0,8750

After obtaining the alternative normalization value, the calculation of the preference value in MARCOS is continued with the calculation of the optimization value. The following calculation shows the preference value calculated using FUCOM-MARCOS on the Batik Air alternative. For the next alternative, use the same formula to generate preference values for determining favorite airlines using FUCOM-MARCOS. The airline weighted normalized alternative data as shown in Table 7. S_{ai} is the largest value in the list of alternatives in a criterion, and S_{aai} is the smallest value in the list of alternatives in a criterion. S_{ai} and S_{aai} will be used to calculate the value of the alternative utility rate. S_{ai} and S_{aai} value as shown in Table 8.

$$V_{ij} = n_{ij} \times w_j$$

Table 7. Airlines Weighted Normalized Alternative Data

Alter-native	A1	A2	A3	A4	A5	A6
C1	0,1595	0,1396	0,1595	0,1296	0,1196	0,1196
C2	0,1026	0,0733	0,1173	0,0586	0,0586	0,044
C3	0,0972	0,0972	0,1111	0,0833	0,0694	0,0694
C4	0,1058	0,1209	0,1209	0,1058	0,0907	0,1058
C5	0,1171	0,1428	0,0859	0,1734	0,1628	0,1698
C6	0,0979	0,1119	0,1259	0,1119	0,0839	0,0979
C7	0,0931	0,1064	0,1064	0,1064	0,0798	0,1064
C8	0,0641	0,0641	0,0855	0,0641	0,0428	0,0748
Si	0,8374	0,8563	0,9126	0,8332	0,7077	0,7878

Table 8. Airline S_{ai} and S_{aai} value

Alternative	Sai	Saai
C1	0,1595	0,1196
C2	0,1173	0,044
C3	0,1111	0,0694
C4	0,1209	0,0907
C5	0,1734	0,0859
C6	0,1259	0,0839
C7	0,1064	0,0798
C8	0,0855	0,0428
Si	1	0,6162

$$K_i^- = \frac{S_i}{S_{aai}}$$

$$K_1^- = \frac{S_1}{S_{aa1}} = \frac{0,8374}{0,6162} = 1,3591$$

$$K_i^+ = \frac{S_i}{S_{ai}}$$

$$K_1^+ = \frac{S_1}{S_{a1}} = \frac{0,8374}{1,0000} = 0,8734$$

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-}$$

$$f(K_1^-) = \frac{1,3591}{0,8734 + 1,3591} = \frac{1,3591}{2,1965} = 0,618$$

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-}$$

$$f(K_1^+) = \frac{0,8734}{0,8734 + 1,3591} = \frac{0,8734}{2,1965} = 0,3813$$

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + \frac{1-f(K_i^+)}{f(K_i^+)} + \frac{1-f(K_i^-)}{f(K_i^-)}}$$

$$f(K_1) = \frac{0,8734 + 1,3591}{1 + \frac{1-0,3813}{0,3813} + \frac{1-0,6187}{0,6187}} = 0,6781$$

The ranking for determining favorite airlines using FUCOM-MARCOS as shown in Table 9 and graph of preference value for determining favorite airline using FUCOM-MARCOS as shown in Figure 5.

Table 9. Favorite Airline Determination Preference Value

Criteria	Preference Value	Ranking
Garuda Indonesia	0,7390	Ranked 1 st

Table 10. Weighted Scenario Between Criteria for Normalized Consistency Analysis

Criteria	Preference Value	Ranking
(A3) Citilink	0,6934	Ranked 2 nd
(A2) Batik Air	0,6781	Ranked 3 rd
(A1) Indonesia AirAsia	0,6747	Ranked 4 th
(A4) NAM Air	0,6379	Ranked 5 th
(A6) Lion Air	0,5731	Ranked 6 th
(A5)		

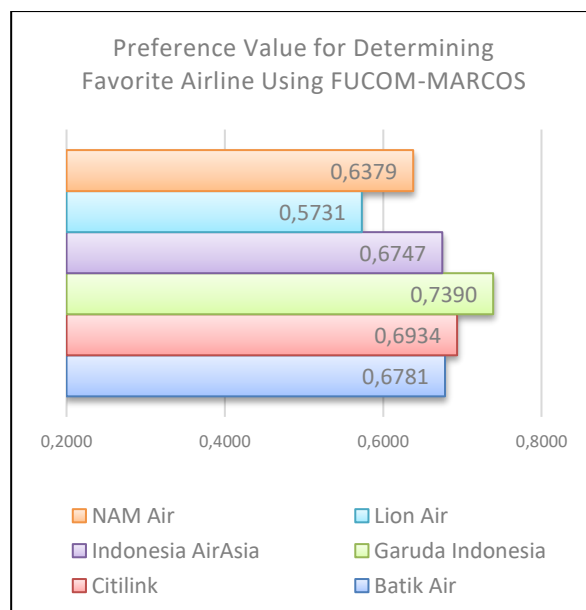


Figure 5. Graph of Preference Value for Determining Favorite Airline using FUCOM-MARCOS

From the ranking graph for the preference value for determining favorite airlines using FUCOM-MARCOS in Figure 5, the results of calculations using FUCOM-MARCOS show that Garuda Indonesia is the most favorite airline in Indonesia, followed by Citilink, Batik Air, Indonesia AirAsia, NAM Air and Lion Air to become the last position based on the data tested. Testing of the ranking on FUCOM-MARCOS is carried out using consistency analysis, with the aim of finding how consistent an alternative ranking is to changes in the weighted criteria conditions. There are 17 scenarios offered to calculate the consistency analysis, which are shown in Table 10.

Based on this scenario, the preference value is recalculated, the rating for FUCOM-MARCOS and the average ranking of all scenarios is sought. The results of the ranking distribution to calculate the consistency analysis and the average ranking distribution are shown in Table 11.



Weighted Criteria	W1	W2	W3	W4	W5	W6	W7	W8
Basic Scenario	0,15953	0,11728	0,11110	0,12093	0,17337	0,12586	0,10643	0,08551
Scenario $w_1 + 0,5$	0,43969	0,07819	0,07406	0,08062	0,11558	0,08391	0,07095	0,05701
Scenario $w_2 + 0,5$	0,10635	0,41152	0,07406	0,08062	0,11558	0,08391	0,07095	0,05701
Scenario $w_3 + 0,5$	0,10635	0,07819	0,40740	0,08062	0,11558	0,08391	0,07095	0,05701
Scenario $w_4 + 0,5$	0,10635	0,07819	0,07406	0,41395	0,11558	0,08391	0,07095	0,05701
Scenario $w_5 + 0,5$	0,10635	0,07819	0,07406	0,08062	0,44891	0,08391	0,07095	0,05701
Scenario $w_6 + 0,5$	0,10635	0,07819	0,07406	0,08062	0,11558	0,41724	0,07095	0,05701
Scenario $w_7 + 0,5$	0,10635	0,07819	0,07406	0,08062	0,11558	0,08391	0,40428	0,05701
Scenario $w_8 + 0,5$	0,10635	0,07819	0,07406	0,08062	0,11558	0,08391	0,07095	0,39034
Scenario $w_1 + 1$	0,57977	0,05864	0,05555	0,06046	0,08668	0,06293	0,05321	0,04276
Scenario $w_2 + 1$	0,07977	0,55864	0,05555	0,06046	0,08668	0,06293	0,05321	0,04276
Scenario $w_3 + 1$	0,07977	0,05864	0,55555	0,06046	0,08668	0,06293	0,05321	0,04276
Scenario $w_4 + 1$	0,07977	0,05864	0,05555	0,56046	0,08668	0,06293	0,05321	0,04276
Scenario $w_5 + 1$	0,07977	0,05864	0,05555	0,06046	0,58668	0,06293	0,05321	0,04276
Scenario $w_6 + 1$	0,07977	0,05864	0,05555	0,06046	0,08668	0,56293	0,05321	0,04276
Scenario $w_7 + 1$	0,07977	0,05864	0,05555	0,06046	0,08668	0,06293	0,55321	0,04276
Scenario $w_8 + 1$	0,07977	0,05864	0,05555	0,06046	0,08668	0,06293	0,05321	0,54276

Table 11. Rank Distribution Consistency Analysis Calculation

Alternative	Number of Ranking						GeoMean of Rank Distribution
	1 st	2 rd	3 rd	4 th	5 th	6 th	
Batik Air	-	4 times	5 times	4 times	4 times	-	3,29068
Citilink	-	10 times	7 times	-	-	-	2,36341
Garuda Indonesia	15 times	-	-	-	-	2 times	1,23466
Indonesia AirAsia	2 times	-	4 times	9 times	2 times	-	3,26012
Lion Air	-	-	-	2 times	1 times	14 times	5,65948
NAM Air	-	3 times	1 times	2 times	10 times	1 times	4,06398

Based on the consistency analysis, it shows that from 17 different scenarios of the weighting criteria modification, it shows that Garuda Indonesia remains the customer favorite for selecting airlines in Indonesia. Of the 17 tests conducted by Garuda Indonesia, it reached 15 times the first rank and 2 times the sixth rank. This is due to the 2 times the test focuses on the price factor. The price set by Garuda Indonesia is indeed the most expensive among its competitors, but other factors such as comfort, cleanliness, customer service and others have a better value compared to competitors. This research shows that the selected sample of Decision maker shows that price is the main choice in selecting their favorite airline. Garuda Indonesia is the favorite airline based on the choice of sources as the sampling.

CONCLUSION

This research has successfully implemented FUCOM-MARCOS in determining the favorite airlines in Indonesia based on decision makers who were sampled, using 8 criteria and 6 tested alternatives. In calculating the weighting of the criteria using FUCOM, it shows that the price factor (C5) is the factor most taken into account by the Decision maker, followed by the factor of convenience (C1), cleanliness (C6) and customer service (C4). Calculations using FUCOM-MARCOS show that Garuda Indonesia is the favorite airline in Indonesia with a preference value of 0.7390, followed by Citilink as the second favorite airline,

Batik Air in third place, and respectively Indonesia AirAsia, NAM Air and Lion. Water is in the last rank of tested alternatives. When the consistency analysis was carried out, Garuda Indonesia remained stable as the first choice by occupying the top 15 out of 17 tests with an average ranking distribution of 1.23466.

REFERENCE

- [1] T. Santia, "Rentetan Kejadian Pesawat Maskapai Nasional di Awal 2021, Masalah Mesin hingga Pecah Ban," *Liputan 6*, Mar. 12, 2021. <https://www.liputan6.com/bisnis/read/4504854/rentetan-kejadian-pesawat-maskapai-nasional-di-awal-2021-masalah-mesin-hingga-pecah-ban>.
- [2] W. S. Widodo, "Airbus Umumkan Rugi Rp 18,8 Triliun Negara Pandemi Corona," *Detik.com*, Feb. 23, 2021. <https://travel.detik.com/travel-news/d-5401132/airbus-umumkan-rugi-rp-188-triliun-negara-pandemi-corona>.
- [3] J. Dalle, "Pandemi Corona dan Drama 'Terra Incognita,'" *Detik.com*, Nov. 16, 2020. <https://news.detik.com/kolom/d-5256888/pandemi-corona-dan-drama-terra-incognita>.
- [4] D. Kuswaraharja, "Cara Dapatkan Rapid Test Antigen Gratis di 5 Maskapai," *Detik.com*, Mar. 08, 2021. <https://travel.detik.com/travel-news/d-5485219/cara-dapatkan-rapid-test-antigen-gratis-di-5-maskapai>.

- [5] N. Indriyani, E. Ali, U. Rio, and R. Rahmaddeni, "Menentukan Kualitas Pelayanan Maskapai Penerbangan Domestik Dengan Menggunakan Metode Naïve Bayes;," *SATIN*, vol. 6, no. 1, pp. 37-44, Jun. 2020, doi: 10.33372/stn.v6i1.605.
- [6] S. Seimahuira, "Implementasi Datamining dalam Menentukan Destinasi Unggulan Berdasarkan Online Reviews TripAdvisor Menggunakan Algoritma K-Means," *Jurnal Technologia*, vol. 12, no. 1, pp. 53-58, 2021.
- [7] N. K. A. P. Sari, "Implementation of the AHP-SAW Method in the Decision Support System for Selecting the Best Tourism Village," *Jurnal Teknik Informatika C.I.T Medicom*, vol. 13, no. 1, pp. 22-31, Mar. 2021.
- [8] G. S. Mahendra and E. Hartono, "Implementation of AHP-MAUT and AHP-Profile Matching Methods in OJT Student Placement DSS," vol. 13, no. 1, p. 9, 2021.
- [9] G. S. Mahendra and I. P. Y. Indrawan, "Metode AHP-TOPSIS Pada Sistem Pendukung Keputusan Penentuan Penempatan Atm," *JST (Jurnal Sains dan Teknologi)*, vol. 9, no. 2, pp. 130-142, 2020, doi: 10.23887/jst-undiksha.v9i2.24592.
- [10] I. Badi and A. Abdulshahed, "Ranking the Libyan airlines by using Full Consistency Method (FUCOM) and Analytical Hierarchy Process (AHP)," *Operational Research in Engineering Sciences: Theory and Applications*, vol. 2, no. 1, pp. 1-14, 2019, doi: 10.31181/oresta1901001b.
- [11] B. Matić *et al.*, "A New Hybrid MCDM Model : Sustainable Supplier Selection in a Construction Company," *Symmetry*, vol. 11, no. March, pp. 1-24, 2019, doi: 10.3390/sym11030353.
- [12] M. Adnan, R. Adin, Z. Nunić, Ž. Stević, and S. Sremac, "Selection of transportation mean using integrated FUCOM-ARAS model," *st and*, p. 6, 2019.
- [13] D. S. Pamucar, D. Božanic, and A. Randelovic, "Multi-criteria decision making: An example of sensitivity analysis," *Serbian Journal of Management*, vol. 12, no. 1, pp. 1-27, 2017, doi: 10.5937/sjm12-9464.
- [14] Ž. Stević, B. Mičić, D. Lukić, M. Tomašević, and S. Sremac, "Supplier Selection for Distribution of Finished Products: Combined FUCOM-MABAC Model," 2019, no. December, pp. 35-40.
- [15] I. Badi and D. Pamucar, "Supplier selection for steelmaking company by using combined Grey-Marcos methods," *Decision Making: Applications in Management and Engineering*, vol. 3, no. 2, pp. 37-48, 2020, doi: 10.31181/dmame2003037b.
- [16] M. Stanković, Ž. Stević, D. K. Das, M. Subotić, and D. Pamučar, "A New Fuzzy MARCOS Method for Road Traffic Risk Analysis," *Mathematics*, vol. 8, no. 3, p. 457, Mar. 2020, doi: 10.3390/math8030457.
- [17] A. Puška, I. Stojanović, A. Maksimović, and N. Osmanović, "Project Management Software Evaluation by Using the Measurement of Alternatives and Ranking According to Compromise Solution (MARCOS) Method," *Operational Research in Engineering Sciences: Theory and Applications*, vol. 3, no. 1, pp. 89-101, 2020, doi: 10.31181/oresta2001089p.
- [18] J. Mitrović Simić, Ž. Stević, E. K. Zavadskas, V. Bogdanović, M. Subotić, and A. Mardani, "A Novel CRITIC-Fuzzy FUCOM-DEA-Fuzzy MARCOS Model for Safety Evaluation of Road Sections Based on Geometric Parameters of Road," *Symmetry*, vol. 12, no. 12, p. 2006, Dec. 2020, doi: 10.3390/sym12122006.
- [19] Ž. Stević and N. Brković, "A Novel Integrated FUCOM-MARCOS Model for Evaluation of Human Resources in a Transport Company," *Symmetry*, vol. 4, no. 1, pp. 4-4, 2020, doi: 10.3390/logistics4010004.
- [20] R. Chattopadhyay, S. Chakraborty, Industrial Engineering and Management Department, Maulana Abul Kalam Azad University of Technology, West Bengal, India, and S. Chakraborty, "An integrated D-MARCOS method for supplier selection in an iron and steel industry," *Decis. Mak. Appl. Manag. Eng.*, vol. 3, no. 2, pp. 49-69, Oct. 2020, doi: 10.31181/dmame2003049c.
- [21] I. Đalić, Ž. Stević, Ž. Erceg, P. Macura, and S. Terzić, "Selection of a distribution channel using the integrated FUCOM-MARCOS model," *International Review*, vol. 4, no. 3, pp. 80-96, 2020, doi: 10.5937/intrev2003080Q.
- [22] R. Wirth and J. Hipp, "CRISP-DM : Towards a Standard Process Model for Data Mining," *Semantic Scholar*, vol. 1, no. 24959, pp. 1-11, 2000.
- [23] E. Exenberger and J. Bucko, "Analysis of Online Consumer Behavior - Design of CRISP-DM Process Model," *AOL*, vol. 12, no. 3, pp. 13-22, Sep. 2020, doi: 10.7160/aol.2020.120302.
- [24] C. Schröer, F. Kruse, and J. M. Gómez, "A Systematic Literature Review on Applying CRISP-DM Process Model," *Procedia Computer Science*, vol. 181, pp. 526-534, 2021, doi: 10.1016/j.procs.2021.01.199.
- [25] M. A. Rivai, "Analysis of Corona Virus spread uses the CRISP-DM as a Framework : Predictive Modelling," *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 9, no. 3, pp. 2987-2994,

- 2020, doi:
10.30534/ijatcse/2020/76932020.
- [26] G. S. Mahendra and P. G. S. C. Nugraha, "Komparasi Metode AHP-SAW dan AHP-WP pada SPK Penentuan E-Commerce Terbaik di Indonesia Comparison of AHP-SAW and AHP-WP Methods on DSS to Determine the Best E-Commerce in Indonesia," *Jurnal Sistem dan Teknologi Informasi (JUSTIN)*, vol. 08, no. 4, pp. 346-356, 2020, doi: 10.26418/justin.v8i4.42611.
- [27] B. Setiani, "Tanggung Jawab Maskapai Penerbangan Sebagai Penyedia Jasa Penerbangan Kepada Penumpang Akibat Keterlambatan Penerbangan," *JHN*, vol. 7, no. 3, Feb. 2016, doi: 10.26555/novelty.v7i3.a3930.
- [28] I. Setiawan, D. Nusraningrum, and Y. Pahala, "Deregulasi Penerbangan dan Kinerja Perusahaan Penerbangan Niaga Berjadwal di Indonesia," *Jurnal Manajemen Transportasi dan Logistik*, vol. 2, no. 1, p. 1, Jul. 2017, doi: 10.25292/j.mtl.v2i1.130.

Identify Cholesterol Disease Risk Levels Using Multiple Linear Regression Algorithms

Deny Haryadi^{1*}; Dewi Marini Umi Atmaja²

Teknologi Informasi^{1*}
Institut Teknologi Telkom Jakarta
<https://ittelkom-jkt.ac.id/>
denyharyadi@ittelkom-jkt.ac.id

Bisnis Digital²
Universitas Medika Suherman
<https://medikasuherman.ac.id/>
dewi@medikasuherman.ac.id

Abstract—Cholesterol is one of the fat compounds found in the bloodstream that are necessary for the formation of several hormones and new cell walls in the liver. Normal cholesterol levels in the human body are in the range of < 200 mg / dL. If cholesterol levels in the blood are abnormal or excessive, it can result in dangerous diseases such as heart disease or stroke. In this study, cholesterol disease prediction will be carried out using models formed from linear regression methods, so that the results of this study can be used as a reference for early prevention of cholesterol disease and become a means of decision making. Linear regression is one of the prediction methods in data mining that can be used to find out how dependent variables/criteria can be predicted through independent variables or predictor variables individually. In this study by utilizing some data of patients with cholesterol disease that has been stored in the database using several attributes, namely age, BMI, glucose, and cholesterol. So by applying a linear regression algorithm can be done a prediction in the identification of cholesterol diseases based on functional relationships on the attributes in the data. The results of this study showed an RMSE value of 0.347 with a standard deviation of ± 0.000 . This shows that the model resulting from linear regression algorithms with the above cases is quite accurate.

Keywords: cholesterol disease, prediction, data mining, linear regression algorithms, RMSE.

Intisari—Kolesterol adalah salah satu senyawa lemak yang ditemukan dalam aliran darah yang diperlukan untuk pembentukan beberapa hormon dan dinding sel baru di hati. Kadar kolesterol normal dalam tubuh manusia berada pada kisaran < 200 mg/dL. Jika kadar kolesterol dalam darah tidak normal atau berlebihan, dapat mengakibatkan penyakit berbahaya seperti penyakit jantung atau stroke. Pada penelitian ini akan dilakukan prediksi penyakit kolesterol dengan menggunakan model yang dibentuk dari metode regresi linier, sehingga hasil penelitian ini dapat dijadikan acuan untuk pencegahan dini penyakit kolesterol dan menjadi sarana pengambilan keputusan. Regresi linier merupakan salah satu metode prediksi dalam data mining yang dapat digunakan untuk mengetahui bagaimana variabel/kriteria dependen dapat diprediksi melalui variabel independen atau variabel prediktor secara individual. Dalam penelitian ini dengan memanfaatkan beberapa data penderita penyakit kolesterol yang telah disimpan dalam database dengan menggunakan beberapa atribut yaitu umur, indeks berat badan, glukosa, dan kolesterol. Sehingga dengan menerapkan algoritma regresi linier dapat dilakukan suatu prediksi dalam identifikasi penyakit kolesterol berdasarkan hubungan fungsional pada atribut-atribut pada data. Hasil penelitian ini menunjukkan nilai RMSE sebesar 0,347 dengan standar deviasi $\pm 0,000$. Hal ini menunjukkan bahwa model yang dihasilkan dari algoritma regresi linier dengan kasus di atas cukup akurat.

Kata Kunci: Penyakit Kolesterol, Prediksi, Data Mining, Algoritma Regresi Linier, RMSE.

INTRODUCTION

Cholesterol is one of the fatty compounds found in the bloodstream that is necessary for the formation of several hormones and new cell walls in the liver [1]. Cholesterol in the blood is carried by

lipoproteins, which are defined by three classes namely Low-Density Lipoprotein (LDL), High-Density Lipoprotein (HDL), and Triglycerides (TGA). LDL serves to carry cholesterol throughout the body through arterial blood vessels, if the levels are too high then LDL will accumulate in the walls of arteries

(bad cholesterol)[2]. HDL serves to restore excess cholesterol to the liver to be removed from the body (good cholesterol) [3][4]. TGA is formed when the body changes the remaining unused calories in the body, if the body continues to get excessive calorie intake compared to its use, then triglyceride levels will rise which causes stroke or heart disease [5].

Normal cholesterol levels in the human body are in the range of < 200 mg / dL [6]. If cholesterol levels in the blood are abnormal or excessive, it can result in dangerous diseases such as heart disease or stroke[7]. Factors that cause high cholesterol levels are weight, heredity, smoking, lack of exercise, and unhealthy food. Common symptoms that occur in cholesterol disease are easily tired, drowsiness, leg pain, the nape of the head feeling sore, chest pain, yellowish wounds in a few parts of the body, impotence, and yellow patches under the eyelids [8][9].

Cholesterol disease in a person can be identified or predicted by collecting data such as age, BMI, and glucose. The data can be processed using data mining techniques so that new information or knowledge is obtained [6]. Prediction is the process of systematically estimating what is most likely to happen in the future based on past and present information owned so that the error (the difference between something that happened and the approximate result) can be reduced [10].

Linear regression is one of the algorithms in data mining that can be used to find out how dependent variables/criteria can be predicted through independent variables or predictor variables individually [11][12]. In this study, cholesterol disease prediction will be carried out using models formed from linear regression methods, so that the results of this study can be used as a reference for early prevention of cholesterol disease and become a means of decision making.

MATERIALS AND METHODS

A. Research Stages

To facilitate research and run systematically, a flow or stage is made in the research, as in figure 1.

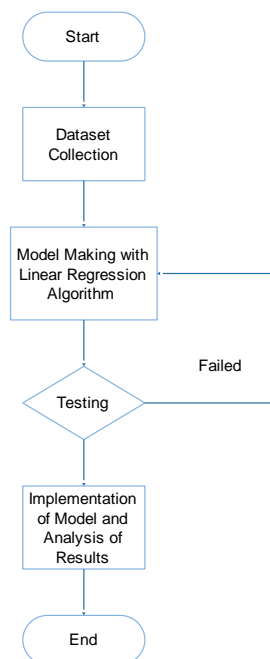


Figure 1. Research Stages

B. Data Collection

The data used in the study was taken from the Kaggle.com website. Then several stages of data processing will be explained as follows [13]:

- a) The process of data cleaning is part of the process of cleaning, deleting data or selection of missing value data, data that is not used in a dataset, in checking the inconsistencies of a data and correcting errors in the data [14][15]. The process of cleaning data is done manually with the help of spreadsheet software or Microsoft excel.

Table 1. Data Cleaning

Age	Attributes / Variables					
	Prevalent Stroke	Prevalent Hyp	Dia bets	BMI	Glucose	Cholesterol
39	0	0	0	26.97	77	0
46	0	0	0	28.73	76	0
48	0	0	0	25.34	70	0
61	0	1	0	28.58	103	1
46	0	0	0	23.1	85	0
43	0	1	0	30.3	99	0
63	0	0	0	33.11	85	1
45	0	0	0	21.68	78	0
52	0	1	0	26.36	79	0
43	0	1	0	23.61	88	0



- b) The data selection process is part of data selection before entering the next stage[16]. The selection of attributes used is based on factors that influence cholesterol disease such as age, BMI, and cholesterol. Data that passes the selection will be analyzed and then determined the attributes to be used and grouped so that a dataset can be divided into training data and testing data [17][18].
- c) Data Transformation is the process of converting the initial data format into a standard data format [19] which can be viewed in Table.

Table 2. Data Transformation

Age	Attributes / Variables		
	BMI	Glucose	Cholesterol
39	26.97	77	0
46	28.73	76	0
48	25.34	70	0
61	28.58	103	1
46	23.1	85	0
43	30.3	99	0
63	33.11	85	1
45	21.68	78	0
52	26.36	79	0
43	23.61	88	0

After data processing is completed, the next stage is data modeling [20][21]. In this study, the algorithm used was linear regression. The general form of a simple linear regression equation is written in the following formula:

$$b = \frac{n \sum_{i=1}^n x_i y_i - \left(\sum_{i=1}^n x_i \right) \left(\sum_{i=1}^n y_i \right)}{n \sum_{i=1}^n x_i^2 - \left(\sum_{i=1}^n x_i \right)^2} \quad (1)$$

$$a = \bar{y} - b\bar{x} \quad (2)$$

$$a = \frac{\sum_{i=1}^n y_i}{n} - b \frac{\sum_{i=1}^n x_i}{n} \quad (3)$$

With

n: number of data pairs

Yi: the i-th non-freebie value Y

Xi: the i-th free changer value X

Calculating linear regression equations:

$$Y = a + b X \quad (4)$$

With

Y: non-free changer

X: free changer

a: constant

b: slope

RESULTS AND DISCUSSION

A. Model Making With Linear Regression Algorithm

The study used the Linear Regression algorithm, to identify cholesterol diseases and will obtain Root Mean Square Error (RMSE) results as well as predictions that can be used in decision-making when patients are identified with cholesterol disease. The source of the data as an object in this study is historical data taken from the Kaggle.com site. The data used in this study consisted of attributes or variables such as age, BMI, glucose, and cholesterol.

B. Split Validation

Validation techniques divide data into two parts at random, some as training data and others as data testing. By using Split Validation will be conducted training experiments based on a predetermined split ratio, then the rest of the split ratio data training will be considered as data testing.

Table 3. Cholesterol Dataset

Age	Attributes / Variables		
	BMI	Glucose	Cholesterol
39	26.97	77	0
46	28.73	76	0
48	25.34	70	0
61	28.58	103	1
46	23.1	85	0
43	30.3	99	0
63	33.11	85	1
45	21.68	78	0
52	26.36	79	0
43	23.61	88	0
50	22.91	76	0
43	27.64	61	0
46	26.31	64	0
41	31.31	84	0
38	21.35	70	1
48	22.37	72	0
46	23.38	89	1
38	23.24	78	0
41	26.88	65	0
42	21.59	85	0
52	34.17	113	0

Age	Attributes / Variables		
	BMI	Glucose	Cholesterol
52	25.11	75	0
44	21.96	83	0
47	24.18	66	1
35	26.09	83	0
61	32.8	65	1
60	30.36	74	0
36	28.15	63	0
43	27.57	75	0
59	20.77	88	1
61	18.59	75	1
54	24.71	87	0
37	38.53	83	0
56	28.09	75	0
52	40.11	225	0
42	28.93	90	0
36	27.78	80	0
43	26.87	78	0
41	23.28	74	0
54	26.21	100	0
53	21.51	215	1
49	20.68	98	0
65	30.47	87	0
46	23.59	74	0
63	22.15	75	1
36	24.33	62	0
63	27.1	79	1
51	23.47	95	0
47	19.66	75	0
62	28.27	75	0
46	20.35	94	0
54	17.61	55	0
49	25.65	80	0
44	22.29	82	0
40	25.45	87	1
56	23.58	93	0
67	24.25	74	0
53	19.64	73	0
57	24.88	72	0
57	26.84	64	1
63	28.6	45	0
62	29.64	202	0
38	23.01	78	0
47	20.13	83	0

Age	Attributes / Variables		
	BMI	Glucose	Cholesterol
52	23.51	87	0
42	28.61	95	0
37	33.29	87	0
41	33.8	75	0
44	22.16	83	1
59	34.55	103	1
44	24.04	68	0
44	21.16	89	0
45	45.8	63	0
41	30.58	65	0
60	26.52	83	0
39	32.51	70	1
53	22.49	87	0
52	26.03	82	0
61	29.35	83	0
36	22.73	65	0
62	23.89	77	0
61	38.46	78	0
41	28.56	70	0
41	25.42	76	0
53	18.23	75	0
39	24.8	97	0
51	27.38	77	0
66	28.55	104	0
60	28.57	65	1
65	29.33	96	0
63	26.64	126	0
56	23.72	120	0
56	22.36	66	0
47	27.98	75	0
60	29.66	105	0
45	20.68	71	0
48	24.23	64	0
42	23.25	99	0
63	26.76	56	0
42	26.93	79	0

C. Linear Regression Calculation

Table 4. Cholesterol Disease Prediction

Age	Attributes / Variables		
	BMI	Glucose	Cholesterol
49	29.62	60	?
67	25.75	87	?



48 23.62 68 ?

$$\Psi = \alpha + \beta_1 \Xi_1 + \beta_2 \Xi_2 + \beta_3 \Xi_3 \quad (26)$$

$$y = -0.334 + (0,009 \times 49) + (-0,001 \times 29,62) + (0,001 \times 60)$$

$$= -0,334 + (0,441) + (-0,03) + (0,06)$$

$$= 0,137 \quad (27)$$

$$y = -0.334 + (0,009 \times 67) + (-0,001 \times 25,75) + (0,001 \times 87)$$

$$= -0,334 + (0,603) + (-0,026) + (0,087)$$

$$= 0,33 \quad (28)$$

$$y = -0.334 + (0,009 \times 48) + (-0,001 \times 23,62) + (0,001 \times 68)$$

$$= -0,334 + (0,432) + (-0,024) + (0,068)$$

$$= 0,142 \quad (29)$$

D. Implementation of Model

- a) After the data collection process is completed, the next stage carried out is to make data modeling on the rapid miner. The model used in rapid miners uses linear regression algorithms. The first step is to enter cholesterol data into the rapidminer to be processed.
- b) In this study, in figure 2. the dataset was divided into 2 parts, namely 90% of training data and 10% data testing using split validation. Split Validation is a validation technique that divides data into two parts randomly, partly as data training and some as data testing.

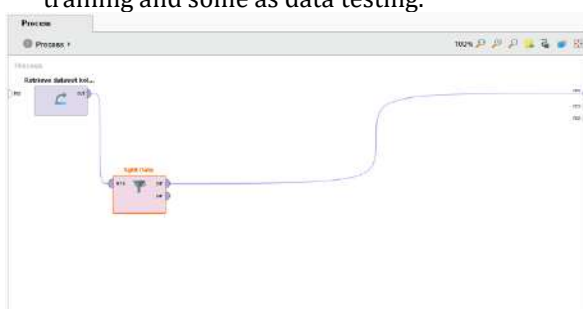


Figure 2. The process of sharing data with split validation

- c) The next process in figure 3. is to set split validation parameters by dividing training data and testing data in the rapidminer.

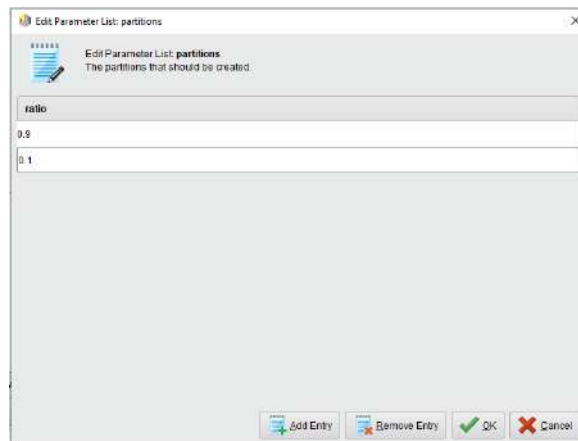


Figure 3. The process of sharing training data and data testing

- d) The next process in figure 4. is to enter a linear regression algorithm to see the prediction results in the rapidminer.

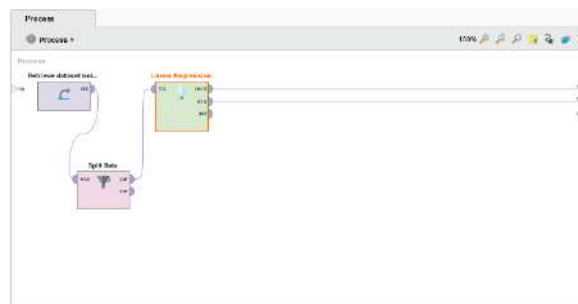


Figure 4. The process of inserting linear regression algorithms in rapid miners

- e) After that, in figure 5. select attributes are carried out to find out the prediction results of the rapidminer, the results of manual calculations and test results in the rapidminer.

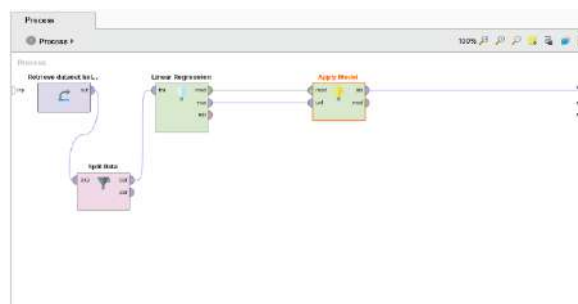


Figure 5. Model evaluation process in rapid miner

- f) In figure 6. this process aims to enter training data and testing data that will be tested to produce predictions on class attributes.



Row No.	Cholesterol	prediction(C...	Age	BMI	Glucose
1	0	0.060	39	26.970	77
2	0	0.128	46	28.730	76
3	0	0.116	48	25.340	70
4	1	0.301	61	28.580	103
5	0	0.112	46	23.100	85
6	0	0.149	43	30.300	90
7	1	0.314	63	33.110	85
8	0	0.084	45	21.680	78
9	0	0.172	52	26.300	79
10	0	0.094	43	23.610	88
11	0	0.130	50	22.910	76
12	0	0.071	43	27.640	81
13	0	0.095	46	26.310	84
14	0	0.112	41	31.310	84
15	1	0.008	38	21.350	70

Figure 6. Predicted results

- g) In figure 7. when the prediction has been sought, the next step is to measure how accurate the prediction results have been made.

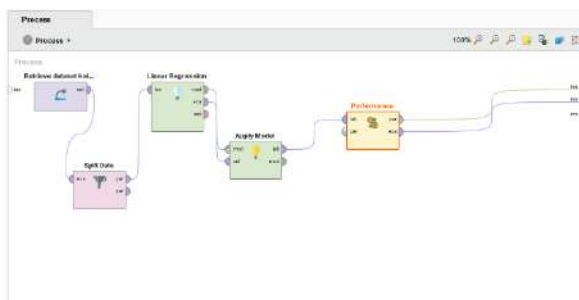


Figure 7. Root mean squared error search process

- h) In figure 8. to facilitate the reading of cholesterol data, it is necessary to input performance tools to find Root Mean Squared Error. Here are the results:

root_mean_squared_error

root_mean_squared_error: 0.347 +/- 0.000

Figure 8. Root test results mean squared error

- i) The second step is the implementation of linear regression algorithms using rapidminer tools. Here are the stages in the application of linear regression algorithms:
Determine the prediction of test data carried out by the rapidminer and produce a confidence value that has been predicted.
Specifies performance with output to find Root Mean Squared Error
- j) In the split validation model there are two parts, namely the training section (used for classification algorithms) and the testing section (using the Apply Model feature to apply the model to the testing data and the Performance feature to display root mean squared error).

In 100 records of the training data dataset, after calculating the values for X_1Y , X_2Y , X_3Y , $X_1X_2X_3$, X_1^2 , X_2^2 and X_3^2 , the overall results of each are 4963 for the total value of the X_1 variable, the total value of the X_2 variable is 2624.7, the total value of the X_3 variable is 8414, the total value of the Y variable is 17, the total value of X_1Y is 914, the total value of X_2Y is 443.6, the total value of X_3Y is 1482, the total value of $X_1X_2X_3$ is 11203795, the total value of X_1^2 is 254035, the total value of X_2^2 is 71174.93, and the total value of X_3^2 is 778358. The total value above is used to convert the formula to find the value of coefficient a , coefficient b_1 , coefficient b_2 and coefficient b_3 so that the value of a is -0.334, the value of b_1 is 0.009, the value of b_2 is -0.001, and the value of b_3 is 0.001. These three coefficient values will be used in the application of the multiple linear regression algorithm equation. From the coefficient values above, by using a simple mathematical model, we can determine the equation of the Linear Regression algorithm with the model $Y = -0.334 + (0.009.X_1) + (-0.001.X_2) + (0.001.X_3)$, where the X_1 variable is Age, variable X_2 is BMI, and variable X_3 is Glucose.

The multiple linear regression equation will then be implemented in predicting the testing data. In general, the application of the Linear Regression equation is applied to predict 3 dataset records as testing data that has been determined. From the calculations carried out manually and compared to the process in the Rapid Miner application, the results shown do not have a significant difference, in other words, both manual calculations and those processed in the application show similar results. Below is a comparison table between the results of manual calculations and those in the Rapid Miner application on the Y variable.

Table 5. Comparison of manual and rapid miner

Age	BMI	Glucose	Cholesterol (Y) Manual	Cholesterol (Y) Rapid miner
49	29.62	60	0	0
67	25.75	87	0	0
48	23.62	68	0	0

E. Analysis of Results

Meanwhile, the comparison of the actual Y variable value from the testing (observation) data with the predicted Y variable value in the Rapid Miner application can be seen through the following graph.

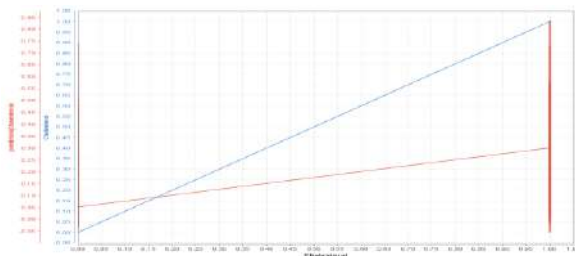


Figure 9. Graph of comparison of the value (Y) of observations with (Y) predictions

In general, in figure 9. it can be seen through the graphic image, the actual value of the Y variable (observation) is marked with a blue line, while the predicted value of the Y variable is marked with a red line. This graph will later be evaluated using the RMSE method to see how big the error value is. Furthermore, the evaluation of this model is to find the root mean squared error or RMSE, through the RapidMiner application, the RMSE value is 0.347 with a standard deviation of +/- 0.000.

CONCLUSION

Based on the results of the tests that have been carried out in this study, a conclusion can be drawn, namely: In this study by utilizing some data of patients with cholesterol disease that has been stored in the database using several attributes, namely age, BMI, glucose, and cholesterol. So by applying a linear regression algorithm can be done a prediction in the identification of cholesterol diseases based on functional relationships on the attributes in the data. The process of classifying cholesterol disease data using linear regression algorithms starts from the data selection stage (attributes used and determination of training data and data testing), the algorithm testing stage (linear regression), and the RMSE test stage (using split validation) so that it can provide information in the identification and prevention of cholesterol diseases. The process of processing cholesterol disease data using linear regression algorithms starts from modeling (manual calculation of linear regression algorithms), the process of testing data on rapidminers, and comparing the value of the results of manual calculations with the results of the data testing process on the rapidminer. Based on the results of the tests that have been carried out that the variables or attributes used in this study (age, BMI, glucose, and cholesterol) have a significant effect on this study, it is proven that using a linear regression algorithm is able to give good results with a Root Mean Squared Error value: $0.347 + /- 0.000$. This is due to a correlation or functional relationship (cause and effect) between

one variable (dependent or criteria) and other variables (independent or predictor). This testing process is carried out to identify cholesterol disease with a linear regression algorithm.

REFERENCE

- [1] F. J. P. Putri, "Pengukuran Kadar Kolesterol Pada Jaringan Kulit Tiruan (Phantom) Menggunakan Teknik Diffuse Reflectance Spectroscopy," p. 120, 2017, [Online]. Available: <http://repository.its.ac.id/47486/>.
- [2] B. Sofiandi, J. Raharjo, and K. Usman, "Identifikasi Pola Citra Iris Mata Untuk Mendeteksi Kelebihan Kadar Kolesterol Menggunakan Metode Gray Level Co-occurrence Matrix (glcm) Dan Decision Tree," *eProceedings ...*, vol. 6, no. 3, pp. 10242–10249, 2019.
- [3] A. Saputra, W. Broto, and L. B. R., "Deteksi Kadar Kolesterol Melalui Iris Mata Menggunakan Image Processing Dengan Metode Jaringan Syaraf Tiruan Dan Gray Level Co-Occurrence Matrix (Glcm)," vol. VI, pp. SNF2017-CIP-65-SNF2017-CIP-74, 2017, doi: 10.21009/03.snf2017.02.cip.09.
- [4] M. A. SIDDIK, L. NOVAMIZANTI, and I. N. A. RAMATRYANA, "Deteksi Level Kolesterol melalui Citra Mata Berbasis HOG dan ANN," *ELKOMIKA J. Tek. Energi Elektr. Tek. Telekomun. Tek. Elektron.*, vol. 7, no. 2, p. 284, 2019, doi: 10.26760/elkomika.v7i2.284.
- [5] M. A. C., "Oleh : DESTRI ARIANTI," 2010.
- [6] H. A. D. Rani, E. Supriyati, and T. Khotimah, "DETEKSI IRIS MATA UNTUK MENENTUKAN KELEBIHAN KOLESTEROL MENGGUNAKAN EKSTRAKSI CIRI MOMENT INVARIANT DENGAN K-MEANS CLUSTERING Handini," *Pros. SNATIF*, pp. 287–292, 2014.
- [7] M. Busthomi, N. Nafi'iyah, and N. Q. Nawafilah, "Sistem Pakar Diagnosa Penyakit Kolesterol Pada Remaja Dengan Metode Certainty Factor," *J. Process.*, vol. 15, no. 1, p. 23, 2020, doi: 10.33998/processor.2020.15.1.670.
- [8] L. Mahanani, "Perbandingan 3 Metode dalam Data Mining untuk Penentuan Kadar Kolesterol di RSUD dr.Moewardi Surakarta," 2016, [Online]. Available: <http://eprints.ums.ac.id/43275/>.
- [9] S. Puspitorini, "Uji Korelasi Dan Analisis Clustering Gula Darah Puasa, Kolesterol Total, Trigliserida, Serta Asam Urat," *FORTECH (Journal Inf. Technol.*, vol. 1, no. 1,

- pp. 49–54, 2017.
- [10] M. K. Harahap and N. Khairina, “Jaringan Syaraf Tiruan Perceptron untuk Pengenalan Pola Makanan Sehat Rendah Kolesterol,” pp. 209–214, 2018, doi: 10.31227/osf.io/acmj8.
- [11] D. Haryadi, D. Marini, U. Atmaja, A. R. Hakim, and N. Suwaryo, “IDENTIFIKASI TINGKAT RESIKO PENYAKIT STROKE MENGGUNAKAN ALGORITMA REGRESI LINEAR BERGANDA,” vol. 1, no. November, pp. 1198–1207, 2021.
- [12] R. A. Permata, D. Triyanto, and Ilhamsyah, “Aplikasi Penyusun Menu Makanan Untuk Pencegahan Hiperkolesterolemia Menggunakan Algoritma Genetika,” *J. Coding Sist. Komput. Untan*, vol. 04, no. 2, pp. 96–106, 2016.
- [13] D. Haryadi, “Penerapan Algoritma K-Means Clustering Pada Produksi Perkebunan Kelapa Sawit Menurut Provinsi,” *J. ICT (Informatics ...)*, vol. 1089, pp. 1–15, 2021, [Online]. Available: http://ejournal.akademitelkom.ac.id/j_ict/index.php/j_ict/article/download/71/57.
- [14] D. Marini, U. Atmaja, W. Witanti, and A. I. Hadiana, “Pembangunan Sistem Informasi Biaya Proyek pada PT . Skyline Semesta Menggunakan Metode Earned Value Management (EVM),” *J. Univ. Jendral Achmad Yani*, vol. 2, no. 2, pp. 3–8, 2018.
- [15] D. Haryadi and R. Mandala, “Prediksi Harga Minyak Kelapa Sawit Dalam Investasi Dengan Membandingkan Algoritma Naïve Bayes, Support Vector Machine dan K-Nearest Neighbor,” *IT Soc.*, vol. 4, no. 1, 2019, doi: 10.33021/itfs.v4i1.1181.
- [16] N. Suwaryo, D. Haryadi, D. Marini, U. Atmaja, and A. R. Hakim, “Analisa Data Mining Menggunakan Algoritma Apriori Untuk Mencari Pola Pemakaian Obat,” vol. 1, no. November, pp. 1208–1217, 2021.
- [17] D. M. U. Atmaja, “Penerapan Algoritma K-Nearest Neighbor Untuk,” vol. 1, no. November, pp. 199–208, 2019.
- [18] D. M. U. Atmaja, “Penerapan Algoritma K-Means Clustering Untuk Pengelompokan Penyebaran Covid-19 di Provinsi Jawa Barat,” vol. 1, no. November, pp. 1218–1226, Aug. 2021.
- [19] D. M. U. Atmaja and R. Mandala, “Analisa Judul Skripsi untuk Menentukan Peminatan Mahasiswa Menggunakan Vector Space Model dan Metode K-Nearest Neighbor,” *IT Soc.*, vol. 4, no. 2, pp. 1–6, 2020, doi: 10.33021/itfs.v4i2.1182.
- [20] D. Haryadi, “Implementation of K-Medoids Clustering Algorithm for Grouping Palm Oil Exports by Destination Country,” pp. 129–134, 2021.
- [21] D. Haryadi and D. M. U. Atmaja, “Penerapan Algoritma K-Means Clustering Untuk Pengelompokan Tingkat Risiko Penyakit Jantung,” *J. Informatics Commun. Technol.*, vol. 3, no. 2, pp. 51–66, 2021, doi: 10.52661/j_ict.v3i2.85.

IMPROVING THE PERFORMANCE OF SUPPORT VECTOR MACHINE WITH FORWARD SELECTION FOR PREDICTION OF CHRONIC KIDNEY DISEASE

Esty Purwaningsih

Sistem Informasi
Universitas Bina Sarana Informatika
www.bsi.ac.id
esty.epw@bsi.ac.id

Abstract—Chronic kidney disease is a disorder that affects the kidneys and arises due to various factors, usually occurs slowly and is chronic. For prevention and control, proper treatment is needed, so that detection of this disease can play a very important role. This study aims to determine the level of accuracy in predicting chronic kidney disease through SVM based on forward selection and to determine the performance of Feature Selection which is applied to the SVM method in solving problems in chronic kidney disease. The test uses 10 k-fold cross validation by dividing the training and testing data from each experiment. In this study, experiments were carried out on the SVM method using various kernels and it was seen that SVM with the dot kernel was 98.50% with AUC 1,000 which was superior to the polynominal kernel and RBF. However, when the experiment was carried out again by applying FS to SVM, it was found that SVM+FS with the RBF kernel outperformed the other kernels by 99.75% with AUC 1,000. So it can be concluded that the Forward Selection on SVM has succeeded in improving its performance, especially in this case, namely the prediction of chronic kidney disease.

Keywords: chronic kidney, forward selection, SVM, features

Intisari—Penyakit ginjal kronis merupakan kelainan yang mengenai organ ginjal dan timbul akibat berbagai faktor, biasanya timbul secara perlahan dan sifatnyamenahun. Untuk pencegahan dan penanggulangannya, diperlukan penanganan yang tepat, sehingga deteksi pada penyakit ini dapat berperan sangat penting. Penelitian ini bertujuan untuk mengetahui tingkat akurasi pada prediksi penyakit ginjal kronis melalui SVM berbasis forward selection serta mengetahui kinerja Feature Selection yang diterapkan kedalam metode SVM dalam memecahkan masalah pada penyakit ginjal kronis. Pengujian menggunakan 10 k-fold cross validation dengan membagi data training maupun testing dari setiap eksperimen. Pada penelitian ini dilakukan percobaan pada metode SVM dengan menggunakan berbagai macam kernel dan terlihat SVM dengan kernel dot yaitu 98,50% dengan AUC 1,000 lebih unggul dari pada kernel polynominal dan RBF. Namun ketika dilakukan percobaan kembali dengan menerapkan FS pada SVM, didapat bahwa SVM+FS dengan kernel RBF mengungguli dari kernel lainnya yaitu sebesar 99,75% dengan AUC 1,000. Sehingga dapat disimpulkan bahwa Forward Selection pada SVM berhasil meningkatkan kinerjanya khususnya pada kasus ini yaitu prediksi penyakit ginjal kronis.

Kata Kunci : ginjal kronis, forward_selection, SVM, fitur.

INTRODUCTION

A vital organ in the body that looks like a legume is located behind the stomach or abdomen, functions as an excretory organ, it is located on the right side and the left side of the spine is a vital organ of the kidney [1].

Kidney function will decrease if it is caused by tissue damage to the kidneys, medically described a significant level of decline in 3 (three) months and even more is called chronic kidney failure [2].

Problems that occur in terms of public health by looking at the prevalence coupled with the increasing incidence of kidney failure and with a poor prognosis with a very large level of expenditure in the world are included in chronic kidney disease or also called CKD, namely Chronic Kidney Diseases. From the results of the analysis, the increasing number of elderly people plus the presence of diseases such as diabetes and hypertension also triggers an increase in the prevalence of kidney failure [3] [4].

From the results of the World Health Organization (WHO) report, diseases that are included in the top 10 (ten) diseases in the world that cause death, especially in high-income countries are chronic kidney disease [5].

Riskesdas Results [6], also shows an increase in prevalence rates with increasing age and prevalence in men, which is shown in Figure 1 as follows:

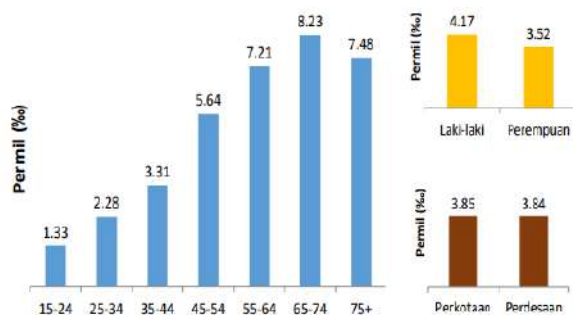


Figure 1. Prevalence (Permil) of 'Chronic Kidney' Disease Based on Doctor's Diagnosis 'At Age 15 Years According to Characteristics

To be able to prevent and overcome this chronic kidney disease, proper treatment is needed, because the number of deaths is expected to continue to increase over time. So the detection of this disease can play a very important role.

There are several studies conducted using machine learning techniques that aim to solve cases of chronic kidney disease, including using the Artificial Neural Network and Support Vector Machine (SVM) methods [7], where in this study aims to assist in the prevention of Chronic Kidney Disease (CKD) by utilizing machine learning techniques for early diagnosis. The classification techniques used in this research include Artificial Neural Network (ANN) and Support Vector Machine (SVM) methods. The empirical results of the experiment show that ANN performs better than SVM, with an accuracy of 99.75% and 97.75% respectively.

Furthermore, in the K-Nearest Neighbor (KNN), SVM and Soft Independent Modeling of Class Analogy (SIMCA) methods [8], The authors labeled patients as CKD or non-CKD with greater than 93% accuracy. SVM processes noise disturbance from composite datasets better and has the highest accuracy in predicting CKD compared to the other two models because the accuracy reaches 99%.

Naive Bayes method, LDA, KNN, Decision tree, Forest Random [9], it was found that K-Nearest Neighbor (KNN) with random subspace classifier has a prediction accuracy of 94%. It is recommended to use kernel or neural based

classifier instead of KNN with random subspace classifier.

On the C4.5 Algorithm [10], The accuracy of the algorithm was found to be 98.25%. Artificial Neural Network (ANN) Method, Naive Bayes and Decision Tree [11], This system was implemented using data from Prince Hamzah Hospital in Jordan. The performance of machine learning techniques is analyzed by calculating sensitivity, specificity, and accuracy. Decision Tree, is the most accurate technique in predicting chronic renal failure (CRF). It is recommended to apply more machine learning techniques, including Support Vector Machine (SVM), to predict CRF.

SVM, Decision tree, Naive Bayes and KNN [12], Different machine learning techniques were applied to the data set, and their accuracy was calculated using the root mean square error and the mean absolute error and by plotting the receiver operating characteristic curve. The Decision Tree algorithm was found to be the most accurate with an accuracy of 99.75%, while the second accurate SVM with an accuracy of 97.75%. So it is recommended to implement ANN and fuzzy logic to the dataset and analyze the accuracy.

KNN, SVM and Naive Bayes [13], The accuracy rate of 97.8% is the highest level, with the proposed method, namely the urine test attribute. Accuracy increases in the age group of 35 years and over using the same attributes. Different combinations of dataset attributes result in different accuracy rates ranging from 83.75% to 97.8%.

SVM [14], The study compares the results of implementing SVM on all features and implementing SVM on Feature Selection Methods. Features are selected using wrapping and filter techniques.

PSO based C4.5 algorithm with bagging technique [5], This study was conducted to find out which model gives the best results in detecting chronic kidney disease. The method used in this case study is able to select attributes so that it can increase the accuracy value better with a result of 99.70% compared to the C4.5 algorithm model which produces an accuracy of 91.72%.

So many researchers have conducted research on chronic kidney disease, but in this study applied a Support Vector Machine (SVM) classification model based on forward selection. Where the SVM model has the advantage of a high level of accuracy and can overcome classification problems in both linear and nonlinear regression. However, according to Ilhan and Tezel in [15] of the advantages of SVM, it also has drawbacks where it is difficult to choose features for optimal input.

So that forward selection plays a role in selecting features that can improve machine learning performance, especially in predicting chronic

kidney disease. From the advantages of each model and its algorithm, this study aims to determine the level of accuracy in predicting chronic kidney disease through SVM based on forward selection and to determine whether the performance of forward selection is more effectively applied in the SVM method to solve problems in chronic kidney disease.

MATERIALS AND METHODS

Data mining has an interest in society and the world, especially in the field of information systems, because a number of big data can create useful information according to needs and desires. [16].

According to Witten [17] that in data mining there are several applications that focus on forecasting which predicts an event in the future in a new situation in which there is new data that comes from the history of data that has happened before.

The focus of this study is to build a predictive model for chronic kidney disease by comparing the performance of the SVM method with the forward selection algorithm. The purpose of this study is to develop an algorithm training model that is used to predict chronic kidney disease, to compare the performance value of accuracy between the SVM method and forward selection, analyze the effect of kernel parameter values on model performance, and feature subsets from the results of the forward selection feature selection.

The training process of the SVM method is first carried out with normalization [18]. Normalization used in the form of minimum and maximum values of normalization. minimum and maximum (Min-max) normalization is done by changing the original data into linear data with a value range of +1 (plus 1) and -1 (minus 1).

The data is processed by being entered into the SVM training system. Several SVM kernel functions are used including radial (RBF), dot (linear), and polynomial with parameter C between values of 0.0-100. The best test uses the method of calculating accuracy through a process step called 10 k-fold cross validation by dividing the training and testing data from each experiment.

This research was conducted in several stages, as shown in the following figure:

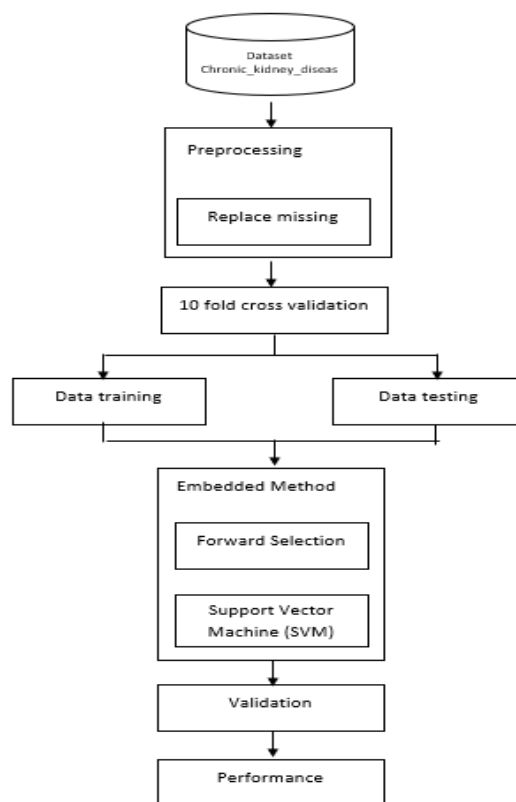


Figure 2. Research model schema

The dataset used in this study is chronic_kidney_disease data which was downloaded from the UCI machine learning repository on the page <https://archive.ics.uci.edu/ml/machine-learning-databases/00336/>.

In the chronic_kidney_disease (CDK) dataset or in other words chronic kidney disease, there are 25 attributes, including 24 free attributes and 1 label. The 24 free attributes consist of Age, Blood Pressure (mmHg), Specific Gravity, Albumin, Sugar, Red Blood Cells, Pus Cell, Pus Cell Clumps, Bacteria, Blood Glucose Random (mgs/d), Blood Urea (mgs/d. dl), Serum Creatinine (mgs/dl), Sodium (mEq/L), Potassium (mEq/L), Hemoglobin (gms), Packed Cell Volume, White Blood Cell Count (cells/cumm), Red Blood Cell Count (millions / cmm), Hypertension, Diabetes Mellitus, Coronary Artery Disease, Appetite, Pedal Edema and Anemia. While the attribute label consists of 1 = CDK and 2 = No CDK.

The number of records in the chronic_kidney_disease dataset is 400 records. Can be seen in Table 1.

Table 1. Sample Dataset (before preprocessing)

age	bp	sg	al	su	rbc	pc	pcc								
48	80	1.020	1	0	?	1	2								
7	50	1.020	4	0	?	1	2								
62	80	1.010	2	3	1	1	2								
48	70	1.005	4	0	1	2	1								
51	80	1.010	2	0	1	1	2								
60	90	1.015	3	0	?	?	2								
68	70	1.010	0	0	?	1	2								
24	?	1.015	2	4	1	2	2								
52	100	1.015	3	0	1	2	1								
53	90	1.020	2	0	2	2	1								
50	60	1.010	2	4	?	2	1								
63	70	1.010	3	0	2	2	1								

ba	bgr	bu	sc	sod	pot	hemo	pcv								
2	121	36	1.2	?	?	15.4	44								
2	?	18	0.8	?	?	11.3	38								
2	423	53	1.8	?	?	9.6	31								
2	117	56	3.8	111	2.5	11.2	32								
2	106	26	1.4	?	?	11.6	35								
2	74	25	1.1	142	3.2	12.2	39								
2	100	54	24.0	104	4.0	12.4	36								
2	410	31	1.1	?	?	12.4	44								
2	138	60	1.9	?	?	10.8	33								
2	70	107	7.2	114	3.7	9.5	29								
2	490	55	4.0	?	?	9.4	28								
2	380	60	2.7	131	4.2	10.8	32								

wbcc	rbcc	htn	dm	cad	appet	pe	ane	class								
7800	5.2	1	1	2	1	2	2	1								
6000	?	2	2	2	1	2	2	1								
7500	?	2	1	2	2	2	1	1								
6700	3.9	1	2	2	2	1	1	1								
7300	4.6	2	2	2	1	2	2	1								
7800	4.4	1	1	2	1	1	2	1								
?	?	2	2	2	1	2	2	1								
6900	5	2	1	2	1	1	2	1								
9600	4.0	1	1	2	1	2	1	1								
12100	3.7	1	1	2	2	2	1	1								
?	?	1	1	2	1	2	1	1								
4500	3.8	1	1	2	2	1	2	1								

To make the data valid and of good quality, initial data processing or also called **preprocessing** is

carried out, namely identifying data and cleaning up problematic data by replacing missing. As for changing records on attributes rbc (normal to 1, abnormal to 2), pc (normal to 1, abnormal to 2), pcc (present to 1, notpresent to 2), htn (yes to 1, no to 2), dm (yes becomes 1, no becomes 2), cad (yes becomes 1, no becomes 2), appet (good becomes 1, poor becomes 2), pe (yes becomes 1, no becomes 2) and ane (yes becomes 1, no be 2).

Table 2. Sample Dataset (after preprocessing)

age	bp	sg	al	su	rbc	pc	pcc	ba								
48	80	1020	1	0	1	1	2	2								
7	50	1020	4	0	1	1	2	2								
62	80	1010	2	3	1	1	2	2								
48	70	1005	4	0	1	2	1	2								
51	80	1010	2	0	1	1	2	2								
60	90	1015	3	0	1	1	2	2								
68	70	1010	0	0	1	1	2	2								
24	76	1015	2	4	1	2	2	2								
52	100	1015	3	0	1	2	1	2								
53	90	1020	2	0	2	2	1	2								

bgr	bu	sc	sod	pot	hemo	pcv	wbcc	rbcc								
121	36	1	138	5	15	44	7800	5								
148	18	1	138	5	11	38	6000	5								
423	53	2	138	5	10	31	7500	5								
117	56	4	111	3	11	32	6700	4								
106	26	1	138	5	12	35	7300	5								
74	25	1	142	3	12	39	7800	4								
100	54	24	104	4	12	36	8406	5								
410	31	1	138	5	12	44	6900	5								
138	60	2	138	5	11	33	9600	4								
70	107	7	114	4	10	29	12100	4								

htn	dm	cad	appet	pe	ane	class								
1	1	2	1	2	2	ckd								
2	2	2	1	2	2	ckd								
2	1	2	2	2	1	ckd								
1	2	2	2	1	1	ckd								
2	2	2	1	2	2	ckd								
1	1	2	1	1	2	ckd								
2	2	2	1	2	2	ckd								
2	1	2	1	1	2	ckd								
1	1	2	1	2	1	ckd								
1	1	2	2	2	1	ckd								

After preprocessing, the dataset is divided into training data and testing data using **10-fold cross validation**, after which the data will be



selected through the **embedded feature selection method**, according to Zhu & Song[15] the feature search process is embedded into the classification algorithm, and the learning process with the feature selection process cannot be separated which in this study is applied to SVM.

Support Vector Machine is included in the prediction algorithm. Where in applying the SVM algorithm it is necessary to find the distance from a dataset. While in reality many cannot be separated in a linear way [19]. It is called a non-linear dataset, where dataset conditions cannot be separated by fields that separate data between classes from one another. So that this problem can be solved through Feature Space. Where is a method of converting the input space (dot product) which can only separate linear data into high dimensional form (feature space). Feature space or also known as kernel trick then changed to K Kernel (x_i, x_j) [19]. Kernel functions that can be used include radial (RBF), polynomial, and dot (linear). The following is the formulation of the three kernels:

Table 3. Kernel SVM Testing

Kernel Name	Kernel $K(x, y), i=1, 2, \dots, N$
Dot (Linear)	$K(x, y) = x^T y + c$
Polynomial	$K(x, y) = (\alpha x^T y + c)^d$
Radial (RBF)	$K(x, y) = \exp(-g \ x - y\ ^2)$

Attribute selection which is commonly referred to as Feature Selection used in data mining is a process to find a subset of feature selection results from a dataset [19] yang bertujuan untuk menghilangkan atribut yang tidak relevan. which aims to eliminate irrelevant attributes. There are 3 feature selections [19], including:

1. Based Feature Selection
Use a statistical method to assess each attribute. Attributes that will be ranked will be made a matrix first in order to identify the relevant or irrelevant attributes that will be removed from the dataset.
2. Embedded Feature Selection
Run feature selection during the training process from parameters to get optimal values. In this type of feature selection, it adopts the principle of regularization methods which have a limiting penalty factor.
3. Wrapper Feature Selection
Perform a search process from a combination of attribute groups by comparing one attribute with other attributes.
The attribute search process using forward selection is the first time with an empty model, then the variables are inputted until the attribute model combination is met properly. Below is the pseudo code of the forward selection:

1. Create an empty set: $Y_k = \{\emptyset\}, k = 0 \dots \dots \dots (1)$

2. Choose the best features:
 $X_+ = \arg \max_{x \in Y_k} [J(Y_k + X_+)] \dots \dots \dots (2)$
3. If $J((Y_k + x_+) > J(Y_k)) \dots \dots \dots (3)$
 - a. Update $Y_{k+1} = Y_k + x_+$
 - b. $k = k + 1$
 - c. Back to step -2

Next, **validation** is carried out using the confusion matrix which can be seen in table 4 so that the accuracy value can be obtained, as follows:

Table 4. Confusion Matrix

Real Condition	Prediction Result	
	+	-
+	True Positives	False Negatives
-	False Positives	True Negatives

True positive, the prediction engine can predict a positive value as a positive value, meaning that a true positive represents the correct value, which is in accordance with actual conditions. Same goes for true negatives.

False negative, the machine predicts a positive value as a negative value. This means that the negative value generated by the prediction engine is wrong or can be called a false negative value, because the actual value should be positive.

Accuracy formula is obtained by the following equation:

$$\text{Accuracy} = \frac{(TN+TP)}{(TN+FN+TP+FP)} \times 100\% \dots \dots \dots (4)$$

The value of the confusion matrix will be 'used to calculate' predictive **performance** [20]. The performance measurement consists of True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN) variables.

RESULTS AND DISCUSSION

The dataset used is chronic_kidney_disease data obtained from the UCI machine learning repository on the page <https://archive.ics.uci.edu/ml/machine-learning-databases/00336/>. This research uses the Support Vector Machine (SVM) method based on forward selection. The results of this study aim to determine the level of accuracy of the method applied in this study, as well as to determine whether the forward selection performance is more effectively applied in the SVM method to solve problems in chronic kidney disease.

After the dataset is preprocessed, then the data is processed by applying 10-fold cross validation by dividing the data into 90% training data and 10%



testing data. After that, the first experiment was carried out by entering training data into the Support Vector Machine (SVM) method by comparing the dot, polynomial, and RBF kernels. Percobaan kedua, dengan menerapkan teknis seleksi fitur *embedded method* yaitu forward selection pada SVM dengan kernel *dot*, *polynomial*, dan RBF.

From two experiments, namely SVM (dot, polynomial, RBF) and SVM + FS (dot, polynomial, RBF), the accuracy values can be obtained as shown in table 5 below:

Table 5. Support Vector Machine (SVM) Accuracy Value

Algorithm	TP	TN	F P	F N	Accurac y	AUC
SVM (Dot)	24 4	15 0	0	6	98,50%	1,00 0
SVM (Polynomial)	23 9	15 0	0	11	97,25%	0,98 6
SVM (RBF)	25 0	11 9	3 1	0	92,25%	0,99 9

Table 5 shows that SVM with dot kernel has higher accuracy than SVM with polynomial kernel and RBF which is 98,505 with AUC 1,000. While in Table IV is a table display of the comparison of the accuracy values of the SVM method based on Forward Selection (FS) with the dot, polynomial and RBF kernels. It can be seen that SVM+FS with the RBF kernel outperforms the accuracy and AUC values of other kernels, with an accuracy value of 99.75% and an AUC of 1,000.

Table 6. SVM Accuracy Value With Forward Selection

Algorithm	TP	TN	FP	FN	Accuracy	AUC
SVM + FS (Dot)	248	150	0	2	99,50%	0,998
SVM + FS (Polynomial)	232	150	0	18	95,50%	0,964
SVM + FS (RBF)	250	149	1	0	99,75%	1,000

The accuracy results obtained by comparing the accuracy value and the AUC value in the SVM method with the accuracy value and the AUC value in the SVM + FS method, it has increased. It can be seen from the graphs 3 and 4 as below.

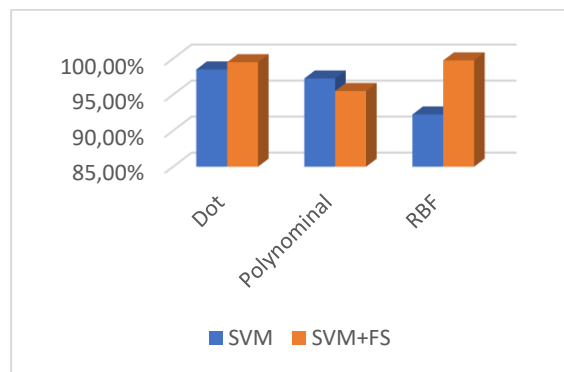


Figure 3. Comparison of Accuracy Values in the SVM Method with the SVM+FS Method

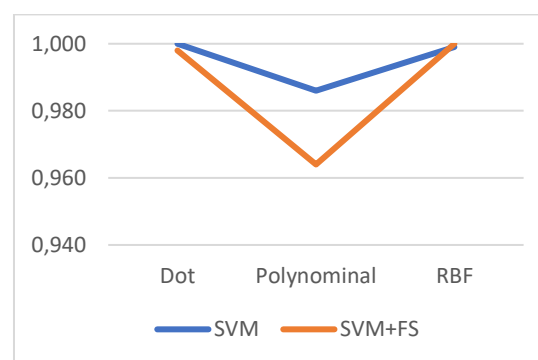


Figure 4. Comparison of AUC Value in the SVM Method with the SVM+FS method

CONCLUSION

Support Vector Machine (SVM) has the advantage of a high level of accuracy, but SVM also has the disadvantage that it is difficult to select features for optimal input, but Forward Selection can overcome the problems of SVM with feature selection to improve machine learning performance. So this study aims to determine the accuracy of the prediction of chronic kidney disease in the SVM method based on Forward Selection (FS) and to determine the performance of the FS which is applied to the SVM method in solving problems in chronic kidney disease.

From the results of the research, experiments were carried out on the SVM method using various kernels and it was seen that SVM with the dot kernel was 98.50% with AUC 1,000 which was superior to the polynomial kernel and RBF. However, when the experiment was carried out again by applying FS to SVM, it was found that SVM+FS with the RBF kernel outperformed the other kernels by 99.75% with AUC 1,000. So it can be concluded that the Forward Selection on SVM has succeeded in improving its performance, especially in this case, namely the prediction of chronic kidney disease. For

further research, it is recommended to compare the accuracy results by entering parameter values in SVM because one of the shortcomings of SVM is that it is weak in determining the optimal parameter values.

REFERENCE

- [1] Aulia, "Fungsi dan Faktor Risiko Ginjal," *P2PTM Kementerian Kesehatan*, 2017. [Online]. Available: <http://p2ptm.kemkes.go.id/kegiatan-p2ptm/subdit-penyakit-jantung-dan-pembuluh-darah/fungsi-dan-faktor-risiko-ginjal>. [Accessed: 04-Mar-2022].
- [2] E. Febria Sari, "Waspada Ginjal Kronis," *Hermina Galaxy*, 2021. [Online]. Available: <https://herminahospitals.com/id/articles/waspada-gagal-ginjal-kronis.html>. [Accessed: 04-Mar-2022].
- [3] "Chronic Kidney Disease," *worldkidneyday.org*, 2022. [Online]. Available: <https://www.worldkidneyday.org/facts/chronic-kidney-disease/>. [Accessed: 04-Mar-2022].
- [4] Pusdatin, "Situasi Penyakit Ginjal Kronis," *pusdatin kemkes*, Indonesia, pp. 1–4, 2017.
- [5] I. Yulianti, R. Amegia Saputra, M. Sukrisno Mardiyanto, and A. Rahmawati, "Optimasi Akurasi Algoritma C4.5 Berbasis Particle Swarm Optimization dengan Teknik Bagging pada Prediksi Penyakit Ginjal Kronis Optimization of C4.5 Algorithm Based On Particle Swarm Optimization with Bagging Technique on Prediction of Chronic Kidney Dise," *Techno.COM*, vol. 19, no. 4, pp. 411–421, 2020.
- [6] Kemenkes RI, "Hasil Riset Kesehatan Dasar Tahun 2018," 2018.
- [7] N. A. Almansour *et al.*, "Neural network and support vector machine for the prediction of chronic kidney disease: A comparative study," *Comput. Biol. Med.*, vol. 109, no. October 2018, pp. 101–111, 2019.
- [8] Z. Chen, X. Zhang, and Z. Zhang, "Clinical risk assessment of patients with chronic kidney disease by using clinical data and multivariate models," *Int. Urol. Nephrol.*, vol. 48, no. 12, pp. 2069–2075, 2016.
- [9] A. Y. Al-Hyari, A. M. Al-Tae, and M. A. Al-Tae, "Clinical decision support system for diagnosis and management of Chronic Renal Failure," *2013 IEEE Jordan Conf. Appl. Electr. Eng. Comput. Technol. AEECT 2013*, 2013.
- [10] A. A. Serpen, "Diagnosis Rule Extraction from Patient Data for Chronic Kidney Disease Using Machine Learning," *Int. J. Biomed. Clin. Eng.*, vol. 5, no. 2, pp. 64–72, 2016.
- [11] R. Ani, G. Sasi, U. R. Sankar, and O. S. Deepa, "Decision support system for diagnosis and prediction of chronic renal failure using random subspace classification," *2016 Int. Conf. Adv. Comput. Commun. Informatics, ICACCI 2016*, pp. 1287–1292, 2016.
- [12] N. Tazin, S. Lecturer, S. A. Sabab, and M. T. Chowdhury, "Effective Classification and Feature Selection," *2016 Int. Conf. Med. Eng. Heal. Informatics Technol.*, pp. 1–6, 2016.
- [13] S. B. Akben, "Early Stage Chronic Kidney Disease Diagnosis by Applying Data Mining Methods to Urinalysis, Blood Analysis and Disease History," *Irbm*, vol. 39, no. 5, pp. 353–358, 2018.
- [14] H. Polat, H. Danaei Mehr, and A. Cetin, "Diagnosis of Chronic Kidney Disease Based on Support Vector Machine by Feature Selection Methods," *J. Med. Syst.*, vol. 41, no. 4, 2017.
- [15] H.- Harafani, "Forward Selection pada Support Vector Machine untuk Memprediksi Kanker Payudara," *J. Infortech*, vol. 1, no. 2, pp. 131–139, 2020.
- [16] E. Purwaningsih, "Application of the Support Vector Machine and Neural Network Model Based on Particle Swarm Optimization for Breast Cancer Prediction," *Sinkron*, vol. 4, no. 1, p. 66, 2019.
- [17] E. Purwaningsih, "Penerapan Particle Swarm Optimization pada Metode Neural Network untuk Perawatan Penyakit Kutil melalui Immunotherapy," *J. Sist. dan Teknol. Inf.*, vol. 8, no. 2, p. 207, 2020.
- [18] W. Li and Z. Liu, "A method of SVM with normalization in intrusion detection," *Procedia Environ. Sci.*, vol. 11, no. PART A, pp. 256–262, 2011.
- [19] J. Han, J; Kamber, M; & Pei, *Data Mining Concepts and Techniques. In Data Mining*. 2012.
- [20] E. Purwaningsih, "Seleksi Mobil Berdasarkan Fitur dengan Komparasi Metode Klasifikasi Neural Network, Support Vector Machine, dan Algoritma C4.5," *J. Pilar Nusa Mandiri*, vol. XII, no. 2, pp. 153–160, 2016.

IMPLEMENTATION OF ARAS ALGORITHM ON DECISION SUPPORT SYSTEM TO DETERMINE THE BEST LECTURER

Supriatin^{1*}; Alex Rizky Saputra²; Budy Satria³

Department of Information System^{1*}, Department of Informatic²
Universitas AMIKOM Yogyakarta
<https://home.amikom.ac.id>
supriatin@amikom.ac.id^{1*}, alex.saputra@students.amikom.ac.id²

Department of Computer Engineering³
AMIK Mitra Gama
<http://www.amikmitragama.ac.id>
budysatriadeveloper@gmail.com

(*) Corresponding Author

Abstract— In the world of higher education, lecturers are one of the main components in building quality and quantity. Good quality will give good results as well, to improve the quality of each lecturer, it is necessary to have an award given to lecturers from the campus so that it becomes a motivation for lecturers to improve the quality given to students and the community. AMIK Mitra Gama is a private campus located in the Duri Riau area, in this case to improve the quality of education one of the steps taken is to give awards and appreciation to the best lecturers who will be selected every year. To realize this, we need an easy calculation system that is carried out in the form of ranking according to the final value, therefore a decision support system using the ARAS method is chosen because it is very appropriate for the selection process and provides convenience in the calculations which are determined based on ranking. The decision support system using the ARAS method uses 8 criteria that are set as a reference in determining the best lecturers, namely Recent Education, Lecturer Functional Position, Lecturer Certification, Number of Journal Publications, Roles in Research, Journal Publication History, Research Grants, and Community Service. There are 10 lecturers in the field of computers who will be used as alternative data with lecturer codes D01, D02, D03, D04, D05, D06, D07, D08, D09, D10. The results obtained from this study are the lecturer code D04 = 0.0974, D06 = 0.0965, D09 = 0.0932, D07 = 0.0903, D03 = 0.0901 was selected as the best lecturer in 2021/2022. So that the results of this study can help the campus to determine the best lecturers every year fairly and be selected based on rankings.

Keywords: decision support system, additive ratio assesment, lecturer, AMIK mitra gama.

Intisari— Dalam dunia pendidikan perguruan tinggi, dosen merupakan salah satu komponen utama dalam membangun kualitas dan kuantitas. Kualitas yang baik akan memberikan hasil yang baik pula, untuk meningkatkan kualitas setiap dosen perlu adanya penghargaan yang diberikan kepada dosen dari pihak kampus agar menjadi motivasi para dosen meningkatkan kualitas yang diberikan kepada mahasiswa/i serta masyarakat. AMIK Mitra Gama merupakan kampus swasta yang berada di daerah Duri Riau, dalam hal ini untuk meningkatkan mutu pendidikan salah satu langkah yang dilakukan adalah pemberian penghargaan dan apresiasi kepada dosen terbaik yang akan dipilih setiap tahunnya. Untuk merealisasikan hal ini maka dibutuhkan sebuah sistem perhitungan yang mudah dan dilakukan dalam bentuk perangkingan sesuai nilai akhir, maka dari itu dipilih sebuah sistem pendukung keputusan menggunakan metode ARAS karena ini sangat tepat untuk proses pemilihan serta memberikan kemudahan dalam perhitungannya yang ditentukan berdasarkan rangking. Sistem pendukung keputusan menggunakan metode ARAS ini menggunakan 8 kriteria yang ditetapkan sebagai acuan dalam menentukan dosen terbaik yaitu Pendidikan terakhir, Jabatan Fungsional Dosen, Sertifikasi Dosen, Jumlah Publikasi Jurnal, Peran Dalam Penelitian, Riwayat Publikasi Jurnal, Hibah Penelitian, dan Pengabdian Masyarakat. Terdapat 10 dosen bidang komputer yang akan dijadikan sebagai data alternatif dengan kode dosen D01, D02, D03, D04, D05, D06, D07, D08, D09, D10. Hasil yang diperoleh dari penelitian ini adalah kode dosen D04 = 0,0974, D06 = 0,0965, D09 = 0,0932, D07 = 0,0903, D03 = 0,0901 terpilih sebagai dosen terbaik pada tahun 2021/2022. Sehingga dengan hasil penelitian ini dapat membantu pihak kampus untuk melakukan penentuan dosen terbaik setiap tahunnya dengan adil dan dipilih berdasarkan perangkingan.

Kata Kunci: sistem pendukung keputusan, additive ratio assesment, dosen, AMIK mitra gama.



INTRODUCTION

Lecturers are scientific teaching staff who have responsibility for implementing the Tri Dharma of Higher Education, which include: Teaching, Research and Community Service, as in Law Number 14 of 2005 which contains Teachers and Lecturers, Lecturers are designated as expert instructors and researchers with the main task of changing, creating, and disseminating knowledge, innovation, and expression through education, examinations, and local administration (Law No. 14 of 2005)[1].

College is an optional final stage in formal education, in this case it can be delivered in the form of universities, colleges, colleges, seminaries, music schools, and institutes of technology [2].

In every institution of higher education, whether in the form of universities, institutes, or colleges, it is necessary to evaluate the performance of the best employees, in this case the lecturers. This assessment is carried out to determine the effect of lecturers' teaching on students, because lecturers are the main focus in the transformation of knowledge provided by educational institutions to their students.

AMIK Mitra Gama is a private university located in the Duri area of Riau. As a campus education provider, AMIK Mitra Gama conducts performance assessments of lecturers. This is done in order to motivate lecturers in improving services to students and the community.

In determining the best lecturers, it is necessary to have a criterion or limitation that can be a reference in the selection and ranking as the best alternative in decision making. These criteria are taken from the lecturer performance load (BKD) which will then be expanded with several supporting sub-criteria. There are 4 main criteria, namely educational and teaching activities, research activities, service activities, and supporting activities [3].

Decision support system (DSS) is a system that is able to provide decision recommendations using several criteria determined through the method process in the decision-making system, namely AHP, SAW, ARAS and others. In the managerial world, the application of DSS in the decision-making process has been widely applied. Decision making using a decision support system with a value approach [4].

Additive Ratio Assasment (ARAS) method is one of the methods used in DSS based on multi-criteria with a ranking concept that uses the utility degree, namely by comparing the overall index value of each alternative to the overall index value of the optimal alternative [5]. The use of the ARAS method in decision making will be easier because

the ARAS method in general does a lot of ranking by comparing it with other alternatives so as to get more accurate results [6]. In contrast to other methods that are also used in DSS, namely the simple additive weighting (SAW) method which in its application requires two criteria, namely the benefit criteria and the cost criteria[7] which must then be reprocessed before the ranking results are obtained. In addition, there is also the Technique for Order Preference by Similarity to Positive Ideal (TOPSIS) method which in its application uses two kinds of solutions, namely positive ideal solutions and negative ideal solutions. Which will be the basis for consideration to find the best alternative decision by looking at the smallest distance of the positive solution and the largest distance of the negative solution[8].

The ARAS method performs the maximum summation of all criteria so that with one addition all variables can get accurate ranking results, this is what makes the ARAS method often used in decision support systems due to accurate variable determination and efficient results for one addition.

The ARAS method has been applied in research on a decision support information system for assessing lecturer performance which is designed using the PHP and MySQL programming languages as the database with alternative results that can be used as a reference in determining lecturer performance[9]. ARAS is also used in making lecturer performance appraisal applications as the main method for determining objective criteria and alternative data and can speed up the calculation process [10].

In a previous study entitled the application of the ARAS method in the assessment of the best teachers, the ARAS ranking method to obtain the results of the Best Teacher assessment was more targeted because the ranking process in the assessment was based on criteria and weighted calculations [11]. The ARAS method was also applied in a study entitled acceptance of non-cash food aid, with the aim that the beneficiaries are selected accurately and on target [12]. Decision support systems can also be applied in selecting the best high school and vocational schools [13].

A decision support system has also been implemented in the provision of rewards and punishments for bank bri employees as an effort to improve the performance of its employees [14]. The decision support system using ARAS was also carried out in the selection of the best military police [15] and the best danru chairman [16]. In previous studies to determine the best housing based on conditions and location, a decision-making system using the ARAS method was also carried out [17]. The results obtained from this study are not absolute but are in the form of an assessment based

on the weight of the criteria that have been determined and the alternatives ranked from the highest to the lowest value [18]. ARAS is a method in a decision-making system that has a utility to a function value so that efficient results are obtained on a number of feasible alternatives. ARAS is also used in the ranking method because it has an optimization value[19].

By making a decision support system using ARAS in determining the best lecturers on the AMIK Mitra Gama campus, it aims to be a lecturer reference in increasing creativity in conveying knowledge to students. As well as being a benchmark for institutions in improving the quality of education and curriculum on campus.

MATERIALS AND METHODS

The stages in research using the ARAS algorithm on a decision support system to determine the best lecturers are as follows:

1. Identifying problems, namely problems found when making decisions in determining the best lecturers on the AMIK Mitra Gama campus in accordance with the information and data obtained.
2. Analyzing the problem, namely the problem found in determining the best lecturer and then analyzing it.
3. Data collection, namely collecting data needed for research needs by means of observation, literature and interviews.
4. Establish criteria, namely to be a reference in the calculation process using the ARAS method in determining a decision.
5. Data analysis, namely the data that has been obtained will be managed and from the data can also be given a weight for each criterion.
6. Implementation of ARAS in order to obtain the best results in determining a decision.
7. Alternate ranking, which is to carry out a ranking process in order to get the highest value from all alternative data.
8. System evaluation, namely conducting a system evaluation process with accuracy to be a comparison between the actual data and the data resulting from the calculation of the ARAS method.
9. Conclusion, which is to draw a conclusion on the data that has been analyzed and processed previously so as to produce an accurate decision in this research.

The data used by the author in this study was sourced directly from the AMIK Mitra Gama campus which was obtained by direct observation. The data used as a reference in this study is a list of the names of lecturers in the field of computers at the AMIK

Mitra Gama campus. There are 10 lecturers who will be implemented in the ARAS method for the calculation process based on the criteria that have been set in determining the best lecturers.

Techniques in data collection used by the author are:

1. Observation, the writer collects data from the object of research directly by observing and visiting the campus of AMIK Mitra Gama.
2. Literature study, namely the author approaches using several references such as journals and books related to the research topic.
3. Interviews, namely the authors conduct direct discussions with the relevant campus parties to be able to obtain the necessary information as research material.

The following are the steps in the calculation using the ARAS method:

1. Formation of Decision Making Matrix.

$$X = \begin{bmatrix} X_{01} & \dots & X_{0j} & \dots & X_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ X_{i1} & \dots & X_{ij} & \dots & X_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ X_{n1} & \dots & X_{mj} & \dots & X_{mn} \end{bmatrix}$$

$$i = \overline{0, m}; j = \overline{1, n}; \dots \dots \dots (1)$$

Which one :

- m = number of alternatives
- n = number of criteria
- X_{ij} = performance value of alternative *i* against *j*
- X_{0j} = optimum value of criteria

2. Normalization of Decision Making Matrix for all criteria.

$$X = \begin{bmatrix} X_{01} & \dots & X_{0j} & \dots & X_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ X_{i1} & \dots & X_{ij} & \dots & X_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ X_{n1} & \dots & X_{mj} & \dots & X_{mn} \end{bmatrix}$$

$$i = \overline{0, m}; j = \overline{1, n}; \dots \dots \dots (2)$$

$$X_{ij} = \frac{X_{ij}}{\sum_{i=0}^m X_{ij}} X_{ij} \dots \dots \dots (3)$$

If the proposed criteria have a minimum value, then for the normalization process there are 2 stages, that is :

$$X_{ij} = \frac{1}{X_{*ij}} ; X_{ij} = \frac{X_{ij}}{\sum_{i=0}^m X_{ij}} X_{ij} \dots \dots \dots (4)$$

3. Determine the matrix weights that have been normalized in stage 2.



$$\sum_{j=1}^n W_j = 1 \dots\dots\dots(5)$$

4. Determine the optimum function value.

$$S_i = \sum_{j=1}^n X_{ij} ; i = o, m \dots\dots\dots(6)$$

S_i is the overall index value on the i -th alternative [20].

5. Set the rating level.

$$K_i = \frac{S_i}{S_0} ; i = \overline{o, m} \dots\dots\dots(7)$$

RESULTS AND DISCUSSION

1. Alternative Data

In making a decision system required data to be processed and referred to as alternative data (D1) as shown in Table 1 below.

Table 1. List of Computer Lecturers
AMIK Mitra Gama

No	Lecturer Code	Study program
1	D01	Informatics Management
2	D02	Computer Engineering
3	D03	Computer Engineering
4	D04	Informatics Management
5	D05	Informatics Management
6	D06	Computer Engineering
7	D07	Computer Engineering
8	D08	Informatics Management
9	D09	Informatics Management
10	D10	Informatics Management

2. Determining the Criteria and Weights

In determining the ranking of each of the available alternative data, the process of assigning a weight value is first carried out. To determine the weight value of each criterion (W1) can be seen in Table 2 below.

Table 2. Kriteria dan Nilai Bobot

No	Criteria (C _i)	Information	Score Weight (%)
1	C1	Last education	10
2	C2	Functional Position	15
3	C3	Lecturer Certification	20
4	C4	Number of Article Publications	15
5	C5	Role in Research	15
6	C6	Journal Publication History	10
7	C7	Research Grant	10
8	C8	Community dedication	5

In Table 2, it is explained that the initials (Ci) of the criteria are given along with a description of each criterion, then the weight and variable values are given for each criterion. For the last education criteria (C1) as shown in Table 3 below.

Tabel 3. Last Education Criteria (C1)

Variable	Parameter	Value Weight
S3	Very good	5
S2	Good	4

In Table 3 there are variables for the latest education criteria, namely Strata-3 (S3) and Strata-2 (S2). The weight value of each variable is 5 with very good parameters and 4 with good parameters.

Table 4. Functional Position Criteria (C2)

Variable	Parameter	Value Weight
Head Lecturer	Very good	5
Lecturer	Good	4
Expert Assistant	Pretty good	3

In Table 4 there are criteria for functional positions with 3 variables, namely Head Lector, Lector, and Expert Assistant. The highest parameter is very good with a weight value of 5 and the lowest parameter is 3 with a weight value of 3.

Table 5. Lecturer Certification Criteria (C3)

Variable	Parameter	Value Weight
Already	Very good	5
Not yet	Good	4

In Table 5 there are criteria for lecturer certification. The weight value is 5 for those who have been certified by lecturers and the value is 4 for those who have not been certified by lecturers.

Table 6. Criteria for the Number of Journal Publications (C4)

Variable	Parameter	Value Weight
2 Titles / Year	Very good	5
1 Title / Year	Good	4
0 Titles / Year	Not good	2

In Table 6 there are three variables for the criteria for the number of journal publications, namely 2 titles/year, 1 title/year, and 0 titles/year. In this case, the variable determination is based on 1 academic year, namely 2021/2022 odd to 2021/2022 even. The highest weight value is 5 with very good parameters and the lowest weight value is 2 with less good parameters.

Table 7. Criteria for Roles in Research (C5)



Variable	Parameter	Value Weight
1st author	Very good	5
2nd author	Good	4
Author 3 to 5	Pretty good	3

In Table 7 there are criteria for the role in the study which has three variables, namely the 1st author, 2nd author, and 3rd author to 5. In this case the determination of variables is based on 1 academic year, namely 2021/2022 odd to 2021/2022 even. For the highest weight value is 5 and the lowest weight value is 3.

Table 8. Criteria for Article Publication History (C6)

Variable	Parameter	Value Weight
International Journal	Very good	5
Accredited National Journal	Good	4
National Journal	Pretty good	3

In Table 8 there are criteria for journal publication history which has three variables, namely international journals, accredited national journals, and national journals. The highest weight value is 5 with very good parameters and the lowest weight value is 3 with quite good parameters.

Table 9. Research Grant Criteria (C7)

Variable	Parameter	Value Weight
Ministry of Education and Culture	Very good	5
Local Government / University	Good	4
Nothing	Not Good	2

In Table 9 there are research grant criteria which have three variables, namely Kemdikbudristek, local government/university, and none. In this case the variable is based on 1 academic year, namely 2021/2022 odd to 2021/2022 even. For the highest weight value is 5 with very good parameters and the lowest weight value is 2 with less good parameters.

Table 10. Criteria for Community Service (C8)

Variable	Parameter	Value Weight
National	Very Good	5
Local / Regional	Good	4
Nothing	Not Good	2

In Table 10 there are criteria for community service which have three variables, namely national, local / regional, and none. For the highest weight value is 5 with very good parameters and the lowest weight value is 2 with less good parameters.

3. Determine the criteria and weight values

Step 1: formation of a decision matrix (*decision making matrix*)

Table 11. Decision Matrix

(D _i)	C1	C2	C3	C4	C5	C6	C7	C8
D00	4	4	5	5	5	4	5	4
D01	4	4	5	5	3	4	2	2
D02	4	4	5	4	3	4	2	4
D03	4	4	4	4	3	4	5	4
D04	4	4	5	5	4	4	5	2
D05	4	4	5	4	4	4	2	2
D06	4	4	5	5	5	4	2	4
D07	4	3	5	4	3	4	5	4
D08	4	3	4	4	3	4	5	2
D09	4	3	4	5	5	4	5	2
D10	4	3	4	5	5	4	2	2

For all criteria worth Max

In Table 11 there are 8 criteria, namely C1-C8 and 10 alternative data, namely D01-D10. D00 is an additional initialization for the criteria column with a max value taken from the highest value for each criterion.

Step 2: normalize the decision matrix for all criteria that have been scored.

$$X = \begin{bmatrix} 4 & 4 & 5 & 5 & 5 & 4 & 5 & 4 \\ 4 & 4 & 5 & 5 & 3 & 4 & 2 & 2 \\ 4 & 4 & 5 & 4 & 3 & 4 & 2 & 4 \\ 4 & 4 & 4 & 4 & 3 & 4 & 5 & 4 \\ 4 & 4 & 5 & 5 & 4 & 4 & 5 & 2 \\ 4 & 4 & 5 & 4 & 4 & 4 & 2 & 2 \\ 4 & 4 & 5 & 5 & 5 & 4 & 2 & 4 \\ 4 & 3 & 5 & 4 & 3 & 4 & 5 & 4 \\ 4 & 3 & 4 & 4 & 3 & 4 & 5 & 2 \\ 4 & 3 & 4 & 5 & 5 & 4 & 5 & 2 \\ 4 & 3 & 4 & 5 & 5 & 4 & 2 & 2 \end{bmatrix}$$

The matrix above is added from top to bottom of each row to get the results [44, 40, 51, 50, 43, 44, 40, 32].

After all the matrices are added up, then normalization of the matrix is carried out for all the criteria that have been determined. The results of each calculation of the decision matrix from criteria C1 to C8 are obtained with normalized results as follows:

0,0909	0,1000	0,0980	0,1000	0,1163	0,0909	0,1250	0,1250
0,0909	0,1000	0,0980	0,1000	0,0698	0,0909	0,0500	0,0625
0,0909	0,1000	0,0980	0,0800	0,0698	0,0909	0,0500	0,1250
0,0909	0,1000	0,0784	0,0800	0,0698	0,0909	0,1250	0,1250
0,0909	0,1000	0,0980	0,1000	0,0930	0,0909	0,1250	0,0625
0,0909	0,1000	0,0980	0,0800	0,0930	0,0909	0,0500	0,0625
0,0909	0,1000	0,0980	0,1000	0,1163	0,0909	0,0500	0,1250
0,0909	0,0750	0,0980	0,0800	0,0698	0,0909	0,1250	0,1250
0,0909	0,0750	0,0784	0,0800	0,0698	0,0909	0,1250	0,0625
0,0909	0,0750	0,0784	0,1000	0,1163	0,0909	0,1250	0,0625
0,0909	0,0750	0,0784	0,1000	0,1163	0,0909	0,0500	0,0625

Step 3: Determination of normalized weights by means of matrix multiplication as in step 2. The weights used for The multiplication in step 3 is **0,1 , 0,15 , 0,2 , 0,15 , 0,1 , 0,1 , 0,05.**

The weight value used is obtained from Table 2 which was determined in the previous step. The results of all multiplication can be seen from the following matrix:

0,0091	0,0150	0,0196	0,0150	0,0174	0,0091	0,0125	0,0063
0,0091	0,0150	0,0196	0,0150	0,0105	0,0091	0,0050	0,0031
0,0091	0,0150	0,0196	0,0120	0,0105	0,0091	0,0050	0,0063
0,0091	0,0150	0,0157	0,0120	0,0105	0,0091	0,0125	0,0063
0,0091	0,0150	0,0196	0,0150	0,0140	0,0091	0,0125	0,0031
0,0091	0,0150	0,0196	0,0120	0,0140	0,0091	0,0050	0,0031
0,0091	0,0150	0,0196	0,0150	0,0174	0,0091	0,0050	0,0063
0,0091	0,0113	0,0196	0,0120	0,0105	0,0091	0,0125	0,0063
0,0091	0,0113	0,0157	0,0120	0,0105	0,0091	0,0125	0,0031
0,0091	0,0113	0,0157	0,0150	0,0174	0,0091	0,0125	0,0031
0,0091	0,0113	0,0157	0,0150	0,0174	0,0091	0,0050	0,0031

Step 4: determine the value of the optimum function by summing each criterion value for each alternative obtained from the multiplication of the weight matrix. For the results of the matrix calculation of the optimum function values as follows:

From the results of the calculations that have been carried out, the results of the ranking levels of each alternative are obtained. The value of each rank is ordered from the highest to the lowest as in Table 12 below:

0,1040
0,0864
0,0865
0,0901
0,0974
0,0869
0,0965
0,0903
0,0832
0,0932
0,0857

Table 12. Rank Level

Lecturer Code	Score (K _i)	Rank
-	0,1040	-
D01	0,0864	8
D02	0,0865	7
D03	0,0901	5
D04	0,0974	1
D05	0,0869.	6
D06	0,0965	2
D07	0,0903	4
D08	0,0832	10
D09	0,0932	3
D10	0,0857	9

The results obtained from the overall value of the optimum function above if added up are **0,10000.**

Step 5: determine the highest ranking level of all existing alternative values by dividing by the alternative value 0 (D0). The results for the distribution are as follows:

0,1040. 0,0864. 0,0865. 0,0901. 0,0974. 0,0869. 0,0965. 0,0903. 0,0832. 0,0932. 0,0857.

All alternative data in Table 12 that have been processed using the ARAS method have different values (K_i). The results for determining the best lecturers for 2021/2022 based on the highest scores can be seen in Table 13 below:



Table 13. Highest - Lowest Ranking Results

Lecturer Code	Score (K _i)	Rank	Results
D04	0,0974	1	Best
D06	0,0965	2	Best
D09	0,0932	3	Best
D07	0,0903	4	Best
D03	0,0901	5	Best
D05	0,0869	6	-
D02	0,0865	7	-
D01	0,0864	8	-
D10	0,0857	9	-
D08	0,0832	10	-



Image 1. Criteria Data Page On Application



Image 2. The Best Lecturer Ranking Results Using the Application

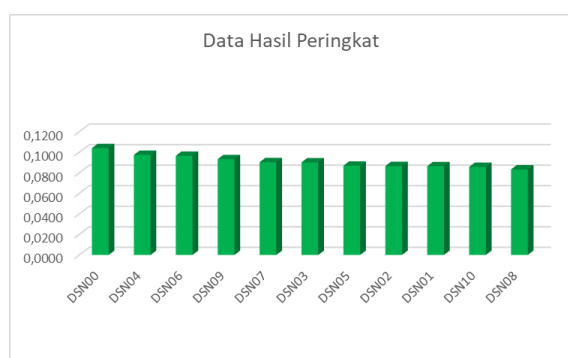


Image 3. Graph of Ranking Results

In Image 1, based on the Table of Best Lecturer assessment results in 2021/2022 based on the highest-lowest scores, there are 5 lecturers who got

the highest scores, namely **D04, D06, D09, D07, D03** who were selected as the best lecturers.

CONCLUSION

In this research, the decision support system to determine the best lecturer performs data analysis and calculation process using the ARAS method. The implementation of ARAS in this study is very helpful in determining the maximum and appropriate results based on the data that has been presented. There are 10 alternative data included in the calculation process, then there are 8 criteria used in this study. Based on the results obtained after using the tier method, there were 5 lecturers with the highest scores, namely D04 = 0.0974, D06 = 0.0965, D09 = 0.0932, D07 = 0.0903, D03 = 0.0901 was chosen as the best lecturer in 2021/2022. So with the results obtained from this research, it can help the campus in determining the best lecturers based on predetermined criteria with fast and objective calculations.

REFERENCE

- [1] I. Colanus, R. Drajana, N. Polimengo, and A. Riadi, "DSS Lecturer Performance Assessment Using the Multi-Attribute Utility Theory Method," *J. NOE*, vol. 4, no. 2, pp. 176–181, 2021.
- [2] M. Ayu Ningrum and A. Fauzi, "Mapping of Private Higher Education Lecturers in Implementing Tridharma Using the Smart Method," *J. Tek. Inform. Kaputama*, vol. 6, no. 1, 2022.
- [3] M. Maryaningsih and D. Suranti, "Application of the Simple Multi Attribute Rating Method Technique (Smart) in the Selection of the Best Lecturers Technique," *JIKO (Jurnal Inform. dan Komputer)*, vol. 4, no. 1, pp. 8–15, 2021, doi: 10.33387/jiko.v4i1.1921.
- [4] R. Hardianto, W. Fana, and Wirdahchoiriah, "Application of the Decision Support System in Determining the Best Lecturer for PG PAUD Study Program Using the AHP Method," *Indones. J. Comput. Sci.*, vol. 10, no. 2, pp. 322–336, 2021.
- [5] Damayanti, "Red Member Acceptance Decision Support System for Eligible Traders at Indogrosir Using the ARAS Method," *Semin. Nas. Teknol. Komput. Sains*, pp. 453–458, 2020.
- [6] C. Tarigan, E. F. Ginting, and R. Syahputra, "Decision Support System In Determining Teacher Performance With Additive Ratio Assessment Method (ARAS)," *J-SISKO TECH (Jurnal Teknol. Sist. Inf. dan Sist. Komput.*

- TGD*), vol. 5, no. 1, p. 16, 2022, doi: 10.53513/jsk.v5i1.4245.
- [7] B. Satria and L. Tambunan, "Decision Support System for Eligible Housing Assistance Recipients Using FMADM and SAW" *JOINTECS (Journal Inf. Technol. Comput. Sci.*, vol. 5, no. 3, p. 167, 2020, doi: 10.31328/jointecs.v5i3.1361.
- [8] G. Wibisono, A. Amrulloh, and E. Ujianto, "Application of Topsis Method in Determining the Best Lecturer," *Ilk. J. Ilm.*, vol. 11, no. 2, pp. 102–109, 2019, doi: 10.33096/ilkom.v11i2.430.102-109.
- [9] A. Y. Labolo, "Lecturer Performance Assessment Decision Support System Using Additive Ratio Assessment Method (Aras)," *Simtek J. Sist. Inf. dan Tek. Komput.*, vol. 5, no. 1, pp. 31–35, 2020, doi: 10.51876/simtek.v5i1.69.
- [10] W. Murniati, S. Hamdi, and S. Fadli, "Application of Lecturer Performance Assessment Using Additive Ratio Assessment (Aras) Method," *J-ENSITEC (Journal ...)*, vol. 08, no. 02, pp. 639–648, 2022, [Online]. Available: <https://www.ejournal.unma.ac.id/index.php/j-ensitec/article/view/2059%0Ahttps://www.ejournal.unma.ac.id/index.php/j-ensitec/article/download/2059/1463>.
- [11] A. S. Nadeak, "Application of the ARAS Method (Additive Ratio Assessment) in the Best Teacher Assessment," *Semin. Nas. Teknol. Komput. Sains*, vol. 2, no. 2010, pp. 571–578, 2019.
- [12] J. Hutagalung, D. Nofriansyah, and M. A. Syahdian, "Receipt of Non-Cash Food Assistance (BPNT) Using the ARAS Method," vol. 6, pp. 198–207, 2022, doi: 10.30865/mib.v6i1.3478.
- [13] M. Iqbal, B. Satria, and T. Radillah, "Implementation of DSS Using the ARAS Method for Determining the Best Website-Based High Schools and Vocational Schools," *Indones. J. Comput. Sci.*, vol. 10, no. 2, pp. 425–435, 2021.
- [14] R. Rosmini, D. Darmawati, and M. Fadlan, "Decision Support System for Rewarding and Punishing Bank Bri Employees Using Additive Ratio Assessment Method (Aras)," *Sebatik*, vol. 25, no. 2, pp. 748–755, 2021, doi: 10.46984/sebatik.v25i2.1659.
- [15] D. T. Azmi, "The Best Military Police Selection Decision Support System Using the Additive Ratio Assessment (ARAS) Method (Case Study: Military Police Detachment (Denpom) I / 5 Medan," *J. Maj. Ilm. Inf. dan Teknol. Ilm.*, vol. 7, no. 2, pp. 159–164, 2020.
- [16] S. W. Sari and B. Purba, "Decision Support System for Choosing the Best Danru Chair Using the ARAS Method," *Semin. Nas. Teknol. Komput. Sains SAINTEKS 2019*, pp. 291–300, 2019.
- [17] R. Sanjaya, "Decision Making System to Determine the Best Housing Based on Conditions and Locations Using ENTROPHY and ARAS Methods," *Semin. Nas. Teknol. Komput. Sains SAINTEKS 2020*, pp. 447–452, 2020.
- [18] E. A. Panjaitan and Y. Desnelita, "Implementation of the Rank Order Centroid and Additive Ratio Assessment Methods in Lecturer Performance Assessment," *Semin. Nas. Inform.*, 2021.
- [19] H. Halimah, D. Kartini, F. Abadi, I. Budiman, and M. Muliadi, "The Aras Method Sensitivity Test Using the Sahnnon Entropy and Swara Criteria Weighting Approach in the Selection of Prospective Employees," *J. ELTIKOM*, vol. 4, no. 2, pp. 96–104, 2020, doi: 10.31961/eltikom.v4i2.194.
- [20] E. Ndruru, "Utilization of Decision Support Systems in the Selection of the Best PKW Using the Aras Method at LPK2-Pascom Medan," *J. Inf. Log.*, vol. I, no. 2, pp. 26–34, 2019.

EVALUATING USER ENGAGEMENT AND READING BEHAVIOR ASPECTS OF WEB VISITORS BY ANALYZING INDICATORS ON GOOGLE ANALYTICS DATA

Shumaya Resty Ramadhani^{1*}; Indah Lestari²;

Informatics Engineering^{1*}, Information Systems²
Politeknik Caltex Riau
www.pcr.ac.id
shumaya@pcr.ac.id^{1*}, indah@pcr.ac.id²

(*) Corresponding Author

Abstract— Web-based technology is used as source of information and marketing even in educational institutions. This development unintentionally changes reading patterns, from paper to online media. However, user engagement and reading behavior are often overlooked while developing the website. Understanding these two pillars can help the improvement process become more effective. Politeknik Caltex Riau has an official web provides information on campus life and study programs for prospective students. The information is clear and precise, yet there are many repeated questions. By that, the process of understanding the problems, determining parameters, implementation, data collection, and analysis is carried out. Evaluation is necessary to understand demographics, engagement, behavior, and events by implementing Google Analytics. From implementation, 49% of readers are aged between 18-24 years old, included in the category of actively searching for a university. The smartphone is used by 56% of total readers on the website. From evaluation, it is known that most readers do not read the content thoroughly. It can be seen from the total scroll event, which is high at the beginning and keep decreasing while scrolling down the page. But the bounce and sessions number keep rising. This phenomenon shows that the reader's engagement is shallow, and reading comprehension is vague. There is also an indication of the effect of a smaller screen size with an increase in bounce rate of almost 50% compared to a large screen. Thus, further studies can focus on deepening and evaluating web design and evaluating more indicators provided on Google Analytics.

Keywords: User Engagement; Reading Behavior; Google Analytics; Website, Online Articles

Intisari— Teknologi berbasis web kerap digunakan sebagai media informasi dan pemasaran oleh berbagai pihak, seperti institusi pendidikan. Hal ini seiring dengan perubahan pola baca masyarakat yang beralih pada media online. Akan tetapi, keterlibatan pengguna dan kebiasaan dalam sebuah sistem berbasis website cukup sering diabaikan dalam pembuatan sistem. Padahal, dengan memahami kedua hal tersebut dapat membantu proses perbaikan sistem menjadi lebih tepat sasaran dan efektif. Kampus Politeknik Caltex Riau memiliki web resmi berisi informasi kehidupan kampus dan pengenalan program studi bagi calon pendaftar. Informasi yang diberikan cukup lengkap dan jelas, faktanya masih menimbulkan pertanyaan berulang. Dengan memperhatikan masalah tersebut, maka dilakukan proses pemahaman masalah dan penentuan parameter ukur, implementasi, pengumpulan data dan analisis data tersebut. Evaluasi diperlukan guna memahami ketepatan target pengunjung, keterlibatan dan kebiasaan dan aksi pengguna dengan mengimplementasikan Google Analytics pada web. Dari hasil implementasi diketahui bahwa target pengunjung rentang usia 18-24 tahun adalah sebesar 49% dari total pengunjung, dimana usia tersebut masuk kategori pelajar yang mencari universitas. Sebanyak 56% pembaca diketahui menggunakan ponsel untuk mencari informasi. Dari hasil evaluasi diketahui bahwa sebagian besar pembaca tidak menyelesaikan bacaannya. Realita ini terlihat dari total event scroll yang hanya bernilai tinggi diawal tetapi nilai lompatan dan sesi juga tinggi. Fenomena ini menunjukkan rendahnya keterikatan pembaca terhadap konten yang disajikan dan pemahaman bacaan cukup diragukan. Terdapat juga indikasi pengaruh ukuran layar yang mengecil dengan meningkatnya angka lompatan hampir 50% daripada ukuran layar besar. Dengan demikian, studi selanjutnya dapat berfokus pada pendalaman dan evaluasi terhadap design yang disesuaikan dengan ukuran layar.

Kata Kunci : Keterikatan Pengguna; Kebiasaan Membaca; Google Analytics; Website; Artikel Online



INTRODUCTION

The vast development of technology has had a considerable impact on the development of information and communication in society, causing changing patterns of character and culture of people. One example that has been affected by the advance in technology is reading behavior. The presence of the internet globally in the digital era makes it easier for people to get online access through web portals. With the change in this practice, the reading interest and information understanding can no longer be measured by how many books we have read but should be analyzed through the number of contents, engagement, and reading behavior or event obtained by evaluating online media [1].

Young generations tend to be more interested in reading online articles than printed media such as books, magazines, and newspapers [2]. The change in behavior towards digital media allows researchers to figure out the extent to which readers are attached to an online article [3]. Not many online readers read through an entire article, especially one that provides lengthy content. One factor is the influence of interest or increased interest in reading content that is considered attractive [4]. This behavior causes the dissemination of information to be inadmissible. Several factors drive the decline in literacy levels among online readers, including heavy topics and extended content. Long content may attract less interest in people to complete their reading, or some may choose to only focus on certain parts of the story [5]. The design of the article page display that is less attractive is also very influential. When reading activities are carried out using smartphone devices, the light produced by the smartphone screen could easily make the eyes tired, primarily if the content text uses a relatively small font size. Imagine when a reader has to read an article using a handphone with limited screen size and a bad design. This thing could lead to a decrement in the reader's interest.

Visitors' attachment to web content is one indicator of the success of information delivery and one of the marketing strategies. In this case, the Politeknik Caltex Riau (PCR) utilizes various media to interact with the community, especially with prospective students, using the website, Instagram, and other social platforms. The official website, <https://www.pcr.ac.id>, provides various kinds of news related to study programs, activities of the academic community, prospective students, and sharing information on multiple achievements that occur on campus to the public. Looking at the variance information presented and how to detail the student registration instruction posted on the

website, the most minor repeated questions are expected, especially from future students. The fact is that when the registration process opens, people keep asking the same questions even though readers can find the information on the site easily. As a result, the admissions team has to explain the same information to applicants who ask questions step by step. This reality shows that the information is not appropriately conveyed to the reader. Consequently, some questions arose about whether the website hit the target audience, whether the design is attractive enough for readers to keep surfing, how deep the content attachment of the users, whether the people read the content while opening the page, etc.

Therefore, to understand why this phenomenon exists, the study focuses on analyzing users' engagement with the PCR web portal and their behavior as an initial identification of the problem. The analysis will be carried out to identify the distribution of visitors, demographics, devices, content attachment, and the behavior of web portal readers. This information is needed to determine which factors influence the reading interest of web visitors. Hence, we could better understand which part of the problem is. The result is later used to determine whether the problem is caused by unattractive content or unsatisfactory information design. Thus the aspects that need improvement can be evaluated. The analysis in this study uses data sourced from Google Analytics embedded on the official PCR website. In addition, the research also uses a new event such as scroll tracking that is installed for a certain period to measure the behavior of portal visitors.

Literature Reviews

The author uses references from several existing studies to support understanding and guide the study. Online reading media get specific treatment when compared to physical books. Based on research [5], no direct relationship has been found between the length of the article and the reading interest of the web visitor. Nevertheless, there are two categories of reader engagement on the website there is shallow and deep engagement. Shallow engagement is when visitors read less than 50% of the entire article. When a visitor reads more than 50%, the reader has got the gist of the article and has accomplished scrolled through the web page. Another study was conducted to measure the reading patterns of internet users for five types of documents, namely journals, news, magazines, written texts, and brochures. Based on the research results, it is known that readers prefer to read journals in the form of printed documents, while the other four papers are selected to be read online [6]. Despite that, a recent study on thousands of

students and focus groups of six secondary schools on enjoying reading printed and digital materials shows exciting results. The teenagers were fond of physical books initially but preferred online reading as they got older. This habit influences content preference in online reading behavior later on [7].

Another study also shows a relation between the online content provided and the high interest of online readers, such as news, sports, culinary, etc. This relation is known based on the click habit on websites that create different patterns. Hence, even though several information choices are provided or even recommended on sites, the readers will choose articles that attract their interest [8]. Additionally, the study on the design side shows a significant effect when using small fonts on the content. Text that uses small letters and wide display causes reading ability to decrease. This fact indicates that the proper typography design has a considerable impact on the ability to read [9]. One tool used in this research is Google Analytics (GA), which provides free quantitative data for analysis. This tool is mainly used to evaluate content performance, behavior, and user attachment in numerous forms to decide on marketing strategy or evaluate the platform for improvement [10, 11]. Hence, the analysis of user engagement and behavior on the official website is necessary as a preliminary study to identify the reading interest of online readers.

MATERIALS AND METHODS

The website used for this study contains news and information about the institute that is presented mainly by the text. As this web is the official website, thus the main objective of the web is to post achievement news and more information for prospective students. The length of the text for each article is about 250-800 words, including figures captions on average. The usage of Google Analytics as the tool is proposed and is embedded into the website that automatically applies to all pages on <http://www.pcr.ac.id>. The tool collects data related to webpage traffic in various variables. In this study, we used several indicators related to user behavior to measure visitors' engagement with the platform. The outcome is to be analyzed for further discussion.

Indicators

1. Demographic

Analysis of demographics is vital, especially for this research, as it is a study of several factors, such as age, sex, race, etc., based on population. Demographics analysis is often overlooked, which is regrettable since it contains many aspects that could support the growth of research and understanding of the target by various variables

[12]. It is essential to ensure whether the audience of the webpage hits the mark as its impact will affect the output, and also necessary to design a marketing strategy.

2. Device Category

One other variable that shall be considered is recognizing which type of devices are used to open the website and read the articles. According to a previous study, reading through mobile devices could speed up reading behavior and reduce reading comprehension [13]. Therefore, to ensure that the reader understands the information conveyed, it is necessary to know what type of device is used; developers could serve thus better approach and analysis. Besides, knowing the commonly-used device to access pages can be used as a reference for better web design and typography.

3. Event and Session Duration

Duration is one approach to evaluating the users' engagement with the content on the website. By collecting and analyzing the duration per session and per pageview, the readers' attachment to the article could be measured and discussed later. To understand the reader's activity on a website, an analysis of scroll events is required. Scroll Tracking is implemented to examine the reader's behavior toward the articles and how far the reading activity is recorded. This feature allows splitting the articles into some part of percentage, e.g., 10%, 20%, etc. Accordingly, we could measure the length of the reading article.

Data Collection Technique

The data collected by Google Analytics is used as initial data and could be used as the primary indicator to execute future research. Google Analytics has been installed on the PCR web portal for about a year, starting from the beginning of January 2019 to December 2021, with the help of the PCR technology center team to identify reader behavior and engagement. Scroll tracking as one of the supporting parameters is added. We implemented the Scroll Tracking event to Google Analytics Tag Manager to get the scroll percentage done by readers on the visited web pages. The period of collecting data is carried out for almost two years to identify the data trend in detail. Some of the Google Analytics features collect data such as summaries of web usage, demographics, behavior, devices used, and events during the data collection period. Additionally, scroll tracking is also a unique feature that allows web owners to monitor to which extent the readers are doing the read activities. For example, for an article page with a length of about 20 cm, the owners could implement a scrolling feature to divide the web page into specific percentages such as 10%, 25%, 50%, 75%, and so

on. In this way, the extent to which users have read articles as long as 20 cm can be obtained [14]. Therefore, to identify behavior, scroll tracking is needed.

RESULTS AND DISCUSSION

This section explained the analysis of engagement and behavior of visitors according to several criteria, such as demographics, devices, duration, and scrolling action.

Demographics

According to information collected regarding demographics, around 50% of web visitors are approximately 18 to 24 years old. The second position is dominated by the age range of 25 to 34 years for about 30% (Figure 1) and the rest is divided into several age groups. The number of visitors based on gender was almost equal for both men and women. The majority of visitors were men, about 52.8%, and the rest were women.

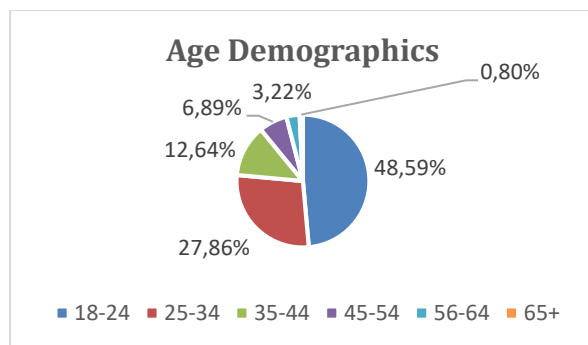


Figure 1. Visitor Age Demographic

This result aligns with the expected target of the web, which is to attract prospective students and the wider community who pay attention to the institution's development. The average age of children entering elementary school is 6-7 years. Hence students would be 16-17 years old when entering high school. High school students should have started searching for information about the campus they are interested in when joining the 3rd grade of high school, around 18 [15]. That way, this result can be said to meet the target audience's expectations because the majority of web visitors are in that age range (18-24 years old) that are looking for information on university admission.

Session Duration

In line with the previous finding, it is also known that the mainly accessed pages are the profile of the study program at the Polytechnic of Caltex Riau. The information presented on the profile page emphasizes the competencies offered in each existing study program. This result aligns

with the reader's interest to perceive more details to decide on enrolment. Both old and new visitors of both genders opened about two to three pages in one session. The average spending time that occurs is around 2.37 minutes in one session. The spending time stated above is more than sufficient to understand the most part presented on the website to establish comprehension. However, by referring to the rise of the session number, it seems that the reader opens the page and is idle for at least half an hour before the session restart. This is the cause of an increase in the number of sessions on the PCR website, around 131,327 sessions according to age demographics.

Based on a previous study related to reading behavior, people can read around 230 English words per minute for non-fiction works using the silent reading method [16]. Nonetheless, that number would slightly differ concerning the readers' mother language, and the study above was conducted on English speakers. In another study, the number of words and reading time per minute with a similar estimation could also apply to Indonesian speakers [17]. Hence, we can conclude that short to medium length of articles containing around 150-250 words in both languages can be finished in more than a minute without considering their comprehension.

Table 1. Time needed per reading session

No	Duration Session (s)	Session	Pageviews
1	0-10	64.743	68.826
2	11-30	16.338	26.093
3	31-60	10.532	22.407
4	61-180	14.126	45.582
5	181-600	10.690	56.568
6	601-1800	7.096	48.324
7	1800+	2.030	32.048

For this study's purposes, it has been identified that most of the articles on the PCR website contain more than 250 words on average. Meanwhile, based on Table 1, it was found that there were around 64.743 sessions that occurred in a reasonably short time which is less than ten seconds. In line with that, the pageviews number is also relatively high. The high session usually means that visitors of the website are more likely to stay idle (no activities or events) on one or several articles for minutes or reload the pages over time. Following that, it is safe to consider that the reader might not read the entire article or fully understand the contents in a short amount of time. The behaviour identified referring to this data is that the readers only try to search for specific information or keywords and probably miss other points. In addition, it is also known that each user does not focus solely on a single page for a certain amount of



time. To sum up, the attachment between readers and the news posted on web pages is relatively low. The reader opens for at least two pages per session in less than 10 seconds which is impossible unless you only look for specific info. If referring to previous research about the minimum time we need to comprehend the text thoroughly, a good reading session should be above 60 seconds, thus the engagement result is quite disappointing.

Device Category

Derived from the data, 4,221 out of 7,398 (56.84%) web visitors mostly used mobile devices to access this site. 42.89 percent of users use computers or tablets. We then explore the bounce session for each device in more detail. In Figure 2, the overall bounced rate percentage is 33.72%, which is considered a reasonably good number for more comprehensive screen users [18]–[20]. On a smaller screen, on the other hand, although around 60% is still considered an acceptable number, the percentage of bounce activity on smartphones is quite concerning. The number rocketed to 65,91%, twice as much as the bounce rate on other devices. This result means that thousands of users left only a single engagement hit. The trend seems quite different practice from users of desktop devices.

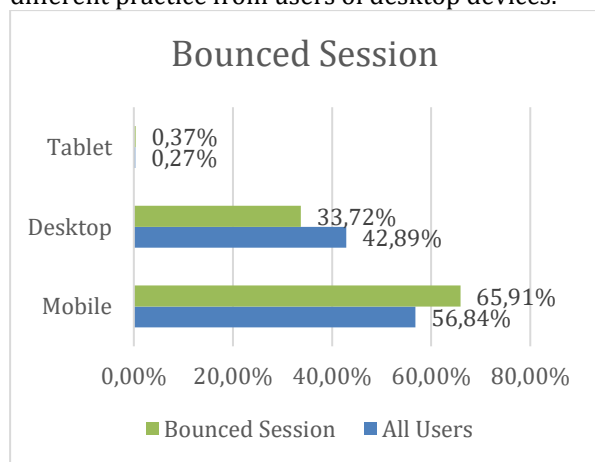


Figure 2. Bounced session on each device category

Typically, web page readers find it easier to surf the web portal by using larger screen devices due to the broader exploration area, and the design will be adjusted. The font size visible is more prominent on the more extensive devices, increasing the text's readability [13]. Aside, users could easily open multiple web pages in a session. Meanwhile, with the means of smartphone usage, behavior changes. Most users need information with fast and straightforward movements, so the activities to explore the news sites tend to be limited. The expected behavior could be unachieved when the information on the mobile page is presented using poor design and typography. It

makes visitors bounce immediately without event. In this case, it is shown in the percentage of mobile bounce in Figure 2.

Table 2. Device Screen Resolution

No	Screen Resolution	Users	Bounce Rate	Pages/Sessions
1	360 x 640	19.847	35.48%	2.12
2	1366 x 768	13.182	25.87%	3.05
3	360 x 760	6.474	34.76%	2.10
4	360 x 720	3.412	35.37%	2.20
5	360 x 780	3.130	30.21%	2.23
6	375 x 667	2.876	37.32%	2.07
7	1920x1080	2.690	19.28%	3.61
8	412 x 892	1.993	30.28%	2.15
9	360 x 800	1.972	30.39%	2.17
10	414 x 736	1.920	33.10%	2.10

While digging into more detail by comparing the screen resolution, the result follows. According to the result in Table 2, two models of screen size are compared, the larger (no. 2 and 7) and small screen size. Based on the data analysis, devices with limited screen size could be a reason that also affects the bounce rate and the number of pages, albeit less significantly. The higher percentage for bounce rate is around 37% while using 375x667 pixels, but it is reduced by half of the latter by only 19% for the larger screen. However, the result indicates that users are somewhat encouraged to leave the page immediately after the goal is obtained while reading using smartphones rather than desktops. Given that information, the percentage of a bounce rate increases when the screen size gets smaller. Note that this indicator is yet to consider reading comprehension and what the leading cause of that behavior would be.

Scrolling Events

Scrolling activity is closely dependent on the length of content displayed on the screen. The scrolling action and behavior vary between reading through a desktop and a smartphone due to the limited screen size. By using a desktop, the space for content becomes wider. The header of the web could take up approximately 10-15% of the page length that is displayed to the reader. Using a computer device makes it safe to assume that the screen size can display the entire information on a screen (100%). In contrast, smartphone size will shrink and construct a more extended scroll area due to adjustments to the website mode. Then to get the content visible on mobile phone, readers should do scrolling activity a bit more to at least 15-25% of the length of the page and reach 60-90% to finish the article.



Table 3. Events per Action

No	Event Action (% Scrolled)	Total Events	Unique Events
1	10 %	111.291	89.528
2	25 %	88.796	73.892
3	35 %	75.637	64.332
4	50 %	58.549	51.106
5	60 %	46.091	41.418
6	70 %	37.321	34.061
7	90 %	22.910	21.332

Based on the tracking results in Table 3. Events per Action, the total events that hit 60-90% of scrolling are 21 to 41 thousand unique events. Therefore, we can say that the occurrence to finish the article is only left around a fifth of the whole event and half of the unique circumstances at the beginning. Most readers are bounced out after opening a particular page without doing a single hit activity such as scrolling. Thus this one behavior could also be identified as shallow engagement.

Table 4. Action behaviour per device

Event Action (% Scrolled)	Mobile Tablet Traffic		Tablet Desktop Traffic	
	Total Events	Unique Events	Total Events	Unique Events
10 %	69.548	55.636	42.040	34.128
25 %	53.743	44.905	35.305	29.187
35 %	47.161	39.846	28.692	24.666
50 %	33.803	29.369	24.926	21.891
60 %	24.038	21.786	22.203	19.763
70 %	19.203	17.553	18.239	16.612
90 %	11.013	10.251	11.981	11.151

From the scroll tracking results in Table 4, the readers' behavior diverges depending on their device. As we already know from the information above, most readers use smartphone devices. The total scroll events that reach up to 50% of the content area are only about half of the initial number. In sum, only a small number of readers finish reading the article in total length. Nonetheless, by looking at the result, it is intriguing to see that the number of unique events of both device type that reaches 70-90% of the page is equally even, meaning that the site has some loyal readers that scroll through the page perhaps to read the articles.

CONCLUSION

The author can conclude several points according to the conducted study. First, the readership target of the official web is on point, which is dominated by teenagers aged 18-24 years old. As the visitors around this age were so into information about admission, the page that opened the most was the study program for each department. They spend more than two minutes on that specific page. Nevertheless, the session rate

says otherwise. The session number is rocketed to a hundred thousand, meaning that most readers stayed idle with zero activity for an extended period on a specific page and restarted the session. Though spending time is enough to finish the article, that does not guarantee the reader can understand the content thoroughly.

Second, according to the table above, the distribution of information might still not be optimal due to the size of the screen that affects the web design. The website lost more than half of the readers before the scrolling event reached 60% of the page on the mobile phone. This event indicates that half of the readers stop scrolling by half of the content and are more likely not to continue reading and finish the articles. This action could also imply that mobile phone readers only look for certain keywords or specific information before leaving the page. Hence the engagement with the content is pretty low, and the reader could miss the vital information by not finishing reading the articles.

Last, by knowing the age demographics, it is expected that young visitors mostly use a mobile phone to surf the website. Therefore, it is necessary to consider future research related to the display adjustment and typography on the website. Even though the impact was not significant, referring to the result, there might be a hint of the relation between screen size that affects the user's reading behavior and comprehension. The improvements in that focus area are needed to provide better design and leverage information delivery to visitors.

REFERENCE

- [1] N. Kurniasih, "Kebiasaan Membaca di Era Digital: Benarkah Masyarakat Indonesia Tidak Gemar Membaca?," 2017, doi: 10.31227/OSF.IO/GA36M.
- [2] DailySocial, "Indonesian News Reading Habits Survey 2017 | Dailysocial," 2017. <https://dailysocial.id/research/indonesian-news-reading-habits-survey-2017> (accessed Oct. 04, 2021).
- [3] N. Grinberg, "Identifying Modes of User Engagement with Online News and Their Relationship to Information Gain in Text," *Web Conf. 2018 - Proc. World Wide Web Conf. WWW 2018*, pp. 1745-1754, Apr. 2018, doi: 10.1145/3178876.3186180.
- [4] J. Lehmann, C. Castillo, M. Lalmas, and R. Baeza-Yates, "Story-focused Reading in Online News and its Potential for User Engagement," *J. Assoc. Inf. Sci. Technol.*, vol. 68, no. 4, pp. 869-883, Apr. 2017, doi: 10.1002/ASI.23707.
- [5] D. Lagun and M. Lalmas, "Understanding and Measuring User Engagement and Attention



- in Online News Reading,” *WSDM 2016 - Proc. 9th ACM Int. Conf. Web Search Data Min.*, pp. 113–122, Feb. 2016, doi: 10.1145/2835776.2835833.
- [6] A. D. Shaikh and B. S. Chaparro, “A Survey of Online Reading Habits of Internet Users,” <http://dx.doi.org/10.1177/154193120404800528>, vol. 48, no. 5, pp. 875–879, Nov. 2016, doi: 10.1177/154193120404800528.
- [7] C. E. Loh and B. Sun, “‘I’d Still Prefer to Read the Hard Copy’: Adolescents’ Print and Digital Reading Habits,” *J. Adolesc. Adult Lit.*, vol. 62, no. 6, pp. 663–672, May 2019, doi: 10.1002/JAAL.904.
- [8] B. D. Sawyer, J. Dobres, N. Chahine, and B. Reimer, “The Cost of Cool: Typographic Style Legibility in Reading at a Glance,” <https://doi.org/10.1177/1541931213601698>, vol. 2017-October, pp. 833–837, Sep. 2017, doi: 10.1177/1541931213601698.
- [9] J. Amar, O. Droulers, and P. Legoh  rel, “Typography in destination advertising: An exploratory study and research perspectives,” *Tour. Manag.*, vol. 63, pp. 77–86, Dec. 2017, doi: 10.1016/J.TOURMAN.2017.06.002.
- [10] M. J. Song *et al.*, “A Process Evaluation of a Web-Based Mental Health Portal (WalkAlong) Using Google Analytics,” *JMIR Ment Heal.* 2018;5(3)e50 <https://mental.jmir.org/2018/3/e50>, vol. 5, no. 3, p. e8594, Aug. 2018, doi: 10.2196/MENTAL.8594.
- [11] M. Yamba-Yugsi, S. Lujan-Mora, and H. Pacheco-Romero, “Using Google Analytics to Analyze Users of a Massive Open Online Course,” *Proc. - 2019 Int. Conf. Inf. Syst. Comput. Sci. INCISCOS 2019*, pp. 280–285, Nov. 2019, doi: 10.1109/INCISCOS49368.2019.00051.
- [12] J. Feyrer *et al.*, “Demographics and Productivity *.”
- [13] Y.-C. Hsieh, C.-T. Kuo, and H. Lin, “The Effect of Screen Size of Mobile Devices on Reading Efficiency,” *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 9754, pp. 435–445, 2016, doi: 10.1007/978-3-319-39943-0_42.
- [14] Y. Ou, “Typography and Its Implementation on Websites,” no. April, 2019.
- [15] Dinas Pendidikan dan Kebudayaan, “Petunjuk Teknis Penerimaan Peserta Didik Baru (PPDB) Provinsi Jawa Tengah.”
- [16] M. Brysbaert, “How many words do we read per minute? A review and meta-analysis of reading rate,” *J. Mem. Lang.*, vol. 109, 2019, doi: 10.1016/j.jml.2019.104047.
- [17] M. R. Sibali and A. F. Amran, “Hubungan Antara Kecepatan Membaca Dengan Kemampuan Memahami Isi Bacaan Siswa Kelas Vii Smp Negeri 4 Kota Makassar,” *Semin. Int. Riksa Bhs.*, 2019, Accessed: Feb. 04, 2022. [Online]. Available: <http://proceedings2.upi.edu/index.php/rik sabahasa/article/view/1023>.
- [18] CXL, “Bounce Rate Benchmarks: What’s a Good Bounce Rate, Anyway?” <https://cxl.com/guides/bounce-rate/benchmarks/> (accessed Mar. 23, 2022).
- [19] Littledata, “Average bounce rate from desktop Google search for All websites 20k - 500k | Littledata Benchmarks.” <https://www.littledata.io/average/bounce-rate-from-desktop-Google-search> (accessed Mar. 23, 2022).
- [20] J. Peyton, “Good, Bad, Ugly, and Average Bounce Rates | The Rocket Blog.” <https://www.gorocketfuel.com/the-rocket-blog/whats-the-average-bounce-rate-in-google-analytics/> (accessed Mar. 23, 2022).

IS/IT STRATEGIC PLANNING USING WARD AND PEPPARD METHOD (CASE STUDY : PT.XY)

Rediva Kezia Wijanarko^{1*}; Andeka Rocky Tanaamah²

Program Studi Sistem Informasi^{1*,2}
Universitas Kristen Satya Wacana
www.uksw.edu

682018076@student.uksw.edu^{1*}; atanaamah@uksw.edu²

(*) Corresponding Author

Abstract— The role of information systems in the company is an important part to assist in business processes. However, there are still obstacles in the company's business processes that are not in appropriate with the vision and mission as well as the goals of the company. So, a good and appropriate IS/IT strategic planning is needed to be able to help companies compete. The purpose of this research is to analyze the strategic planning of the business information system of PT. XY so that it is expected to solve the problem. This study uses a qualitative method conducted by conducting interviews with one of the employees and literature studies which are then analyzed using the Ward and Peppard method which includes Value Chain Activity analysis, Five Competitive Forces analysis, SWOT analysis, Application Portofolio using McFarlan Strategic Grid and proposal analysis information systems. The final result of this research is a portofolio of information system applications such as a Website-based Inventory Management System. In addition, there is an implementation plan for the proposed information system which is expected to help business processes become more efficient and effective.

Keywords: Information System, Inventory, Strategic Planning, Value Chain Activity, Ward and Peppard.

Intisari— Peranan sistem informasi dalam perusahaan menjadi bagian penting untuk membantu dalam proses bisnis. Namun, masih terdapat kendala pada perusahaan dalam proses bisnis yang kurang sesuai dengan visi dan misi serta tujuan dari perusahaan. Maka, dibutuhkan perencanaan strategis SI/TI yang baik dan tepat untuk dapat membantu perusahaan dalam bersaing. Tujuan dari penelitian ini adalah untuk menganalisis perencanaan strategis sistem informasi bisnis PT. XY sehingga diharapkan dapat mengatasi permasalahan. Penelitian ini menggunakan metode kualitatif yang dilakukan dengan melakukan wawancara terhadap salah satu karyawan dan studi literatur yang kemudian di analisis menggunakan metode Ward and Peppard yang meliputi analisis Value Chain Activity, analisis Five Competitive Forces, analisis SWOT, Application Portofolio menggunakan analisis McFarlan Strategic Grid dan analisis usulan sistem informasi. Hasil akhir dari penelitian ini berupa portofolio aplikasi sistem informasi seperti Sistem Inventory Management berbasis Website. Selain itu, terdapat rencana implementasi usulan sistem informasi yang diharapkan dapat membantu proses bisnis agar menjadi lebih efisien dan efektif.

Kata Kunci: Inventori, Perencanaan Strategis, Sistem Informasi, Value Chain Activity, Ward and Peppard

INTRODUCTION

The improvement in Information Technology gives a significant impact on human beings. As well as the improvement of Information Systems that are so important for industry or organization in business. Even though, there are some industries or organizations that still need some development on their current IS/IT. The nature of information systems in today's organizations coupled with increasing pressure to leverage technology assets has increased the importance of the strategic design

of information systems [1]. So, the application of IS/IT and strategic planning is needed by the industries and organizations to improve their business process and hopefully can win the market share. The application of IS/IT can help industries in decision-making. But, before applying the IS/IT to the business process of the organization, well-prepared IS/IT strategic planning is needed that supports the industry or organizations' vision, mission, and goals [2]. Strategic planning is a process of analysis and assessment that creates a strategy by designing several methods of activities

needed and using resources efficiently [3]. The benefit of Information System Strategic Planning is to be more focused on using various methods of Information System Strategic Planning [4].

PT. XY is the largest manufacturing company engaged in the production and distribution of carbonated soft drinks. In carrying out the business process of PT. XY already uses several information systems, but the company has difficulty managing inventory. In addition, the preparation of the company's financial statements also experienced difficulties. The reason for the disguise of the company's name is because the company asked that for the consideration of publication, the company name should be disguised.

Utilization of the Ward and Peppard framework in the PT. XY is considered suitable for structuring a strategic IS/IT plan because this framework has a comprehensive framework [2]. Through the Ward and Peppard method, which can analyze the internal and external business environment, the internal and external IS/IT environment is expected to assist the company in long-term business processes.

Based on the IS/IT Strategic Planning research using the Ward and Peppard method in 2017 [5] resulted in a strategy that not only focuses on IS/IT but also deals with business processes to a portfolio of applications that can be implemented by the company.

After that, in a study that discussed Information System Strategic Planning Using the Ward and Peppard Method in 2020 [6], PT. Hostingan Awan Indonesia is having difficulty with the output of each division that has not been documented and well-integrated between divisions. And there are still some stakeholders who do not have standard SOPs to provide results that are following what they want to achieve. The purpose of this study is to provide solutions for each main and supporting activity according to each stakeholder in the company.

Then in a study entitled Strategic Planning of Information Systems at the Binterbusih Foundation Semarang Using Ward and Peppard [7] problems were found in the manual management and reporting process. Which then resulted in several SI applications such as SI Scholarship Management, SI Archiving and Assets, SI Finance, and Payroll SI Accounting. Some of these applications will be developed independently gradually over 4 years type of application.

Some of these studies found similarities in the research theory, so it is hoped that it can help PT. XY in improving business performance by the vision and mission as well as the company's goals, such as improving service quality, assisting in decision making, expanding the market, and being able to

generate innovative ideas for the implementation of IS/IT in the future [8].

Thus, with the IS/IT Strategic Planning Research Using the Ward and Peppard Method at the company PT. XY is expected to be able to overcome the problems of inventory management and the preparation of the company's financial statements.

MATERIALS AND METHODS

The methodology is a combination of methods, techniques, and tools used to do something. The purpose of using the methodology in IS/IT strategic planning is to minimize the risk of failure, ensure the involvement of all interested parties and minimize individual dependencies, and put more emphasis on the processes and targets set [9]. This study uses a qualitative method, the data collection process is carried out by interviews and literature studies using the Ward and Peppard method. Ward and Peppard's research method starts from an analysis of business conditions and existing IS/IT conditions which are considered less effective. Next is to analyze external business conditions to increase the competitive advantage of an organization. Then an internal IS/IT analysis is conducted to assess whether the use of IS/IT is appropriate and maximal, then compared with the IS/IT conditions from external organizations. This is necessary. Sometimes the existing IS/IT becomes less useful for the organization because it does not meet business needs [10]. In this methodology, there are several methods of data processing, namely SWOT analysis, Value Chain Activities, Five Competitive Forces, and McFarlan Strategic Grid Analysis. (Figure 1)

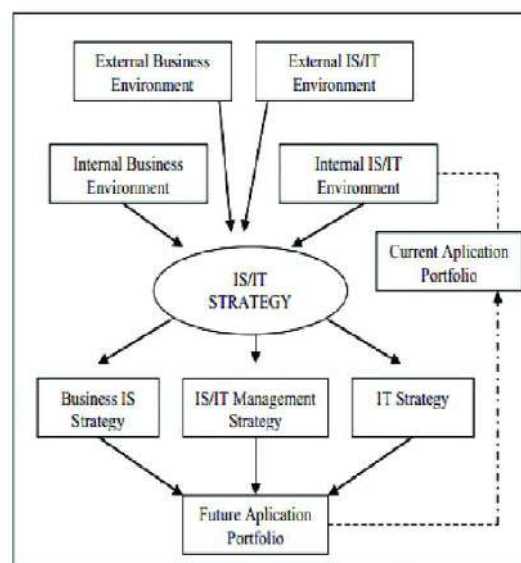


Figure 1. IS/IT Strategic Planning Model [4]

This methodology consists of input stages and output stages. The input stages consist of:

1. Internal Business Environment Analysis, analyzing the current condition of business processes to find appropriate solutions and developments to achieve company goals and be more competitive [11].
2. External Business Environment Analysis, identifying everything that happens outside the company where the Five Competitive Forces method is used in conducting the analysis [11].
3. IS/IT Internal Environmental Analysis. Identify the state of IS/IT in PT. XY by seeing whether it is appropriate and in line with existing business processes [11].
4. IS/IT External Environmental Analysis. Identify trends in the use of technology that is currently developing, both in terms of customers and competitors [11].

While the output stages of IS/IT strategic planning are:

1. Business IS strategy, including how to use IS/IT from the company in achieving business goals [11].
2. IT strategy, including the management of information technology and existing human resources.
3. IS/IT Management Strategy, including IS/IT policies required at PT. XY to maximize its use [11].

From these two stages, a portfolio of future applications will be created, in the form of proposed applications that can be developed to integrate each part and harmonize technological developments with the organization's business development. Furthermore, this portfolio becomes the basis for further system improvement and development [2].

RESULTS AND DISCUSSION

1. Vision and Mission

a. Vision

Every day creates millions of happy moments and share opportunities.

b. Mission

Taking the initiative, being candid and open, focusing on today and the future.

2. Porter's Value Chain Analysis

Value Chain analysis is carried out to map all work processes that occur in the organization into two categories of activities, namely main activities and supporting activities [9]. The following are the results of the Value Chain analysis at PT. XY shown in Figure 2.



Figure 2. Value Chain Analysis Result

Based on Figure 2, the main activities are obtained, namely the procurement of raw materials from the central company, processing of raw materials using production machines and quality control, packaging and distribution to distributor outlets, product pricing and product promotion, quality maintenance, and development and product innovation to serve customers. Support activities were also obtained, namely the use of high-tech machines in the production process, empowerment of human resources, the use of IS/IT in business processes, and the purchase of production raw materials.

3. Porter's Five Competitive Forces Analysis

This method is used to analyze and anticipate 5 external factors of the company that can be a threat [12]. First, is the threat of new entrants with the renewal of government regulations/rules related to packaged beverage companies, so that they can benefit competitors. Second, bargaining with suppliers is concerned that the company cannot procure raw materials independently so the bargaining power of suppliers is of high value because the company requires raw materials from

suppliers. Third, the bargaining power of customers, PT. XY can suppress the bargaining power of customers according to the standard market price. Fourth, is the threat of substitute products, namely the threat from competitors who produce other packaging and offer lower prices, so that PT. XY should produce a better product. Fifth, is intra-industry competition, namely the threat from large companies that also produce packaged carbonated/soda drinks. (Figure 3)

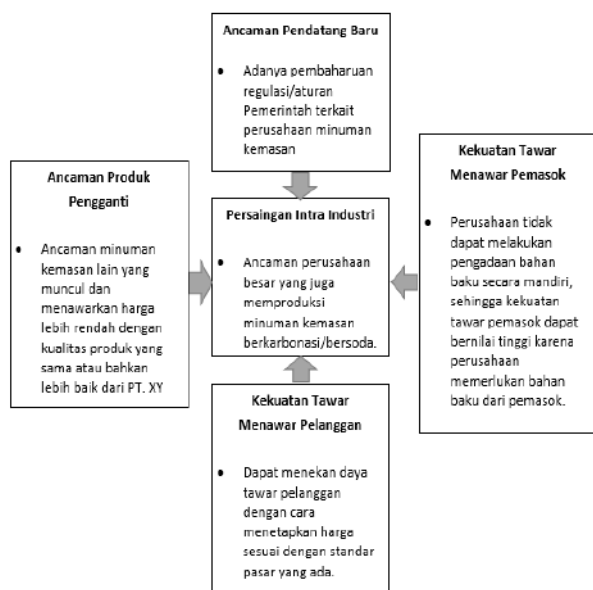


Figure 3. Porter's Five Competitive Forces Analysis

4. SWOT Analysis

SWOT analysis consisting of Strengths, Weaknesses, Opportunities, Threats is used to assess the strengths and weaknesses of the resources owned by the organization or company as well as external opportunities and challenges that will be faced [13]. From the results of interviews conducted, so that the results of the SWOT analysis are shown in Table 1.

Table 1. SWOT Analysis

Strength	Weakness
<ul style="list-style-type: none"> - Distribution data collection system owned by PT. XY can increase sales results through the managed distribution of products to sales outlets. In addition, this system can monitor the distribution process so that the distribution of products can be evenly distributed. 	<ul style="list-style-type: none"> - It is necessary to maintain existing systems and tools regularly to avoid unwanted things from happening.
<ul style="list-style-type: none"> - There is a good Quality Control system to ensure 	

that the products to be distributed to consumers are the best products.

Opportunity	Threat
<ul style="list-style-type: none"> - Consumers are facilitated to get products so that sales results increase. - Consumers are satisfied with good quality products. 	<ul style="list-style-type: none"> - Competitors have a similar system, or even better than the system owned by PT. XY.

5. McFarlan Strategic Grid Analysis Application Portofolio

McFarlan Strategic Grid Analysis aims to analyze an application or information system in an organizational operation based on current conditions, planned conditions, and applications that are considered potential to support the organization's operational business [6]. McFarlan analysis is divided into four quadrants, namely strategic, high potential, key operational, and support. Below are the results of the analysis of the mapping of information systems that currently exist at PT. XY, shown in Table 2.

Table 2. McFarlan Strategic Grid Analysis

STRATEGIC	HIGH POTENTIAL
<ul style="list-style-type: none"> - Article Master Feature for managing company product master data - Order Entry feature to record sales transaction data 	<ul style="list-style-type: none"> - Management Support System consisting of Company Dashboard, Hyperion Essbase, and SQL Server Reporting Service - Oracle Database Usage
KEY OPERATIONAL	SUPPORT
	<ul style="list-style-type: none"> - Email - Microsoft SQL Server Reporting Service for monitoring dan controlling

6. Information System Recommendation

From the results of the analysis of the system owned by PT. XY, obtained a proposed information system that can help and improve the work of the existing system. The following are the results of the proposed information system shown in Table 3.



Table 3. Information System Recommendation

Information System Recommendation	User	Application Type
Sistem <i>Inventory Management</i>	All Employees	Web
Sistem <i>Sales Accounting & Account Receivable</i>	Sales and Marketing	Web

7. Application Portofolio

Then from the results of the proposed information system that produces an Inventory Management System and a Sales Accounting & Account Receivable System, it will be mapped into the McFarlan Strategic Grid which aims to find information systems used in the preparation of application development proposals to produce IS/IT strategic designs for the future [14], application portfolio mapping is shown in Table 4.

Table 4. Application Portofolio Mapping in McFarlan Strategic Grid

STRATEGIC	HIGHT POTENTIAL
KEY OPERATIONAL	SUPPORT
- Inventory Management System	
- <i>Sales Accounting & Account Receivable System</i>	

8. GAP Analysis

In the gap analysis, several existing information systems need to be upgraded (upgraded), deleted (delete), and planned (planning) for updates to suit the expected IS/IT conditions. The following is the result of the gap analysis at PT. XY, shown in Table 5.

Table 5. GAP Analysis

Usulan Sistem Informasi	Upgrade	Delete	Planning
Article Master Feature	✓		
Order Entry Feature	✓		
Sistem <i>Inventory Management</i>			✓
Sistem <i>Sales Accounting & Account Receivable</i>			✓
<i>Management Support System</i>	✓		

Oracle Database	✓
Email	✓
Microsoft SQL Server Reporting Service	✓

9. Information System Recommendation Implementation Planning

The implementation plan is prepared according to the results of the proposed information system that has been made. The implementation plan must also take into account the funds and time the company has, to implement the proposed information system [15]. (Table 6)

Table 6. Implementation Planning Timeline

IS/IT Recommendation	2022	2023	2024
Sistem <i>Inventory Management</i>			
Sistem <i>Sales Accounting & Account Receivable</i>			

CONCLUSION

Based on the results of research and analysis conducted at PT. XY produces application portfolio recommendations in the form of an Inventory Management System and a Sales Accounting & Account Receivable System. This Inventory Management System is a company asset management system designed to assist companies in managing inventory automatically. And for the Sales Accounting & Account Receivable System, is a system for compiling financial reports as a whole. With the implementation of this system, it is hoped that in the future inventory management and financial reports at PT. XY will be more efficient and effective in supporting the entire distribution process, production, and quality of goods owned by the company.

REFERENCE

- [1] M. Metode and W. Dan, "Perancangan Strategis Sistem Informasi... (Nugroho dkk.)," pp. 128–134, 2002.
- [2] D. E. Prasetyo and A. F. Wijaya, "Perencanaan Strategis SI/TI menggunakan Framework Ward and Peppard (Studi

- Kasus: PO. Blue Star),” *J. Telekomun. dan Komput.*, vol. 10, no. 3, p. 177, 2020, doi: 10.22441/incomtech.v10i3.9802.
- [3] A. A. Erwin Teguh Arujisaputra, “PERENCANAAN STRATEGIS SI/TI MENGGUNAKAN METODE WARD AND PEPPARD DI CV.MAXXINDO,” *LPKIA*, vol. 12, no. 01, 2019.
- [4] A. F. Wijaya and V. D. R. Damara, “Perencanaan Strategis Si/Ti Pada Document Management Menggunakan Ward and Peppard (Studi Kasus: Pt. Visionet Data International),” *J. Bina Komput.*, vol. 2, no. 1, pp. 33–43, 2020, doi: 10.33557/binakomputer.v2i1.796.
- [5] Y. Firmansyah, D. Purwaningtias, T. Pudjadi, and A. Tommy, “Tinjauan Metodologi Ward dan Peppard Dalam Menentukan Perencanaan Strategis SI / TI Pada Perusahaan,” *Semin. Nas. Apl. Teknol. Inf.*, vol. 01, no. 02, pp. 7–12, 2017.
- [6] D. E. Ramanda Sembiring Pelawi and A. F. Wijaya, “Information System Strategic Planning In PT. Hostingan Awan Indonesia Using Ward & Peppard Methodology,” *J. Inf. Syst. Informatics*, vol. 2, no. 2, pp. 267–278, 2020, doi: 10.33557/journalisi.v2i2.70.
- [7] D. Wandikbo and M. N. N. Sitokdana, “739-Article Text-1397-1-10-20191221,” no. 1, pp. 61–69, 2019.
- [8] I. G. Susanto and A. F. Wijaya, “Renstra SI atau TI Unit Bisnis (Branch IT Services) Menggunakan Metode Ward and Peppard (Studi Kasus: PT. XYZ),” *J. SITECH Sist. Inf. dan Teknol.*, vol. 2, no. 1, pp. 1–12, 2019, doi: 10.24176/sitech.v2i1.3053.
- [9] Ari Wedhasmara, “LANGKAH-LANGKAH PERENCANAAN STRATEGIS SISTEM INFORMASI DENGAN MENGGUNAKAN METODE WARD AND PEPPARD | Wedhasmara | Jurnal Sistem Informasi,” *Jsi*, vol. VOL. 1, NO, no. 1, pp. 14–22, 2017, [Online]. Available: <https://ejournal.unsri.ac.id/index.php/jsi/article/view/704>.
- [10] S. Parama Putra, K. Rahmat, and E. Guslinar Perdana, “Informasi, Perencanaan Strategis Sistem Pada, Menggunakan Metode Ward and Peppard,” *Eur. J. Endocrinol.*, vol. 171, no. 6, pp. 727–735, 2014, [Online]. Available: <https://ejournal.bioscientifica.com/view/journal/s/eje/171/6/727.xml>.
- [11] E. A. Supriyanto and A. D. Manuputty, “Perencanaan Strategis Sistem Informasi Dengan Metode Ward and Peppard Pada Perusahaan Ekpedisi (Studi Kasus: TIKI Cabang Kota Salatiga),” *J. Inf. Syst. Informatics*, vol. 3, no. 1, pp. 57–71, 2021, doi: 10.33557/journalisi.v3i1.90.
- [12] Y. Septiana, “PERENCANAAN STRATEGIS SISTEM INFORMASI DENGAN PENDEKATAN WARD AND PEPPARD MODEL (Studi Kasus: Klinik INTI Garut),” *Wawasan Ilm.*, vol. 8, no. 1, pp. 68–85, 2017, doi: 10.38204/tematik.v4i1.173.
- [13] N. Sujana, “Perencanaan Strategis Sistem Informasi Dengan Pendekatan Ward and Peppard,” *Tematik*, vol. 4, no. 1, pp. 68–85, 2017, doi: 10.38204/tematik.v4i1.173.
- [14] A. Lah, Y. Rahardja, and M. N. N. Sitokdana, “Perencanaan Strategis Sistem Informasi Menggunakan Metode Ward and Peppard Pada Pt. Serasi Autoraya,” *Sebatik*, vol. 23, no. 1, pp. 185–191, 2019, doi: 10.46984/sebatik.v23i1.467.
- [15] P. Studi, S. Informasi, F. T. Informasi, U. Kristen, and S. Wacana, “(Jurnal Mahasiswa Teknik Informatika) Vol. 6 No. 1, Februari 2022,” vol. 6, no. 1, pp. 79–85, 2022.

3D ANIMATION DESIGN "SCIENCE, LANTERNS TO HEAVEN" USING POSE-TO-POSE METHOD

Desy Apriliyanti ^{1*)}; Juniardi Nur Fadila ²; Fresy Nugroho³

Informatics Engineering ^{1,2,3}
Universitas Islam Negeri Maulana Malik Ibrahim Malang
<http://informatika.uin-malang.ac.id/>
19650007@student.uin-malang.ac.id^{1*)}, juniardi.nur@uin-malang.ac.id², fresy@ti.uin-malang.ac.id³

(*) Corresponding Author

Abstract— In today's era, technology and communication have experienced very rapid development. Islamic values raised through the media is an effort in people's lives today. Including through the media of 3D animated films that rely on entertaining audio-visuals and messages conveyed through animated films can also be easily captured by the audience. In addition, the selection of animated films is based on the number of animated films circulating on social media such as YouTube and other electronic media, this film can actually affect the attention of many people. Animated film designed by the author with the theme of the importance of studying which can lead to Allah SWT's heaven. Making this animated film will use Blender software version 2.80. The method used is "Pose-to-Pose" by determining each keypose movement in order to produce a good movement. Using this method makes the work more effective or faster and if there is an error in the pose, it can be easily corrected. The design of the 3D animated film entitled "Science, Lantern Towards Heaven" is expected to be useful for the audience and take the moral message in it, which is to increase enthusiasm in learning or studying.

Keywords: 3D Animation, Pose to Pose, blender, Islamic, Science.

Abstrak— Pada era sekarang ini, teknologi dan komunikasi sudah mengalami perkembangan yang sangat pesat. Nilai keislaman yang diangkat melalui media merupakan suatu keberuntungan di kehidupan masyarakat sekarang ini. Termasuk melalui media film animasi 3D yang mengandalkan audio-visual yang bersifat menghibur dan pesan yang disampaikan melalui film animasi juga dapat ditangkap dengan mudah oleh penonton. Selain itu, pemilihan film animasi didasarkan pada semakin banyaknya film animasi yang beredar di sosial media seperti youtube maupun media elektronik lainnya, film ini ternyata dapat memikat perhatian banyak orang. Film animasi yang dirancang oleh penulis bertemakan pentingnya dalam menuntut ilmu yang bisa membawa menuju surga-Nya Allah SWT. Pembuatan film animasi ini akan menggunakan software Blender versi 2.80. Metode yang digunakan adalah "Pose-to-Pose" yaitu dengan cara menentukan setiap keypose gerakannya agar menghasilkan gerakan yang baik. Penggunaan metode ini membuat pengerjaan menjadi lebih efektif atau lebih cepat dan jika terdapat kesalahan pose, dapat dengan mudah diperbaiki. Perancangan film animasi 3D yang berjudul "Ilmu, Lentera Menuju Surga" diharapkan penonton dapat terhibur dan mengambil pesan moral di dalamnya yaitu meningkatkan lagi semangat dalam belajar atau menuntut ilmu.

Kata Kunci: Animasi 3D, Pose to Pose, Blender, Islami, Ilmu.

INTRODUCTION

The development of information technology is now growing so rapidly that the use of information technology develops as well. One of the results of the development of information technology is multimedia [1]. The use of multimedia technology can produce an animation that in its development is complicated and requires the perseverance of an animator. Especially since the development of animation from 2D to 3D animation

makes the development of information technology more rapid. [2]

In the production of a 2D animated film and 3D animation, animating is an important process with the final appearance of an animated motion series [3]. The use of a large number of images can produce animation with good quality and smoother animation movements. The audience will not be interested and it is difficult to capture the story told in an animation if the movement looks stiff and less realistic [4]. Animators need to understand the

basic principles and methods used in animating to produce good quality animation motion.[5]

The methods used by animators in creating animation are numerous, one of which is the pose-to-pose method [6]. The pose-to-pose method can make the animating process work well because it has several advantages compared to other methods. The advantages of this method are faster work time, well-conceptualized animated motion, and corrections made to the wrong pose can be done easily.[4]

The creation of the 3D animation "Science, Lanterns To Heaven" is more intended for children to see. In this day and age, children are often lazy to learn because of the frequent playing of games. So, this animation is made which is expected so that children can capture the message conveyed, namely diligence and passion in learning, can manage time, and obey the words of parents. In addition, the creation of this animation also aims so that children can remember prayers before learning easily. Delivered in the form of animation because in the age of children the spectacle that they are very fond of is animated films. In addition, this animated film is also good for the imagination needed and good for the development of children.[7]

Based on the background described by the author above, the animation is made that is as interesting as possible so that more fans and not boring, and the message that the author wants to convey can be captured by the audience. This animation is created using blender software 2.8 and the method used is pose-to-pose.

3D animation is a development of 2D animation. 3D animation is a dimension that has space so it is commonly called building space [8]. There are 3-dimensional elements, namely length, width, and height. The difference with 2D animation is that 2D animation can only be moved to the right and left sides, up, and down. While 3D animation can be moved in a direction that is to the right and left side, up, down, forward, and also backward [9]. The stage of creating 3D animation starts from modeling to rendering.[8]

Animation work using the pose-to-pose method starts from the overall planning of the movement to be made animation and then after that the determination of each key pose or key pose in each character's movement. A key pose is also referred to as the main movement, which is a collection of initial movements or poses that indicate a particular movement. After the key pose is completed, the next is to combine the movements between existing poses by inserting a pose between two poses or images commonly called the breakdown key. Then, so that the movement results are smoother, inserted another image between the

breakdown key and key pose commonly called in between.[11]

The Qur'an is a guide to life for mankind in which there are various instructions. One of them is a guide to study. In Surah al-'Alaq verse 1 it is mentioned that "the study is an obligation for a Muslim." There is no age limit for a person to study. In addition to an obligation, in the hadith of Muslim history no. 2699 it is also mentioned that "whoever takes the path to seek knowledge, Allah will make it easy for him the way to paradise" [12]. From the verses and hadiths, it has been explained that demanding knowledge is very important which is an obligation for Muslims and facilitates the way to the paradise of Allah SWT.

MATERIALS AND METHODS

There are three stages in the flow of research methods to get the final result, must be interrelated all the parts in the workflow commonly called the pipe line, the stage starts from pre-production, production, and lastly is post-production [13]. This stage is presented in figure 1.

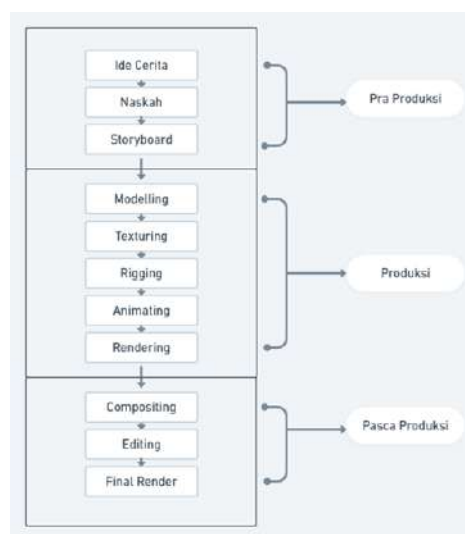


Figure 1. Research Method Diagram

1. Pre-Production Stage

The pre-production stage is the initial process in the creation of a 3D animation. Here's an explanation of the pre-production stages:

Story Ideas

This phase is the phase where the animator creates an idea from a 3D animated story that will be created later. This phase aims to make the storyline clear [14]. To get a story that is creative and interesting, a good story concept is needed by looking for as many references as possible. The process in this phase starts from making a story concept, then taken in outline and then written in

detail including the selection of a character, conflict issues to be raised in the story, and the purpose of the animated story to be created. [15]

Script

Scripting is one of the important things in the process of making 3D animation because the script is the main foundation of a storyline. This script aims to help in the process of portraying the entire course of the story. The content of a script is there are conversations, conditions, narratives, scenes, and also time. [16]

Storyboard

After the script, the next step is to create a storyboard. Storyboards are based on a previously created script, used to make it easier for an animator to create an animated clip [17]. A storyboard contains a series of images that are usually accompanied by directions or dialogue that explain the image with images arranged in sequence according to the scene that has been written on the script. [14]

2. Production Stage

The production phase is the core process of creating 3D animation. This stage is the stage of the start of the construction of a project in which it comes into contact with 3D [18]. Here is an explanation of the stages of production:

Modeling

The modeling stage is used to create an object [6]. Modeling using a blender in the creation of 3D animations is done per character, asset, and environment. Modeling on a blender can be done using a mesh tool that is already available with the shortcut shift + a, then choosing the required mesh object [19].

Texturing

The texturing stage is the stage that is done after the modeling process is completed. This stage is the process of creating and giving color and texture to objects that define the appearance and type of material of the 3D object to make it look more real [20]. One of the techniques used in texturing in blenders is the UV Mapping and Texture Painting techniques. These techniques serve to add detail, surface texture, and color to the object so that the technique can make the coloring of 3D objects more real [21]. In the blender, there is a material mode feature in which contains several methods for the texturing process.

Rigging

The Rigging stage is the stage of giving armature to a 3D object that has been modeled so

that the object can later be moved and look real [10]. The function of the armature is the same as the function of bones in humans, and the structure of the given armature is also the same as the structure of the human bone. Rigging here will facilitate the animating process later. How to add armature to a blender is to press space, then add, and then choose armature. [22]

Animating

The animating stage is the stage of moving 3D objects. The movement is adapted to a pre-designed scenario [22]. At this stage, the whole process uses the pose-to-pose method starting from the determination of the key pose, then extreme, and finally for its refinement is in between [15]. So animators using this method only draw certain keyframes only. This method animates the images one by one, both for frame by frame and keyframe.[23]

Rendering

The rendering stage is the stage to produce an output in the form of an image or movie [24]. [24]. This process will produce an overall image of all animated scenes that have been designed in previous processes including for the laying of light, shadow, color, and others [16]. The main key to the rendering process is the balance between the visual complexity required with the speed of rendering that conveys the number of frames that can be rendered at any given time. [25]

3. Post-Production Stage

The post-production stage is the last stage in the creation of 3D animation containing compositing, editing, and final rendering. Here's an explanation of the post-production stages :

Compositing

The compositing stage is a stage that contains the process of filling the voice of a character or commonly called dubbing. At this stage the voice actor or commonly known as the dubber will record the voice based on the dialogue that has been made before and adjusts to the mouth movements of the animated characters that have been made.

Editing

The editing stage is the merging stage of the animation rendering results in the previous process so that it becomes a 3D animated film. At this stage will also add supporting sound effects and other interests to complement an animated film to be made. In addition, in this editing stage, the editor will also check the suitability of the results with the

existing storyboard before entering the last stage, namely the final rendering [19].

Final Render

Final rendering is the final stage in creating 3D animation. The output of the film can be selected according to the needs ranging from small to large. The greater the measure of the file, the better the quality of the video produced [8]. After the final stage of rendering is completed, it means that 3D animations that have been created can be published and watched.

RESULTS AND DISCUSSION

The animated short film entitled "Science, Lanterns to Heaven" has 2 characters, namely Rehan as a child and Umami as Rehan's Mother. The background of the place used in this animation consists of 2 places, namely in front of the house and in Rehan's bedroom. As for the time used is at night. In addition, this animated short film also added some assets that support the background of the place used such as chairs, tables, mattresses, cabinets, and others.

1. Pre-Production

Story Ideas

The author's story idea used in the making of an animated short film titled "Science, Lanterns to Heaven" is based on two hadiths that say that a Muslim must study that can facilitate the path to paradise of Allah SWT. And based on the number of children in this day and age with advanced technology such as mobile phones that make them often spend a full day just playing mobile phones. Games or social media on mobile phones make children forget their obligation to learn in studying so that this animation is made so that it is realized the importance of studying and can divide the time between learning and playing mobile phones. This animation also included prayer before learning so that children can remember that before learning do not forget to read the prayer to be facilitated in capturing lessons and focus and avoiding the temptations of Satan, in addition to making it easier for children who have not memorized prayers before learning.

Script

Broadly speaking, the animated short film titled "Science, Lanterns to Heaven" tells the story of a child who plays mobile phones until he stops playing mobile phones after being advised by his mother who realizes that he has spent a lot of time playing games to forget about learning.

NASKAH FILM PENDEK ANIMASI ISLAMI 3D

"Ilmu, Lentera Menuju Surga"

Diceritakan bahwa seorang anak yang malas untuk belajar karena asyik bermain *game*. Pada suatu malam, seorang anak laki-laki bernama Rehan sedang asyik bermain *handphone* di dalam kamar hingga lupa belajar. "Ayoo ayoo serang!!! Tembak tembak musuhunya, hahaha seru banget *game* ini," ucap Rehan ketika bermain *game* dengan nada keras hingga terdengar dari luar kamar. Ibunya yang biasa dipanggil Rehan dengan sebutan Umami datang menghampiri Rehan. Sambil menunjuk jam dinding yang sudah menunjukkan pukul 7 malam, Umami meminta Rehan untuk berhenti bermain *handphone* karena sudah waktunya untuk belajar. "Rehan, sekarang sudah jam 7 dan waktunya untuk belajar," ucap ibunya Rehan. "Iya, Umami. Sebentar lagi ya hehe masih seru banget nih Umami," jawab Rehan yang meminta waktu sebentar lagi untuk bermain karena terlalu asyik dengan *handphone*-nya. Mendengar jawaban Rehan, Ibunya pun langsung menasihati Rehan secara lemah lembut dengan memberitahu beberapa hadits yang telah disebutkan di atas dan menjelaskan pentingnya ilmu. Setelah selesai dinasihati oleh ibunya, Rehan pun meletakkan *handphone*-nya dan bersiap untuk belajar.

Sebelum membuka bukunya, Rehan terlebih dahulu membaca doa sebelum belajar sambil menandakan tangganinya. Doa sebelum belajar adalah seperti di bawah ini.

رَبِّ زِدْنِي عِلْمًا وَارْزُقْنِي فِيهَا وَاجْعَلْنِي مِنَ الصَّالِحِينَ

Artinya: "Ya Allah, tambahkanlah aku ilmu dan berikanlah aku rizqi akan kepahaman. Dan jadikanlah aku termasuk golongan orang-orang yang shaleh". Setelah selesai berdoa, Rehan membuka bukunya dan siap untuk belajar. Ibunya pun meninggalkan kamar Rehan.

Figure 2. Story Script "Science, Lanterns to Heaven"

Figure 2 explains the contents of the story script that will be used as a 3D Islamic animated short film. The script contains a sequence of scenes that will be made into an animation accompanied by an explanation of the setting of the place, time, dialogue, and characters.

Storyboard

The author has compiled a storyboard that is used as a reference in the making of this 3D animated short film. The following is an image from the storyboard of the animated short film titled "Science, Lanterns To Heaven".



Figure 3. Storyboard

The storyboard description in figure 3 above is as follows:

- 1) Scene 1 in the first image as an intro showing the house of Rehan and his mother,
- 2) Scene 2 in the second gambar shows Rehan playing mobile phone,
- 3) Scene 3 in the third image shows Rehan who is engrossed in playing mobile phones,
- 4) Scene 4 in the fourth image shows at 7 p.m.,
- 5) Scene 5 in the fifth image shows his mother telling Rehan to learn and stop playing mobile phones,
- 6) Scene 6 in the sixth picture shows his mother advising Rehan,
- 7) Scene 7 of the seventh image shows Rehan praying,
- 8) Scene 8 in the eighth image shows Rehan studying,
- 9) Scene 9 in the ninth image shows Rehan studying and his mother who is out of the room,
- 10) Scene 10 in the tenth image as an outro showing the return of Rehan and His Mother's house.

2. Production

Modeling

In blender already provided some features for modeling an object, such as scale to resize objects, rotate to rotate objects, and many other features in object mode, layout mode, and edit mode. The following is an image of the results of modeling assets using features in blender software.

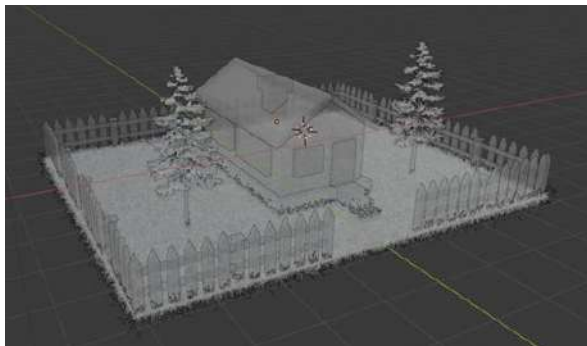


Figure 4. Modeling Home Assets

Figure 4 shows the results of modeling or coding the background of the house and surrounding areas that later in the animation become the first and last scene. Modeling is one of the most important stages in animation creation.



Figure 5. Modelling Bedroom Assets

Figure 5 shows the results of modeling or modeling the background of the bedroom bed and its contents. Modeling of bedroom assets is done in detail because it is the main place in the 3D Islamic animation "Science, Lanterns To Heaven" and almost all scenes of the story scene are set in a bedroom bed.

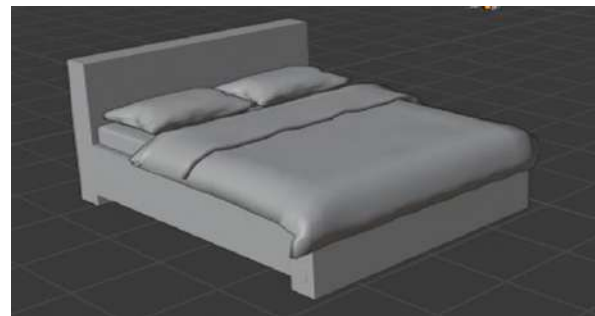


Figure 6. Modeling Bed Assets

Figure 6 shows modeling or modeling one of the assets in the background of the bedroom bed, which is a bed complete with pillows and blankets. Modeling is done as closely as possible with the original, seen from the modeling of pillows and blankets that are as real as possible.

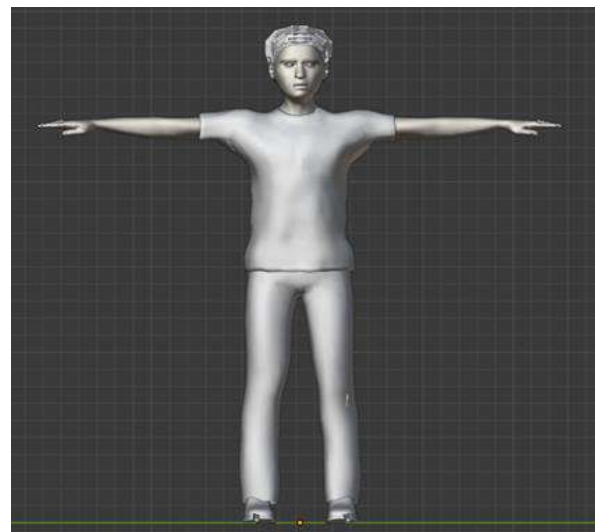


Figure 7. Modeling Male Character Assets

Figure 7 shows the modeling or modeling of one of the animated characters created. Character modeling is done with details from her body to her clothes to look real.

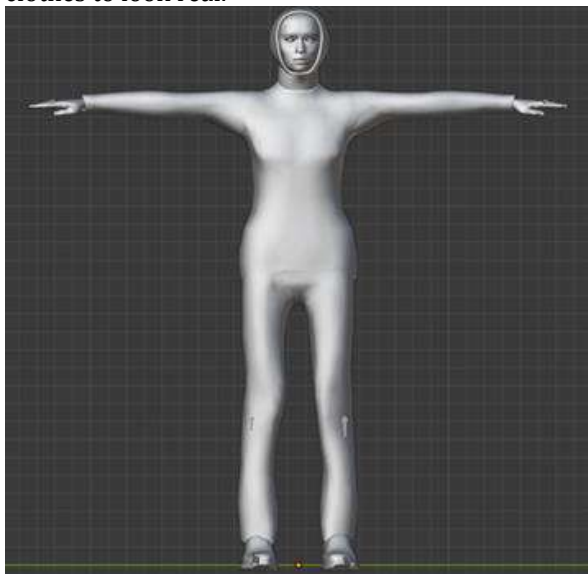


Figure 8. Modeling Female Character Assets

Figure 8 shows the modeling or modeling of one of the animated characters created, namely female characters. Modeling the character on the face is quite difficult because details are needed on the eyes, nose, and others.

Texturing

The blender has been given a feature to texture an object. Texturing can use UV Mapping techniques or use material context tools that are already available in blenders. UV mapping techniques can take some of the textures found on the internet. As for material context tools using basic colors that have been presented in the blender, as well as several other textures. Texturing aims to get 3D objects to become more real. The following is an image of the results of texturing assets using features in blender software.



Figure 9. Texturing Home Assets

Figure 9 shows the results of texturing on the assets of the house and its surroundings. Texturing is done after a modeling process that

makes it more alive. Texturing is done with detail on the part of the tree so that it has a real tree-like texture.



Figure 10. Texturing Bedroom Assets

Figure 10 shows the results of texturing on the part of the bedroom. Texturing is done with details of the color of the wood and also the floor because the bedroom becomes the main setting.



Figure 11. Texturing Bed Assets

Figure 11 shows the texturing results of the assets in the room that is the bed. Wooden textured bed and others use basic colors.



Figure 12. Texturing Male Character Assets

Figure 12 shows the results of texturing on male characters. Texturing on a character is quite difficult because it is done in detail on all parts, from skin color, clothing, and others.



Figure 13. Texturing Female Character Assets

Figure 13 shows the texturing results of the Female character. Texturing on a character is necessary to be like the original. Texturing on clothes is done with details such as on the model and fabric on the clothes.

Rigging

Rigging is the giving of bones to a character object to move as real. After that, a controller is given to set his movements. The controller's given is adjusted to how the character moves expected. The giving of bones in this animation has the same function as bones in humans. The following is an image of the result of rigging character objects using features in blender software.

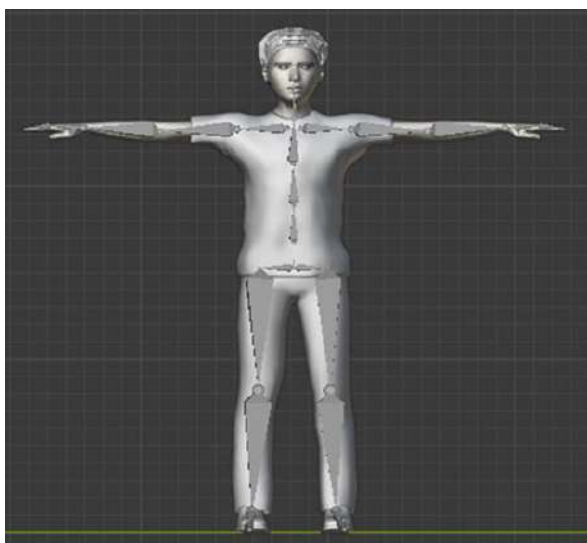


Figure 14. Rigging Male Character Object

Figure 14 shows the results of the male character after the rigging process. Rigging is likened to a human bone so it is done with detail so that it can be moved.

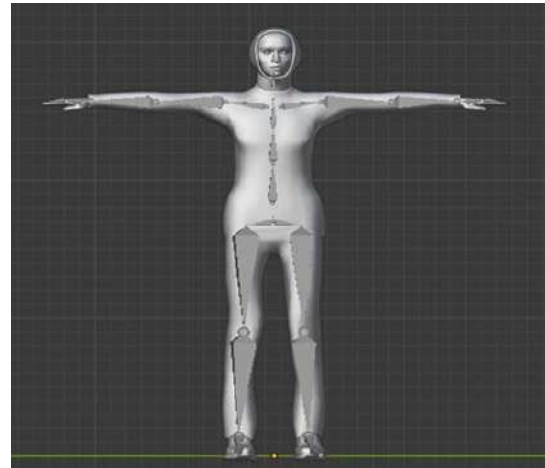


Figure 15. Rigging Female Character Object

Figure 15 shows the results of the Female carcass after the rigging process. Rigging is done on all limbs from head to toe to move like a human.

Animating

Animating is the stage of movement of character objects after the rigging stage before them. The first step taken at the animating stage is to determine the use of frames by using the action editor feature. After that, change from bone mode to pose mode. Then, arrange the movement of bone or bone according to the desired scene. To make it easier, you can search for references from the internet of desired movement scenes as shadows. If the bone has finished set, then click "I" and select "LocRoteScale". The last stage is to set the camera by clicking the camera feature and enabling "Lock Camera to View", then adjust it to what you want. When you're done, disable "Lock Camera to View" and the animation is ready to go to the next stage of rendering. The following is a process image of animating a character object using a feature in the blender software.



Figure 16. Animating Process

Figure 16 describes the process of animating one of the scenes in the animation created. Animating becomes one of the important and difficult processes because in addition to moving the character, in this process there are also settings from the camera, lighting, and others.

Rendering

Rendering is the last stage of production. There are two types of rendering: rendering images and rendering animation. Image rendering is a rendering that produces an images while rendering animation is a rendering that produces a video. The speed of rendering depends on the number of frames and the specifications of the computer or laptop used. The following is an image of the results of rendering using the features in the blender software.



Figure 17. Rehan Scene Rendering Results

Figure 17 shows the rendering of one of the scenes in the animation made, namely in the scene of a male character or named Rehan who is engrossed in playing games on his phone.

3. Post-Production

Compositing

Compositing is a process of voice filling or commonly called dubbing. Voice charging for animated characters using a voice recorder available on a smartphone is then put into the editing stage. Sound recordings correspond to scripts that have been made at an earlier stage and the sound type is adapted to the animated characters.

Editing

Editing is the combination of rendering in the form of images and videos in editing software. In addition to combining rendering results and incorporating compositing results, this stage can also add filters, text, audio, effects, and more by the features of the editing software used. It aims to make the resulting animation more interesting. The following is an image process from editing using features in the video editing application.

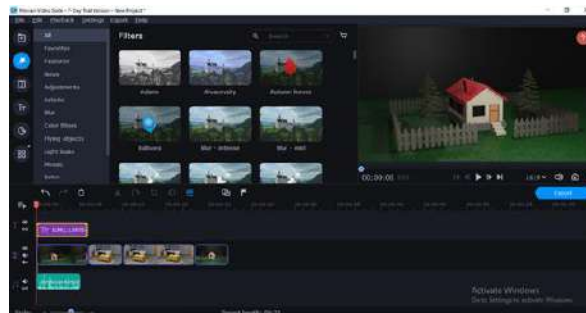


Figure 18. Editing Process

Figure 18 describes the editing process before performing the final rendering. In this editing process in addition to combining several scenes that have been rendered before are also added such as music, dubbing, filters, and others.

Final Render

Final rendering is the last stage in the post-production stage and is also the last stage in the making of a 3-dimensional animated short film. Final rendering is done if the editing stage has been completed by exporting it into mp4 form. The completion of the final stage of rendering means that the filming of the 3-dimensional animated short film "Science, Lanterns To Heaven" has been completed and is ready to be published and watched. The following is an image of the process of final rendering on the video editing application.

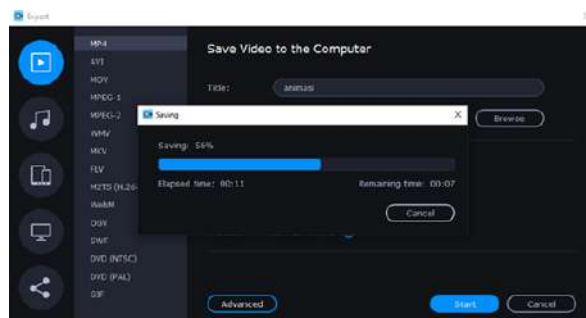


Figure 19. Final Render Process

CONCLUSION

This Islamic-themed 3-dimensional animated short film entitled "Science, Lanterns To Heaven" conveys the importance of studying. The process of making this 3-dimensional animated short film goes through three stages, namely pre-production, production, and post-production. The process of making this animation starts from the determination of the idea of the story to the final rendering and a complete animated film is formed. The method used in this 3-dimensional animation is posed to pose so that the resulting animation looks

smoother and natural so that the message you want to convey can be captured by the audience well.

REFERENCE

- [1] A. Mahardika and H. Destiana, "Animasi Interaktif Pembelajaran Pengenalan Hewan Dan Alat Transportasi Untuk Siswa Taman Kanak - Kanak," *Pilar Nusa Mandiri*, vol. X, no. 1, 2014.
- [2] A. Sirumapea, S. Ramdhan, and S. Aisah, "Film Animasi 3D 'Pemuda yang Hatinya Bergantung pada Masjid,'" *Acad. J. Comput. Sci. Res.*, vol. 3, no. 1, pp. 1-5, 2021, doi: 10.38101/ajcsr.v3i1.317.
- [3] A. R. Putri *et al.*, "Pembuatan Simulasi Perang Zaman Pertengahan dengan Metode Pose to Pose Menggunakan Software Blender," *JISKA (Jurnal Inform. Sunan Kalijaga)*, vol. 6, no. 1, p. 1, 2021, doi: 10.14421/jiska.2021.61-01.
- [4] A. Amin, "Pembuatan Film Animasi Cara Umrah Sesuai Software Blender Skripsi Oleh : Ainul Amin," *Tekno. Pendidik*, p. 134, 2016.
- [5] A. Aryanto, T. Hisyam Muhammad Umar, and D. Winarso, "Analisis Perbandingan Teknik 3D Rendering Cycles Dan Eevee Pada Software Blender," *J. Fasilkom*, vol. 10, no. 1, pp. 11-19, 2020, doi: 10.37859/jf.v10i1.1902.
- [6] D. S. Afrizon, "Metode Pembelajaran Animasi 3D Harimau dengan Algoritma Pose to Pose dan Rekonstruksi Rangka Menggunakan Morphing," pp. 1-115, 2018, [Online]. Available: <https://repository.unsri.ac.id/12539/>.
- [7] E. Tripustikasari and A. D. Septiadi, "Film Animasi Pengenalan Saham Dengan Metode Motion Graphic," *Infotekmesin*, vol. 10, no. 2, pp. 28-32, 2019, doi: 10.35970/infotekmesin.v10i2.51.
- [8] F. Teknologi and D. A. N. Informatika, "Animate Karakter Dalam Produksi Film Animasi 3D 'Mira Diwana' Menggunakan Teknik Pose To Pose," 2018.
- [9] F. Firdaus NA, "Simulasi Gerak Hewan Burung Menggunakan Metode Pose To Pose Dalam Pembuatan Animasi 3d Dalam Surat Al-Fill Skripsi Oleh : Ferly Firdaus Na," p. 91, 2019.
- [10] G. Arka, "Perancangan Dan Pembuatan Klip Video Animasi Band Carmen," pp. 1-54, 2009, [Online]. Available: <http://dx.doi.org/10.1016/B978-0-12-849873-6.00001-7>.
- [11] G. Mencapai and G. Ahli, "Laporan Tugas Akhir Pembuatan Film Animasi 2 Dimensi 'Pertempuran 5 Hari 5 Malam Di Palembang' Kementerian Riset, Teknologi Dan Pendidikan Tinggi Politeknik Palcomtech, 2018.
- [12] H. Nainggolan, "Perancangan Animasi Wayang Pandawa Lima dalam Lakon Pilkada dengan Menggunakan Metode Pose to Pose," *Maj. Ilm. INTL*, vol. 5, no. 1, pp. 64-69, 2017, [Online]. Available: <https://ejurnal.stmik-budidarma.ac.id/index.php/inti/article/view/539>.
- [13] H. Budi Setiawan, "PEMBUATAN FILM ANIMASI 3D 'AIR' MENGGUNAKAN BLENDER 2.5," *Amikom, Yogyakarta*, pp. 1-15, 2012.
- [14] I. H. Purwanto, L. Qodarsih, F. H. Majid, and K. A. Syamrahmarini, "Implementasi Pose To Pose Pada Simulasi Gerak Panda Berjalan Dengan Teknik Frame By Frame," *Explore*, vol. 9, no. 1, p. 43, 2019, doi: 10.35200/explore.v9i1.164.
- [15] K. D, "Etika Menuntut Ilmu dalam Al-Qur'an Surah al-Kahfi Ayat 60-78 (Studi al-Tafsir Marah Labid Syeikh Nawawi al-Bantani)," *UIN SMH BANTEN Instutional Repos.*, pp. 35-40, 2021.
- [16] K. Ainiyah, N. Hidayah, F. P. Damayanti, I. N. Hidayah, J. N. Fadila, and F. Nugroho, "Rancang Bangun Film Animasi 3D Sejarah Terbentuknya Kerajaan Samudra Pasai Menggunakan Software Blender," *JISKA (Jurnal Inform. Sunan Kalijaga)*, vol. 5, no. 3, p. 164, 2020, doi: 10.14421/jiska.2020.53-04.
- [17] M. I. Setiawan, A. Trisnadoli, and E. S. Nugroho, "Penerapan Teknik UV Mapping dan Texture Painting Dalam Pembuatan Film Animasi 3D Bujang Buta," *Teknik*, vol. 40, no. 1, p. 26, 2019, doi: 10.14710/teknik.v39i3.22758.
- [18] S. F. Salmon, V. Tulenan, and B. A. Sugiarto, "Penggunaan Metode Pose to Pose dalam Pembuatan Animasi 3D Tarian Minahasa Maengket," *J. Tek. Inform.*, vol. 12, no. 1, pp. 1-9, 2017, doi: 10.35793/jti.12.1.2017.17867.
- [19] S. Wahyudi, "Pembuatan Film Animasi Tuntunan Sholat Menurut Sunnah Nabi Muhammad SAW Menggunakan Software Blender," pp. 1-136, 2015.
- [20] T. Zebua, B. Nadeak, and S. B. Sinaga, "Pengenalan Dasar Aplikasi Blender 3D dalam Pembuatan Animasi 3D," *J. ABDIMAS Budi Darma*, vol. 1, no. 1, pp. 18-21, 2020.
- [21] U. A. Wildy, "Animating Karakter Pada Film Animasi 3D 'Perjalanan Rempah- Rempah,'" *Politeknik Negeri Jakarta*, 2017.

- [22] V. Waeo, A. S. M. Lumenta, and B. A. A. Sugiarto, "Implementasi Gerakan Manusia Pada Animasi 3D Dengan Menggunakan Menggunakan Metode Pose to pose," *J. Tek. Inform.*, vol. 9, no. 1, pp. 1-8, 2016, doi: 10.35793/jti.9.1.2016.14641.
- [23] Y. Caroline, V. Tulenan, and B. A. Sugiarto, "Rancang Bangun Film Animasi 3 Dimensi Universitas Sam Ratulangi," *J. Tek. Inform.*, vol. 9, no. 1, pp. 1-7, 2016, doi: 10.35793/jti.9.1.2016.14639.
- [24] Y. Syahfitri, "Teknik Film Animasi Dalam Dunia Komputer," *J. SAINTIKOM*, vol. 10, no. 3, pp. 213-217, 2011.
- [25] Y. Affandi, N. Satia Nuryanto, E. Mahendra, and S. Eka Setiawan, "Implementasi Metode Pose to Pose dalam Pembuatan Animasi 2D Gerakan Ruku' Shalat," *Respati*, vol. 14, no. 1, pp. 12-16, 2019, [Online]. Available: <http://jti.respati.ac.id/index.php/jurnaljti/article/view/265>.

PACKAGE RECEIVER BOX BASED ON IOT USING FUZZY MAMDANI AND MOBILE APPLICATION

Ilham Firman Ashari^{1*}; Arimbi Ayuningtyas²

Program Studi Teknik Informatika^{1,2}
Institut Teknologi Sumatera
Itera.ac.id
[firman.ashari@if.itera.ac.id*](mailto:firman.ashari@if.itera.ac.id)

Abstract—The development of information technology is currently growing, where now everything has been transformed digitally. Consumers today to shop no longer need to come to the market. Consumers shop through e-commerce applications and just wait for the goods between the couriers from the expedition to arrive at their doorstep. Based on a survey conducted on March 10, 2021, with 100 respondents, it was concluded that 62% of the problems experienced were the process of receiving packages and security risks during package delivery. Answering the IUI problem requires an IoT-based package receiving box that helps make it easier for couriers to send goods and helps package owners to monitor packages that have been delivered by couriers. This package recipient box is accompanied by an ESP32 Cam camera module to scan the QR code receipt number, ESP8266 helps connectivity and android-based mobile applications with a firebase real-time database to make it easier for package recipients to monitor packages. In helping to facilitate decision making, Mamdani fuzzy logic is used. This research uses the Mamdani method in the use of fuzzy logic with the reason that the formation of fuzzy sets for input and output is formed so that the composition of rules obtained from a collection of correlations between rules and there is affirmation of input from the defuzzification process from the composition of fuzzy rules. From the research experiment, it was found that the system can carry out the package storage process with an average time of 11 seconds and the time required to update to firebase is around an average of ± 3 seconds.

Keywords: Fuzzy Mamdani, IoT, Package Receiver Box, Mobile

Intisari—Perkembangan teknologi informasi saat ini semakin berkembang, dimana sekarang semuanya telah bertransformasi secara digital. Konsumen saat ini untuk berbelanja tidak perlu lagi datang ke pasar. Konsumen berbelanja melalui aplikasi e-commerce dan tinggal menunggu barang antar kurir dari ekspedisi sampai di depan pintu mereka. Berdasarkan survei yang dilakukan pada 10 Maret 2021 dengan 100 responden, disimpulkan bahwa 62% permasalahan yang dialami adalah proses penerimaan paket dan risiko keamanan saat pengiriman paket, dimana kurir tidak menemukan pemilik paket di rumah. Menjawab permasalahan tersebut diperlukan kotak penerima paket berbasis IoT yang membantu mempermudah kurir dalam mengirim barang dan membantu pemilik paket untuk memantau paket yang telah dikirimkan oleh kurir. Kotak penerima paket ini disertai modul kamera ESP32 Cam untuk memindai nomor resi kode QR, ESP8266 membantu konektivitas dan aplikasi mobile berbasis android dengan firebase real-time database untuk memudahkan penerima paket dalam memantau paket. Dalam membantu mempermudah pengambilan keputusan, digunakan logika fuzzy Mamdani. Dari percobaan penelitian didapatkan bahwa sistem dapat melakukan proses penyimpanan paket dengan rata-rata waktu 11 detik dan waktu yang dibutuhkan untuk update ke firebase berkisar rata-rata ± 3 detik.

Kata Kunci: Fuzzy Mamdani, IoT, Packages, Mobile

INTRODUCTION

Entering the era of the industrial revolution 4.0, business and economic activities have transformed into a digital business and economy that is easy and fast to reach by the public. With the convenience that is obtained, people are starting to

be active in using social media and e-commerce to buy goods [1]. One of the conveniences obtained by shopping through the internet is that the goods to be purchased are delivered directly to the house through the delivery company and the buyer can still communicate with the seller via online media or social media [2].

In the process of delivering goods, it takes quite a long time and the estimated time of delivery of goods cannot be determined or uncertain [1]. Based on the survey that has been conducted, it was found that 62% of 100 respondents felt that the absence of people at home was the biggest obstacle in the process of receiving packages. Based on the problems that have occurred, the solution taken by the courier is to leave the goods to the neighbors, put the goods on the fence or the home environment, or store the goods and send them the next day.

From the problems that arise due to the process of receiving packages or goods, a system is needed that can replace the role of the recipient of the package who is not always at home. With this technology, it helps make it easier for users to be able to find out and get information related to their goods by using the internet network as an intermediary for communication [3][4].

Research related to problems that occur using infrared sensors as an indicator of the condition of the door for storing goods or packages that are connected via the homeowner's smartphone, but the drawback is that there is no feature to know when the condition of the box is full and there is no logic for decisions in the status of the box [5]. Another similar system development has been carried out in the manufacture of automatic post boxes by utilizing temperature and humidity sensors to determine the condition of the goods or packages in the box [6]. In system development, a decision-making system is needed to determine the conditions in the system to be made, one of the decision-making systems that can be used is fuzzy logic .

Fuzzy logic is an advanced level of Boolean logic that deals with the concept of truth values. In this regard, fuzzy logic has a condition when it is between 0 or 1 [4]. Fuzzy logic can prove to what extent a value is false and to what extent a value is true. Fuzzy logic has 3 methods, namely Tsukamoto, Mamdani, and Sugeno [7]. In Fuzzy Tsukamoto, each rule is represented by fuzzy sets, with a membership function that is monotonous. In the Mamdani method, when evaluating the rules in the inference engine, the Mamdani method uses the MIN function and the composition between rules uses the MAX function to generate a new fuzzy set. In the Sugeno method, the system output is not in the form of a fuzzy set, but the output is a constant or linear equation [8]. This study uses the Mamdani method in the use of fuzzy logic with the reason that the formation of fuzzy sets for input and output is formed so that the composition of rules obtained from a collection of correlations between rules and there is affirmation of input from the defuzzification process from the composition of fuzzy rules [9].

In research related to fuzzy logic, there is research on the determinants of controlling soil temperature and humidity for plants by utilizing two sensors to produce plant status decisions [10]. Another related research is the fuzzy logic decision making system, which is the scheduling of motorcycle service with the parameters of the condition of the motorcycle and the last date of service in the vehicle [8]. The use of mobile-based applications is easier to use and operate because it is more flexible [11][12]. Based on research that has been done before, when compared with the research done in this report there are differences in the outputs, methods, and tools used. In this study, adapting various reviews of studies that have been carried out and adapting them into the system that will be created. The research that will be carried out utilizes the ESP32-Camera as a Bar Code reader, uses an android smartphone application as a box unlock from the receiving side of the package, and uses Fuzzy logic to classify the status of the package box.

Based on the problems and research described above, an IoT-based package receiver box can be made by using a fuzzy logic decision-making system as a determinant of the state of the box using two inputs, namely the proximity sensor and the weight sensor, the system created will be integrated with the Android smartphone owner of the box and the data will be stored via Firebase.

MATERIALS AND METHODS

This study uses the method or stages of research completion which can be seen in Figure 1.

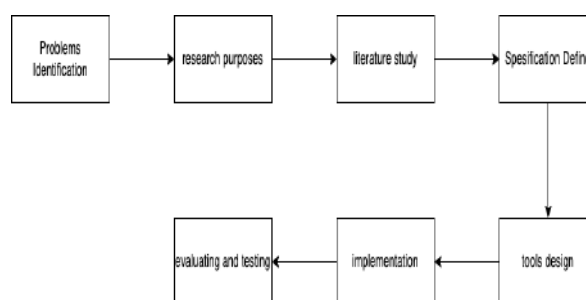


Figure 1. Research Flow

The method of this research consists of 7 stages consisting of:

1. Problems Identification

At the problem identification stage is to find problems that occur in an environment or case study. At this stage, several obstacles that are often felt by respondents who carry out online shopping activities and use freight forwarding services are collected.

2. Research Objective

This stage determines the goals that will overcome the problems that occur. The purpose of this research is to build a package receiver box that can receive packages and notify the package owner when the box is full and the condition when the package has been received by the box.

3. Study of Literature

At this stage, the search for theories and methods in previous studies that are related and useful for building systems is carried out. In this stage determine what method is suitable for use in the decision-making system and determine the flow of the system. In this stage there is a literature study carried out to obtain the basic concepts and theories that underlie the research. Some of the basic theories in this research are:

a. Package Delivery

The definition of delivery is the activity of distributing goods from producers to recipients. Meanwhile, a package is an item that is sent in the form of a package and is usually sent by the post or shipping company [13].

b. Fuzzy Logic

Fuzzy logic is a decision-making system that allows decision making with values between 0 to 1 or false and true values [14]. Fuzzy logic calculations have three methods or systems, namely the Mamdani method, the Sugano method, and the Tsukamoto method. The difference between each of the existing methods is that they have different results and calculation methods. In fuzzy logic there are 3 stages, namely fuzzification, rule or reasoning, and defuzzification stage.

c. ESP32-Camera

ECP32-Camera is a camera module that has been equipped with Wi-Fi and uses the ESP32 microcontroller [15]. This camera module is a microcontroller that has been equipped with an OV2640 camera which can be easily programmed via Arduino IDE [16]. The system that will be made uses an ESP32-cam to be used as a QR Code reader for the package to be received.

d. QR-Code

Quick response code is a 2-dimensional bar code that provides information directly. QR Code is an image that can store data in it. QR Code is an evolution or development of the bar code [17]. QR Code can accommodate thousands of alphanumeric characters up to 4000 characters in one code, so it can be used by everyone to store information. There are 6 types of QR Code, namely QR Code Model 1, QR Code Model 2, Micro QR Code, SQRC, iQR, and LogoQ [18].

4. Determine Specification

At this stage, the components needed for the manufacture of this system are determined. In the development of this system there are several main requirements [19]. The components used in this study are listed in Table 1.

5. Tool and Application Design

At the tool design stage and specifications, the design of tools and applications that are in accordance with the function is carried out. At this stage also carried out the preparation of the workflow of the entire system. This box receiver system was developed using three microcontrollers ESP32-Camera, ESP32 and ESP8266 and connected to each other or communicated via Firebase. The interaction and workflow of this box receiving system is represented through a schematic diagram which can be seen in Figure 2.

Table 1. Hardware Requirements

No.	Name	Function
1.	ESP32	Microcontroller that functions as data processing.
2.	ESP32-Camera	ESP32-Camera functions to take a picture of the QR Code on the package
3.	HC-SR04	Ultrasonic sensor that functions to measure the distance between the package box and the package inside.
4.	Solenoid 12V	The 12V solenoid functions as a package box door lock and opener.
5.	Relay	The 12V solenoid functions as a package box door lock and opener.
6.	TFT LCD Display Module ST7735	The TFT LCD is used as a camera position viewer.
7.	LCD	LCD is used to display notification text to courier.
8.	Load/Weight Sensor	Measure the weight of the package in the box receiving the package.
9.	Keypad	As input for the password used to open the box door when the QR Code cannot be read.
10.	ESP8266	As a microcontroller to process keypad data.

The workflow on the system is designed starting from the package owner entering the receipt number through the android application to the courier process entering the package into the IoT-based package recipient box.

In this stage, fuzzy logic is designed which is used as a decision-making system for the state of the box. The method used in fuzzy logic in the package receiving box system is the Mamdani method, the package status is determined by measuring 1 ultrasonic sensor and 4 weight sensors placed on the inside of the box. There are 3 stages in fuzzy logic design, these stages are fuzzification, inference system, and defuzzification [20].

The stages of fuzzy logic from this research are as follows:

a. Fuzzification

This process is a conversion process from crisp numerical or definite truth values into fuzzy sets by using the membership function [10]. The data from the parameter and variable values that will be used in this study are listed in Table 2.

Table 2. Fuzzification

Parameter Definition and Value	Fuzzy Variable
Ultrasonic Sensor (cm)	Level
45 – 100	Empty
15 – 50	Half Full
0 – 20	Full
Weight/Load Sensor (g)	Level
0-150	Not Heavy
100-15000	There is weight
12500-50000	Heavy
Output	Box Level Condition (Value)
Empty	LED gloomy, (0 – 100)
Half Full	LED lights up normally, (70 – 180)
Full	LED lights up bright, (130 – 255)

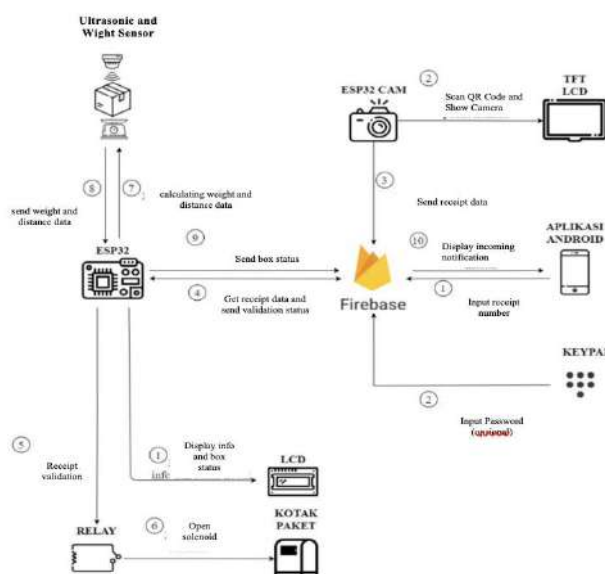


Figure 2. Schematic Diagrams

b. Inference System

Inference system or rule evaluation is a reference in describing the relationship between input and output variables. Explanation of the relationship between input and output usually uses “if-then” [20]. Fuzzy rules are created based on the circumstances to process the data entered. In this study using 2 inputs from sensors, namely 1 ultrasonic sensor and 1 weight sensor. The ultrasonic sensor has 3 variables and the weight sensor has 3 variables. Fuzzy logic rules that can be made using these two inputs form 9 fuzzy rules, namely:

1. Load Sensor “Tidak Berat”, Ultrasonic Sensor “Kosong”, then displays KOSONG.
2. Load Sensor “Tidak Berat”, Ultrasonic Sensor “Setengah”, then displays ADA.
3. Load Sensor “Tidak Berat”, Ultrasonic Sensor “Penuh”, then displays PENUH.
4. Load Sensor “Ada Berat”, Ultrasonic Sensor “Kosong”, then displays ADA.
5. Load Sensor “Ada Berat”, Ultrasonic Sensor “Setengah”, then displays ADA.
6. Load Sensor “Ada Berat”, Ultrasonic Sensor “Penuh”, then displays PENUH.
7. Load Sensor “Berat”, Ultrasonic Sensor “Kosong”, then displays ADA.
8. Load Sensor “Berat”, Ultrasonic Sensor “Setengah”, then displays ADA.
9. Load Sensor “Berat”, Ultrasonic Sensor “Penuh”, then displays PENUH.

c. Defuzzification

The defuzzification stage is the last step in designing fuzzy logic. At this stage, the input obtained is confirmed in the previously determined fuzzy rules [10]. The method that will be used in defuzzification is the centroid method, which is a method with a crisp solution obtained by taking the center point (z^*) Fuzzy area [21].

By using formula:

$$z^* = \frac{\int_z z\mu(z)dz}{\int_z \mu(z)} \quad \begin{matrix} \longrightarrow & \text{Momen} \\ & \longrightarrow & \text{Area} \end{matrix} \quad (1)$$

Description:

μ = Category Index
 z^* = Center Point

6. Implementation

The implementation stage is the stage of making the system, both hardware and software implementation, which has been planned at the design stage. The predefined components are assembled so that they can be connected to each other.

The hardware circuit in this system has 3 circuits, for the first series, namely a series of QR Code scanners, which has an ESP32-Camera as a camera module as well as a microcontroller. The description of the QR Code scanning series is shown in Figure 3.

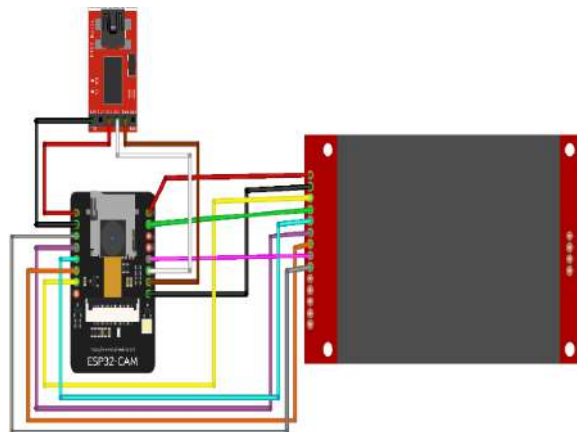


Figure 3. QR Code Circuit

The second circuit is a circuit for the box lock system. In this scheme using ESP32 as a microcontroller and using 2 sensors, namely the weight sensor and the distance sensor. In this circuit there is a calculation for fuzzy logic that will

determine the status of the packet receiving box. The box lock system circuit is shown in Figure 4.

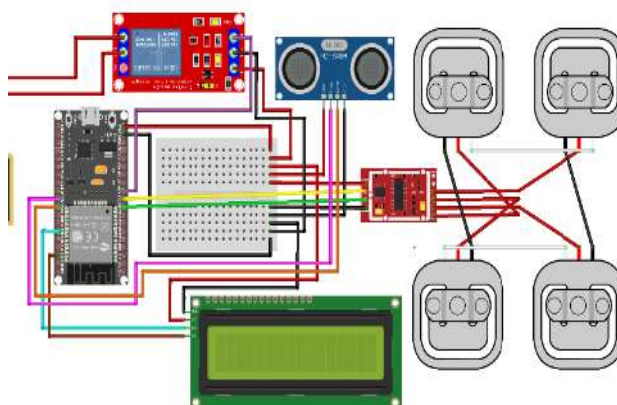


Figure 4. Box Locking System Circuit

The third system circuit is a circuit for password input. This circuit works for couriers if the QR Code on the package to be entered is not legible. In this circuit there is an ESP8266 as a microcontroller and a keypad for password input that will open the door of the package receiver box. The picture of the series of input passwords is shown in Figure 5.

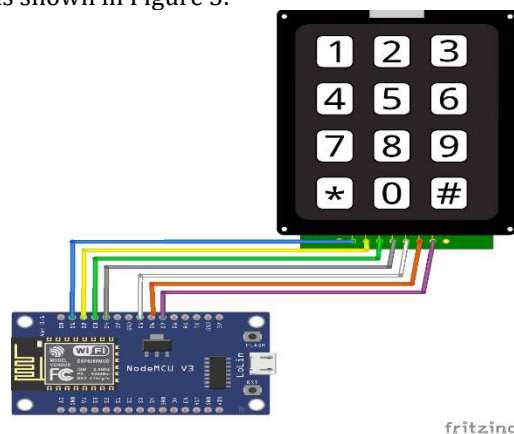


Figure 5. Input Password Circuit

RESULTS AND DISCUSSION

The research results section contains exposure to the results of the analysis related to the research qu

Making this package receiver box system produces a complete device whose all components are connected both hardware and software. This android-based software display has several features such as entering a history receipt number and a description of the status of the contents of the box. In this application there is also a notification feature when the box is full and a notification when a package arrives in the box. The display of the android application can be seen in Figure 6. The

display of the package receiver box that has been made can be seen in Figure 7.



Figure 6. Package Receiver Box Application



Figure 7. Outside and inside view of the package receiving box

The results of making this package receiving box system were evaluated through several test scenarios, namely testing the entire system including hardware testing, software testing, fuzzy logic testing and database testing. In testing the entire system, it aims to determine the time obtained in one package reception process.

Hardware testing is done by testing the HC-SR04 sensor which is compared with a ruler to determine the accuracy of the distance measuring sensor. The experiments and test results of the HC-SR04 sensor can be seen in Table 3.

Table 3. Ultrasonic Sensor Test Result

Specimens	HC-SR04	Ruler	Difference
1.	20cm	±20cm	0cm
2.	40cm	±40cm	0cm
3.	61cm	±60cm	±1cm
4.	81cm	±80cm	±1cm
5.	100cm	±102 cm	±2cm
Average Error			±0.8cm

Hardware testing is done by testing the HC-SR04 sensor which is compared with a ruler to determine the accuracy of the distance measuring sensor. The experiments and test results of the HC-SR04 sensor can be seen in Table 3.

The next sensor test is a weight sensor which is carried out by measuring weight using test data that have different weights. The results of the tests carried out are in Table 4.

From the tests that have been carried out, the results show that the average error resulting from the measurement of the weight sensor is 32.2 grams. The average error results obtained are no more than 50 grams so that the success parameters are met.

Table 4. Weight/Load Sensor Test Results

Sample	Load Sensor	Original Weight	Difference
1.	130g	130,38g	0,38g
2.	500g	543g	43,79g
3.	550g	572g	22,93g
4.	1000g	1093g	93,20g
5.	5000g	5000,71g	0,71g
Error Average			32,2g

In the system flow the packets to be entered will be scanned through the camera module. In this system use ESP32-Camera as a scanner. Camera module testing is carried out to determine the accuracy and time required to open the package receiving box. The results of the tests that have been carried out can be seen in Table 5.

From the tests that have been carried out by scanning 5 QR Codes, it takes 1-2 seconds for the camera module to recognize the QR Code. The scanning speed of the camera depends on the size of the QR Code, the larger the size of the QR Code on the package, the faster the scanning time and the faster data transmission time to Firebase, and vice versa, the smaller the QR Code size on the package, the longer the scanning time and sending data to Firebase.

This test has 1 test item, namely processing the data obtained from the ultrasonic sensor and weight sensor with Fuzzy logic with the success parameter, namely getting the appropriate output results between the system to be made with Matlab references with the Mamdani Fuzzy logic algorithm.

The results of this test can be seen in Figures 8 and 9.

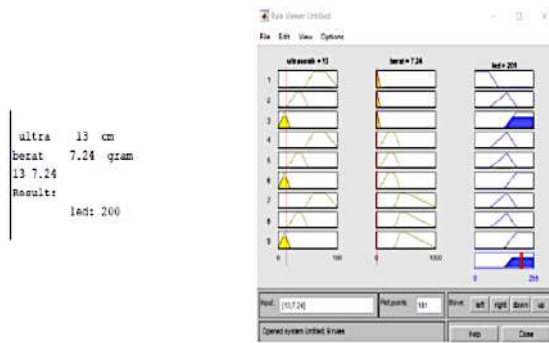







Figure 8. Fuzzy Logics Testing (1)



Figure 9. Fuzzy Logics Testing (2)

Table 5. ESP32-Camera Test Results

No.	Size	Object Display	Scanner	Result	Time s
1.	1x1 cm			Failed	-
2.	2x2 cm			Success	±2s
3.	3x3 cm			Success	±1s
4.	4x4 cm			Success	±1s

No.	Size	Object Display	Scanner	Result	Time s
5.	5x5 cm			Success	±1s

In Figure 8, with input data, the distance of the ultrasonic sensor reading to the top surface of the item is 13 grams and the package weight is 7.24 grams, the result is that the LED output reading is 200, the LED lights up brightly and it means the box is in full condition. In Figure 9, the ultrasonic sensor reading distance to the top surface of the item is 39 cm and the package weight is 6.72 gr, the reading result is LED 130, meaning the box is in a state of contents (half full). More details related to fuzzy test results compared between system and MATLAB output values can be seen in table 6.

Table 6. Fuzzy Value Measurement Results

Input	Output Value System	Output Value (*Matlab)	Difference	Description	
Weight (gr)	Distance (cm)				
6.52	32	120	120	0	Full Package
5.94	14	200	202	2	Full Package
252.9	45	101	120	19	Package Available
513.68	98	0	120	120	Empty Package

With the results that have been obtained from fuzzy logic calculations on the tool and fuzzy logic in MATLAB there is 1 data that has the most difference, if the input distance is 120cm then the system calculation on the tool will experience an error.

CONCLUSION

Based on the results of the research that has been done, it can be concluded that the development of an IoT-based package receiving system went well after going through a series of tests. In the process of opening the box door, a QR-Code scan is used using the ESP32-Cam camera module which can be scanned in ± 2 seconds. The keypad can be used as a door opener when the QR Code cannot be scanned (damaged). The Android-based mobile application can be used to monitor incoming packets, box status, history, and can enter the package receipt number that will be received by the box. In the process of processing data in firebase, it takes ± 3 seconds. The status of the box can be determined using Fuzzy Mamdani logic. In addition, in one packet reception process, the system has 11 seconds per packet, which is enough time to replace the role of the packet recipient.

REFERENCE

- [1] H. Saragih and R. Ramdhany, "Pengaruh Intensi Pelanggan Dalam Berbelanja Online Kembali Melalui Media Teknologi Informasi Forum Jual Beli (Fjb) Kaskus," *J. Sist. Inf.*, vol. 8, no. 2, p. 100, 2013, doi: 10.21609/jsi.v8i2.331.
- [2] I. F. Ashari, "Implementation of Cyber-Physical-Social System Based on Service Oriented Architecture in Smart Tourism Case Study: Bandung Natural Tourism," *J. Appl. Informatics Comput.*, vol. 4, no. 1, pp. 66-73, 2020.
- [3] I. F. Ashari, R. Banjarnahor, and D. R. Farida, "Application of Data Mining with the K-Means Clustering Method and Davies Bouldin Index for Grouping IMDB Movies," vol. 6, no. 1, pp. 7-15, 2022.
- [4] I. F. Ashari and V. Adhelia, "Expert System and IoT for Diagnose of Feline Panleukopenia Virus Using Certainty Factor," *Matrik J. Manajemen, Tek. Inform. dan Rekayasa Komput.*, vol. 21, no. 2, pp. 451-462, 2022, doi: 10.30812/matrik.v21i2.1517.
- [5] T. Khan, "A Solar-Powered IoT Connected Physical Mailbox Interfaced with Smart Devices," *IoT*, vol. 1, no. 1, pp. 128-144, 2020, doi: 10.3390/iot1010008.
- [6] S. Turská and L. Madleňáková, "Concept of smart postal mailbox," *Transp. Res. Procedia*, vol. 40, pp. 1199-1207, 2019, doi: 10.1016/j.trpro.2019.07.167.
- [7] I. F. Ashari, A. Auzan, and V. Syahputra, "Automatic Water Desalination Device using Sugeno Fuzzy Logic (Case Study : Automatic Water Desalination Device using Sugeno Fuzzy Logic (Case Study : Tangkil Coast)," no. August, 2022, doi: 10.22441/incomtech.v12i2.15158.
- [8] A. D. Saputri, R. D. Ramadhani, and R. Adhitama, "Logika Fuzzy Sugeno Untuk Pengambilan Keputusan Dalam Penjadwalan Dan Peningkat Service Sepeda Motor," *J. Informatics, Inf. Syst. Softw. Eng. Appl.*, vol. 2, no. 1, pp. 49-55, 2019, doi: 10.20895/inista.v2i1.95.
- [9] R. Setyaningsih, "Penggunaan Metode Fuzzy Mamdani Untuk Rancang Bangun Sistem Pemilihan Program Studi Pada Kampus Amik-Bsi Jakarta," vol. 2, no. 2, pp. 15-21, 2017.
- [10] N. Nasron, S. Suroso, and A. R. Putri, "Perancangan Logika Fuzzy Untuk Sistem Pengendali Kelembaban Tanah dan Suhu Tanaman," *J. Media Inform. Budidarma*, vol. 3, no. 4, p. 307, 2019, doi: 10.30865/mib.v3i4.1245.
- [11] I. F. Ashari, M. F. Zuhdi, M. T. Gagaman, and S. T. Denira, "Kolepa Mobile Application Development Based on Android Using SCRUM Method (Case Study : Kolepa Minigolf and Coffe Shop)," *J. Appl. Informatics Comput.*, vol. 6, no. 1, pp. 104-112, 2022.
- [12] I. F. Ashari and R. R. Muharram, "Pengembangan Antarmuka Pengguna Kolepa Mobile App Menggunakan metode Design Thinking dan System Usability Scale," *J. Sist. Inf.*, vol. 9, no. 2, pp. 168-176, 2022, doi: 10.30656/jsii.v9i2.4993.
- [13] E. Setiawan, "Kamus Besar Bahasa Indonesia (KBBI)." .
- [14] A. Saelan, "Logika Fuzzy," *Strukt. Disk.*, vol. 1, no. 13508029, pp. 1-5, 2009.
- [15] I. F. Ashari, "Parking System Optimization Based on IoT using Face and Vehicle Plat Recognition via Amazon Web Service and ESP-32 CAM," *Comput. Eng. Appl. J.*, vol. 11, no. 2, pp. 137-153, 2022, doi: 10.18495/comengapp.v11i2.409.
- [16] A. Setiawan and A. Irma Purnamasari, "Pengembangan Passive Infrared Sensor (PIR) HC-SR501 dengan Microcontrollers ESP32-CAM Berbasis Internet of Things (IoT) dan Smart Home sebagai Deteksi Gerak untuk Keamanan Perumahan," *Prosiding Semin. Nas. SISFOTEK (Sistem Inf. dan Teknol. Informasi)*, vol. 3, no. 1, pp. 148-154, 2019.
- [17] I. F. Ashari, M. Idris, and M. A. Nasrullah, "Analysis of Combination of Parking System with Face Recognition and QR Code using

- Histogram of Oriented Gradient Method," *IT J. Res. Dev.*, vol. 7, no. 1, pp. 94–110, 2022, doi: 10.25299/itjrd.2022.9958.
- [18] E. Susanti, C. Iswahyudi, T. Romadhani, S. Wahyuningsih, and F. T. Putra, "Pemanfaatan Teknologi Quick Response (Qr) Code Pada Sistem Manajemen Studi Ekskursi," *Simp. Nas. RAPI XVII - 2018 FT UMS*, pp. 110–118, 2018.
- [19] I. F. Ashari, "Sistem Monitoring dan Kontrol Budidaya Ikan Nila Berbasis IoT dengan Bioflok (Studi kasus: Kelompok Budidaya Ikan Sadewa Mandiri, Pringsewu)," *Suluh Bendang*, vol. 22, no. 2, pp. 417–427, 2022, doi: 10.24036/sb.02680.
- [20] M. A. Wijaya, A. Boedi, and J. Saputra, "Implementasi Fuzzy Logic Terhadap Pengukuran Kecepatan dan Penentuan Arah Angin," *Jurnal Teknik Elektro dan Komputer TRIAC*, vol. 5, no. 2. 2018, doi: 10.21107/triac.v5i2.4104.
- [21] D. A. Puryono, "Metode Fuzzy Inferensi System Mamdani Untuk Menentukan Bantuan Modal Usaha Bagi UMKM Ramah Lingkungan," vol. 1, no. 1, pp. 1–6, 2018, doi: 10.31219/osf.io/hfb73.

SENTIMENT ANALYSIS ON THE PERMENDIKBUD CONCERN PREVENTION AND TREATMENT OF SEXUAL VIOLENCE IN HIGHER EDUCATIONAL ENVIRONMENTS USING SUPPORT VECTOR MACHINE (SVM)

Reinhard Alfaries Saemani¹, Nina Setiyawati^{2*}

Informatics Engineering Study Program
Universitas Kristen Satya Wacana, Salatiga, Jawa Tengah
<https://uksw.edu>
672016104@student.uksw.edu¹, nina.setiyawati@uksw.edu²

(*) Corresponding Author

Abstract— Social media is no longer a foreign thing for people in today's technological era, one of the social media that is often used is Twitter. Twitter is used to communicate with other people and Twitter users can also give each other opinions on an issue. By involving 1252 Tweets, this study aimed to use the Support Vector Machine (SVM) algorithm on Tweet data. The processes carried out in this research are crawling, cleaning, translating, labelling, tokenizing, stop words, stemming, SVM classification. The results showed that the accuracy level of using the SVM algorithm after the param grid was 80.3% using the parameter $C = 10$; $\gamma = 0.1$; and kernel = RBF as a benchmark in the classification process. This shows that the classification process using the SVM algorithm is quite accurate.

Keywords: sentiment analysis, permendikbud, ppks, support vector machine, svm, twitter

Abstrak— Media sosial bukan lagi hal yang asing bagi masyarakat di era teknologi sekarang ini, salah satu media sosial yang sering digunakan adalah Twitter. Twitter digunakan untuk saling berkomunikasi dengan orang lain dan para Twitter juga bisa saling memberikan opini kepada suatu isu. Dengan melibatkan 1252 Tweet, penelitian ini bertujuan untuk melakukan analisis sentimen terhadap Permendikbud Sentimen Pencegahan dan Penanganan Kekerasan Seksual di Lingkungan Perguruan Tinggi (PPKS) menggunakan algoritma Support Vector Machine (SVM) pada data tweet. Adapun proses yang dilakukan dalam penelitian adalah crawling, cleaning, translate, labeling, tokenizing, stop words, stemming, klasifikasi SVM. Hasil penelitian menunjukkan tingkat akurasi dari penggunaan algoritma SVM ini setelah dilakukan grid param adalah 80,3% dengan menggunakan parameter $C = 10$; $\gamma = 0,1$; dan kernel = rbf sebagai tolak ukur dalam proses klasifikasi. Hal ini menunjukkan bahwa proses klasifikasi menggunakan algoritma SVM ini cukup akurat.

Kata Kunci: : permendikbud ppks, support vector machine, svm, twitter

INTRODUCTION

At present, most people have used social media to interact with each other and used to express opinions, one of which is Twitter. Currently, Twitter is one of the most popular social media out of 17 social media as of October 2021 with a total of 463 million users worldwide. [1]. Therefore, especially during the Covid-19 pandemic, it can be said that Twitter is a good source for investigating and conveying public opinion [2], [3] Twitter users can create tweets that will then be shared publicly. Through this tweet, Twitter users can interact with each other and express opinions. Tweets can also

represent an opinion on a product, a political issue, a country's regulations, and so on.

In Indonesia, Twitter users reached 17.55 million as of October 2021, so it ranks sixth in the world [4]. Twitter users in Indonesia tend to focus on topical comments regarding their feelings [5]. In terms of expressing opinions, Twitter users in Indonesia are more focused on trending topics. One of the topics that are currently being discussed in November 2021 is a regulation made by the Ministry of Education, Culture, Research and Technology (Kemendikbud Ristek) regarding the Prevention and Handling of Sexual Violence in Higher Education (Permendikbud PPKS). This regulation made by the Ministry of Education and

Culture has become controversial among the public. The cause of the topic is controversial is that, implicitly, The Ministry of Education and Culture seems to allow sex in a college environment[6]. This controversial opinion developed because of the process of spreading with the use of language in which language can build and destroy one's cognition and psychology as well as the construction of heterodox. [7], [8] The use of language on Twitter can show the expression of feelings and opinions which of course are spread online. In addition to expressing feelings and opinions, social media such as Twitter can also disseminate certain attitudes and behaviours, for example in terms of disseminating government actions in handling emergency response and preventive behaviour. [9], [10].

Sentiment analysis on social media such as Twitter becomes a very important and challenging task due to the characteristics of the data, length of tweets, misspellings, abbreviations, and special characters. [11] so that the basic idea of the approach taken to analyze these characteristics is mediated by an approach to combine several machines learning to make several classifications of emotions in the behaviour of social media users. [12]. Classification is done using the SVM method to get the final result of the build system. SVM is a classification method with the principle of finding the hyperplane that has the largest margin. The hyperplane is a line that separates data between classes or categories. While the margin is the distance between the hyperplane and the closest available data in each class, while the data closest to the hyperplane is called the support vector [13].

Several methods can be used in sentiment analysis on social media such as SVM, Nave Bayes, Decision tree, K-Nearest Neighbor (K-NN), and the like. These methods certainly have different levels of accuracy in analyzing text and image data in social media. The difference in the level of accuracy could be caused by several things such as the involvement of emoji, the popularity of social media, and post-processing by adding specific knowledge [14]-[16].

The current research focuses on the use of the SVM algorithm by involving information data on the Permendikbud trending topic. Sentiment analysis using the SVM algorithm is a model derived from statistical learning theory that gives better results than other methods [17].

MATERIALS AND METHODS

The current research involves 1252 Tweets sourced from responses related to the topic of Permendikbud PPKS number 30 of 2021.

Several stages are carried out to carry out the analysis to provide maximum results.

1. Data collection (*crawling data*)

The first stage in this sentiment analysis is data crawling (collecting data). At this stage, the tweet will be pulled from Twitter so that the data collected will become a dataset that has been labelled.

2. Prior process (*Pre-processing*)

The second stage is pre-processing. The dataset that has been collected will be processed first before being classified. At this stage the dataset will be carried out:

- a. *Cleaning* data, to get rid of unnecessary characters.
- b. *Translating* data, that is to translate the language.
- c. *Labelling* data, i.e. to put a positive, negative, or neutral label on a tweet.
- d. *Tokenizing*, that is dividing words in a sentence.
- e. *Stopping words* is to filter and save the important words.
- f. *Stemming*, i.e. changing a word to its basic form.
- g. *Clouiding words*, which is a visualization of each word that occurs most often.

3. Classificatingi *SVM (Classification)*

After pre-processing, then the data will be tested using the SVM algorithm to get the accuracy of the classification made by SVM.

RESULTS AND DISCUSSION

This study aims to determine the sentiment analysis on opinions about the PPKS Permendikbud made by the Ministry of Education and Culture through Twitter which will then be classified to separate the different classes. The flow in this study can be seen in Figure 1.

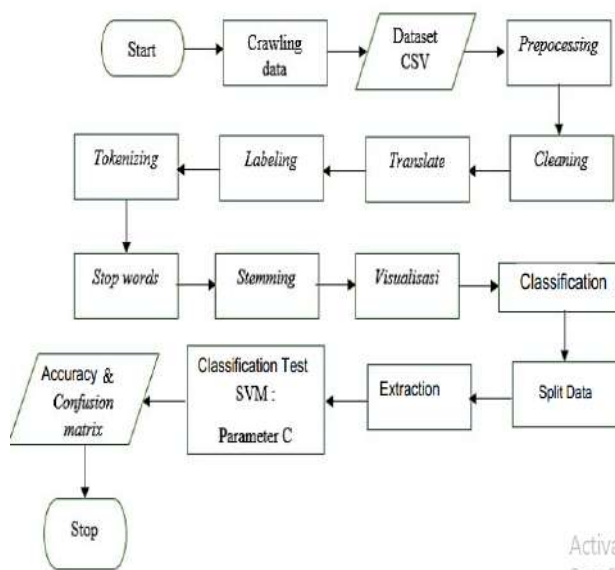


Figure 1. Research Flowchart

1. Crawling data

In this study, the data taken is a review of the PPKS Permendikbud with the keyword on Twitter, namely #Permendikbud30. At this stage, the opinions given from Twitter users will be crawled using the Twitter API to retrieve tweets which are then collected into a single dataset with the number of tweets taken being 1252 Tweets as shown in Table 1.

Table 1. Permendikbud Dataset

Date	Username	Tweet
14/12/20 21 05:53	#WE CARE FOR NKRI	Gilee... gilee! [crazy... crazy...!] because based on consensual, it makes the punishment lighter, so remember the Minister of Education and Culture?! How about the side of justice for her adulterous husband? Is it in line with the positive law/KUHP article 284 that the punishment is for adultery with someone's wife?™??
14/12/20 21 05:50	Achmad Kusnanto	Ini sebenarnya yg dikhawatirkan... Makanya ulama menolak Permendikbud yg kemarin [This is actually what they are worried about... That's why the Ulama rejected the previous Permendikbud]
14/12/20 21 05:09	KOMAHI FISIP UNRI	The inspection team has also been carried out by the ministry, what are the results? is there "flirting" too? We are waiting for your promise, UNRI is the first case after

2. Pre-processing

In the pre-processing stage, cleaning, translating, labelling, tokenizing, stopping words, steaming, and clouding words were carried out on the data.

a. Cleaning

This data cleaning process, as shown in the example Table 2, is intended to remove characters, symbols, or links attached to words.

Table 2. Cleaning Data Results

tweet_clean
because based on consensual it makes the punishment lighter so remember the minister of education and culture how about the side of justice for her adulterous husband is it in line with the positive law KUHP article that the punishment is for adultery someone's wife
Ini sebenarnya yg dikhawatirkan... Makanya ulama menolak Permendikbud yg kemarin [This is actually what they are worried about... That's why the Ulama rejected the previous Permendikbud]
the inspection team has also been carried out by the ministry what are the results is there flirting too we are waiting for your promise UNRI is the first case after Permendikbud no was ratified but until now there has been no firm action by the campus or from the ministry of education and culture
assalamualaikum warahmatullahi wabarakatuh I'm Umar Ardhianto with NIM HKI class e permission to express my opinion I agree with the regulation of the minister of education and culture research and technology no this year

b. Translating data

Translating data to translate a language such as Indonesian to English. This is done because there are still some tweets that are still in Indonesian, which can be seen in Table 3, the results of the translation process on tweets.

Table 3. Translating Data Results

tweet translation

Permendikbud No. 30 was ratified, but until now there has been no firm action by the campus or from the Ministry of Education and Culture.

@abdulaziz_hfr
Assalamu'alaikum
Warahmatullahi
Wabarakatuh, I'm Umar Ardhianto with NIM 212121165, HKI Class 1 E Permission to express my opinion. I agree with the regulation of the Minister of Education and Culture, Research and Technology NO. 30 this year 2021.

14/12/20
21 05:03 Umrdyntt. O

@abdulaziz_hfr I think that related to Permendikbud Number 30 of 2021 is one of the right policies to protect victims because so far there is no clear law on sexual violence.

14/12/20 Frisca
21 04:49 Rahesha

because based on consensual it makes the punishment lighter so remember the minister of education and culture how about the side of justice for her adulterous husband is it in line with the positive law KUHP article that the punishment is for adultery someone's wife

This is actually what I'm worried about, that's why the ulama rejected the previous Minister of Education and Culture the inspection team has also been carried out by the ministry what are the results is there flirting too we are waiting for your promise UNRI is the first case after Permendikbud no was ratified but until now there has been no firm action by the campus or from the ministry of education and culture

assalamualaikum warahmatullahi wabarakatuh I'm Umar Ardhiyanto with NIM HKI class e permission to express my opinion I agree with the regulation of the minister of education and culture research and technology no this year

I think that related to Permendikbud number of is one of the right policies to protect victims because so far there is no clear law on sexual violence

c. Labelling

This data labelling aims to provide positive, negative, and neutral sentiments based on the polarity of each tweet with a positive polarity rating (> 0); neutral (== 0); negative (< 0) can be seen in Table 4.

Table 4. Labelling Data Results

tweet_translating	Polarity	Sentiment
because based on consensual it makes the punishment lighter so remember the minister of education and culture how about the side of justice for her adulterous husband is it in line with the positive law KUHP article that the punishment is for adultery someone's wife	0,227272727	positive
This is actually what I'm worried about, that's why the ulama rejected the previous Minister of Education and Culture	-0,083333333	negative
assalamualaikum warahmatullahi wabarakatuh I'm Umar Ardhiyanto with NIM HKI class e permission to express my opinion I agree with the regulation of the minister of education and culture research and technology no this year	0	neutral

d. Tokenizing

Tokenizing is dividing words in a sentence as shown in Table 5.

Table 5. Tokenizing Data Results

tweet_tokenizing
["because", "on", "the", "basis", "of", "consensual", "it", "makes", "the", "punishment", "lighter", "so", "remember", "the", "minister", "of", "education", "and", "culture", "how", "about", "the", "side", "of", "justice", "for", "her", "adulterous", "husband", "is", "it", "in", "line", "with", "the", "positive",

'lawkuhp', 'article', 'that', 'the', 'punishment', 'is', 'for', 'adultery', 'someones', 'wife']

["This", "is", "actually", "what", "I", "m", "worried", "about", "the", "that", "s", "why", "the", "ulema", "rejected", "the", "previous", "Minister", "of", "Education", "and", "Culture"]

["the", "inspection", "team", "has", "also", "been", "carried", "out", "by", "the", "ministry", "what", "are", "the", "results", "is", "there", "flirting", "too", "we", "are", "waiting", "for", "your", "promise", "unri", "is", "the", "first", "case", "after", "permendikbud", "no", "was", "ratified", "but", "until", "now", "there", "has", "been", "no", "firm", "action", "by", "the", "campus", "or", "from", "the", "ministry", "of", "education", "and", "culture"]

["assalamualaikum", "warahmatullahi", "wabarakatuh", "im", "umar", "ardhiyanto", "with", "nim", "hki", "class", "e", "permission", "to", "express", "my", "opinion", "I", "agree", "with", "the", "regulation", "of", "the", "minister", "of", "education", "and", "culture", "research", "and", "technology", "no", "this", "year"]

["I", "think", "that", "related", "to", "Permendikbud", "number", "of", "is", "one", "of", "the", "right", "policies", "to", "protect", "victims", "because", "so", "far", "there", "is", "no", "clear", "law", "on", "sexual", "violence"]

e. Stopping words

Stopping words is to filter and save words that are important or discard words that are not meaningful as in Table 6.

Table 6. Stopping Words Results

tweet_stopping words
basis consensual make punishment lighter remember minister education culture side justice adulterous husband line positive law KUHP article punishment adultery someone's wife
This worry Ulama reject previous Minister Education Culture
the inspection team also carry ministry result flirt wait promise UNRI first case Permendikbud ratify firm action campus ministry education culture
assalamualaikum warahmatullahi wabarakatuh umar ardhiyanto nim hki class permission express opinion agree regulation minister education culture research technology year
think relate Permendikbud number one right policy protects victims far clear law sexual violence
several legal frameworks well policies often discuss major issue sexual violence law elimination sexual violence PKS also Permendikbud prevent address sexual violence higher education institutions
understand PKS reject Permendikbud regard sexual violence ushul fiqh via

f. Stemming

Stemming is changing a word to its basic form as shown in Table 7.

Table 7. Stemming Data Results

tweet_stemming
basis consensual make punish lighter remember ministry education culture side justice adultery husband

line posit law KUHP article punish adultery someone's wife

this actual worried Ulama reject previous ministry education culture

inspect team also carry ministry result flirt wait promise UNRI first case Permendikbud ratify firm action campus ministry Educ culture

assalamualaikum warahmatullahi wabarakatuh umar ardhianto nim hki class permiss express opinion agree regul minist educ culture research technology year

think rectify Permendikbud number one right policy protect victim far clear law sexual violence

sever legal framework well policy often discuss major issue sexual violence law eliminate sexual violence pk also Permendikbud prevent address sexual violence higher Educ Institut

understand pk reject Permendikbud regard sexual violence ushul fiqh via

g. Clouding Words

Clouding words is a visualization of each word that appears most often.

- Clouding words of positive sentiment totalling 753 tweets as shown in Figure 2.



Figure 2. Positive Word Clouding

- Clouding words of negative sentiment totalling 173 tweets which can be seen in Figure 3.

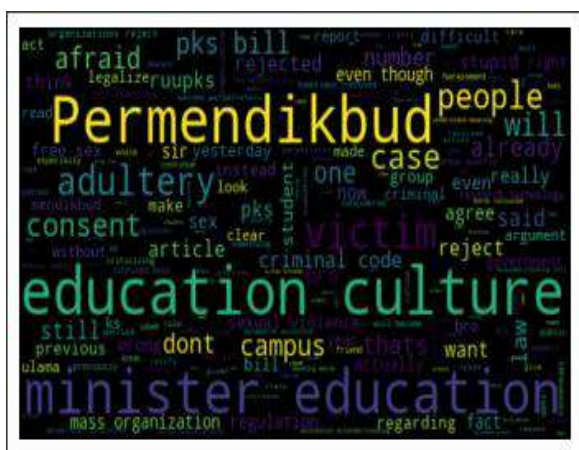


Figure 3. Negative Word Clouding

- Neutral sentiment clouding words totalling 326 tweets as shown in Figure 4.

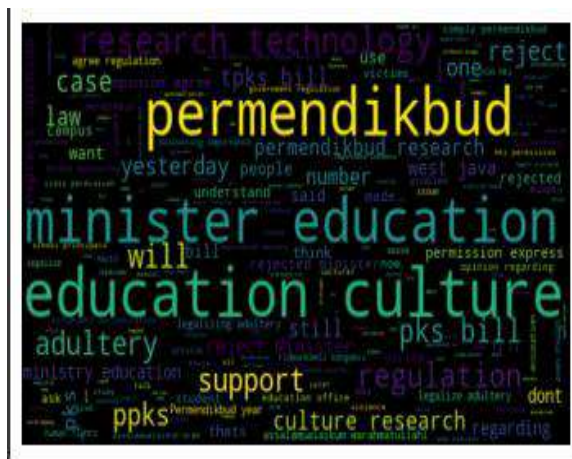


Figure 4. Neutral Word Clouding

3. Classification

At the data classification stage, the data will first be divided into 2, namely 20% training data and 80% testing data. Training data is used to create a model that will be used for testing data to classify then data testing.

a. The "C" Parameter

The classification process uses the C parameter, namely to avoid errors in the classification process, so to avoid small errors in the classification process, the selected C parameter must also be small with a large level of accuracy as in Table 8 by selecting C parameter of 0.75 with an accuracy level of 0.805 or 80.5%.

Table 8. The C Parameter Accuracy

C	Accuracy	Percentage (%)
0.01	0.76	76%
0.05	0.78	78%
0.25	0.8	80%
0.5	0.8	80%
0.75	0.805	80,5%
1	0.8	80%

Table 9. Confusion Matrix

	Negative	Neutral	Positive	Class Precision
Negative Prediction	21	6	10	68%
Neutral Prediction	2	45	6	65%
Positive Prediction	8	18	135	89%
Class Recalling	57%	85%	84%	

Table 10. Performance Evolution

Criteria	Micro Average
Weight Average Precision	81%
Weight Average Recall	80%
Accuracy	80%
Macro Average Precision	74%
Macro Average Recall	75%

In the test data using the parameter $C = 0.75$ in the SVM classification process, it shows the level of accuracy obtained is 80% which can be seen in Table 9 and 10.

b. Grid param

The param grid is used to determine the best parameters and accuracy so that the classification obtained is more accurate. The results of the analysis after the param grid shows the best level of accuracy obtained using the SVM algorithm is 80.3%. This is due to the C parameter = 10; γ = 0.1; and kernel = RBF which is used to overcome or minimize errors and as a benchmark in the classification process so that the accuracy obtained is quite high. Empirically, the use of the SVM algorithm can be said to be more ideal than other algorithms both in terms of the number of classes [18] as well as in terms of the distribution of the ratio of training data and testing data [19]–[21]

CONCLUSION

From the results of the sentiment analysis of the Minister of Education and Culture on the prevention and handling of sexual violence in the university environment, the responses given were dominantly positive. This can be proven by using the SVM Algorithm which can be used in classifying sentiment analysis. The level of accuracy of using this SVM algorithm after the param grid is done is 80.3% using the parameter $C = 10$; $\gamma = 0.1$; and kernel = RBF as a benchmark in the classification process. This shows that the classification process using the SVM algorithm is quite accurate. However, the pre-processing and classification stages certainly cannot be ignored because they are part of the analysis stage.

REFERENCE

[1] Statista.com, "Most popular social networks worldwide as of October 2021, ranked by some active users," *Statista*, 2021. <https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/>.

[2] Z. Bokaee Nezhad and M. A. Deihimi, "Twitter sentiment analysis from Iran about COVID 19 vaccine," *Diabetes Metab. Syndr.*

Clin. Res. Rev., vol. 16, no. 1, p. 102367, 2021, doi: 10.1016/j.dsx.2021.102367.

[3] M. Perez-Cepeda and L. G. Arias-Bolzmann, "Sociocultural factors during COVID-19 pandemic: Information consumption on Twitter," *J. Bus. Res.*, no. xxxx, 2021, doi: 10.1016/j.jbusres.2021.11.008.

[4] Statista.com, "Statista.com," *Leading countries based on some Twitter users as of October 2021*, 2021. <https://www.statista.com/statistics/242606/number-of-active-twitter-users-in-selected-countries/> (accessed Dec. 12, 2021).

[5] D. S. Utami and A. Erfina, "Analisis Sentimen Pinjaman Online Di Twitter Menggunakan Algoritma Support Vector Machine (Svm) [Online Loan Sentiment Analysis on Twitter Using the Support Vector Machine (Svm) Algorithm]," *Semin. Nas. Sist. Inf. ...*, pp. 299–305, 2021, [Online]. Available: <https://sismatik.nusaputra.ac.id/index.php/sismatik/article/view/34>.

[6] B. Amal, U. Nahdlatul, U. Indonesia, and K. J. Pusat, "Tinjauan Hukum Terhadap Frasa 'Tanpa Persetujuan Korban' dalam Permendikbud Nomor 30 Tahun 2021 Tentang," *J. CREPIDO J. Mengenai Dasar-Dasar Pemikir. Huk. Filsafat dan Ilmu Huk.* [Legal Review of the phrase 'Without the Victim's Consent' in Permendikbud Number 30 of 2021 concerning," *J. CREPIDO J. Regarding the Basics of Thinking. Philosophical Law and Legal Studies*], vol. 03, no. November, pp. 86–95, 2021, doi: <https://doi.org/10.14710/crepido.3.2.86-95>.

[7] N. Lustyantie & F. Arung, *Pembelajaran Inovatif Bahasa dan Sastra: Mengembalikan Prinsip Bahasa dan Sastra sebagai Cara Berpikir Inovatif* [Innovative Language and Literature Learning: Bringing Back the Principles of Language and Literature as an Innovative Way of Thinking]. Yogyakarta: Penerbit Deepublish, 2020.

[8] M. Alam, "Reconstructing anti-capitalism as heterodoxa in Indonesia's youth-led urban environmentalism Twitter account," *Geoforum*, vol. 114, pp. 151–158, 2020, doi: 10.1016/j.geoforum.2020.06.005.

[9] A. R. Rahmanti, D. N. A. Ningrum, L. Lazuardi, H. C. Yang, and Y. C. Li, "Social Media Data Analytics for Outbreak Risk Communication: Public Attention on the 'New Normal' During the COVID-19 Pandemic in Indonesia," *Comput. Methods Programs Biomed.*, vol. 205, p. 106083, 2021, doi: 10.1016/j.cmpb.2021.106083.

- [10] P. L. Liu, "COVID-19 information on social media and preventive behaviours: Managing the pandemic through personal responsibility," *Soc. Sci. Med.*, vol. 277, p. 113928, 2021, doi: 10.1016/j.socscimed.2021.113928.
- [11] A. S. M. Alharbi and E. de Doncker, "Twitter sentiment analysis with a deep neural network: An enhanced approach using user behavioural information," *Cogn. Syst. Res.*, vol. 54, pp. 50–61, 2019, doi: 10.1016/j.cogsys.2018.10.001.
- [12] H. Li, Q. Chen, Z. Zhong, R. Gong, and G. Han, "E-word of mouth sentiment analysis for user behaviour studies," *Inf. Process. Manag.*, vol. 59, no. 1, p. 102784, 2022, doi: 10.1016/j.ipm.2021.102784.
- [13] H. N. Irmanda and Ria Astriratma, "Klasifikasi Jenis Pantun Dengan Metode Support Vector Machines (SVM) [Classification of Poem Types Using Support Vector Machines (SVM) Method]," *J. RESTI (Rekayasa Sist. dan Teknol. Informasi)*, vol. 4, no. 5, pp. 915–922, 2020, doi: 10.29207/resti.v4i5.2313.
- [14] C. Liu *et al.*, "Improving sentiment analysis accuracy with emoji embedding," *J. Saf. Sci. Resil.*, vol. 2, pp. 246–252, 2021, doi: 10.1016/j.jnlssr.2021.10.003.
- [15] K. Chakraborty, S. Bhatia, S. Bhattacharyya, J. Platos, R. Bag, and A. E. Hassanien, "Sentiment Analysis of COVID-19 tweets by Deep Learning Classifiers—A study to show how popularity is affecting accuracy in social media," *Appl. Soft Comput. J.*, vol. 97, p. 106754, 2020, doi: 10.1016/j.asoc.2020.106754.
- [16] V. García-Díaz, J. P. Espada, R. G. Crespo, B. C. Pelayo G-Bustelo, and J. M. Cueva Lovelle, "An approach to improve the accuracy of probabilistic classifiers for decision support systems in sentiment analysis," *Appl. Soft Comput. J.*, vol. 67, pp. 822–833, 2018, doi: 10.1016/j.asoc.2017.05.038.
- [17] D. Darwis, E. S. Pratiwi, and A. F. O. Pasaribu, "Penerapan Algoritma Svm Untuk Analisis Sentimen Pada Data Twitter Komisi Pemberantasan Korupsi Republik Indonesia [Application of the Svm Algorithm for Sentiment Analysis on Twitter Data of the Corruption Eradication Commission of the Republic of Indonesia]," *Eductic - Sci. J. Informatics Educ.*, vol. 7, no. 1, pp. 1–11, 2020, doi: 10.21107/edutic.v7i1.8779.
- [18] D. Alita, Y. Fernando, and H. Sulistiani, "Implementasi Algoritma Multiclass Svm Pada Opini Publik Berbahasa Indonesia Di Twitter [Implementation of the Svm Multiclass Algorithm in Indonesian Public Opinion on Twitter]," *J. Tekno Kompak*, vol. 14, no. 2, pp. 86–91, 2020, doi: 10.33365/jtk.v14i2.792.
- [19] F. F. Irfani, "Analisis Sentimen Review Aplikasi Ruangguru Menggunakan Algoritma Support Vector Machine [Sentiment Analysis of Ruangguru Application Review Using Support Vector Machine Algorithm]," *JBMI (Jurnal Bisnis, Manajemen, dan Inform.)*, vol. 16, no. 3, pp. 258–266, 2020, doi: 10.26487/jbmi.v16i3.8607.
- [20] U. Rofiqoh, R. S. Perdana, and M. A. Fauzi, "Analisis Sentimen Tingkat Kepuasan Pengguna Penyedia Layanan Telekomunikasi Seluler Indonesia Pada Twitter dengan Metode Support Vector Machine dan Lexicon Based Features Twitter event detection View project Human Detection and Tracking View project [Sentiment Analysis of User Satisfaction Level of Indonesian Cellular Telecommunication Service Providers on Twitter with Support Vector Machine and Lexicon Based Features Twitter event detection View project Human Detection and Tracking View project]," *J. Pengemb. Teknol. Inf. dan Ilmu Komput.*, vol. 1, no. 12, pp. 1725–1732, 2017, [Online]. Available: <https://www.researchgate.net/publication/320234928>.
- [21] R. S. P. Wanda Athira Luqyana, Imam Cholissodin, "Analisis Sentimen Cyberbullying Pada Komentar Instagram dengan Metode Klasifikasi Support Vector Machine [Analysis of Cyberbullying Sentiments on Instagram Comments with the Support Vector Machine Classification Method]," *J. Pengemb. Teknol. Inf. dan Ilmu Komput. Univ. Brwijaya*, vol. 2, no. 11, pp. 4704–4713, 2018, [Online]. Available: <https://j-ptiik.ub.ac.id/index.php/j-ptiik/article/view/3051>.

ACCOUNTING APPLICATION FOR CONSTRUCTION GOODS PROCUREMENT RECORDING (CASE STUDY PT. PLN (PERSERO) UPT CIREBON)

Widya Jati Lestari^{1*}; Agus Sevtiana²; Alitia Rachmawati³

Program Studi Komputerisasi Akuntansi^{1,3}

Program Studi Manajemen Informatika²

Universitas Catur Insan Cendekia

widya.jatilestari@cic.ac.id^{1*}, a.sevtiana@gmail.com², alitiarachmawati29@gmail.com³

(*) Corresponding Author

Abstract— PT. PLN (Persero) UPT Cirebon is a state-owned company that takes care of the electricity aspects in ULTG Cirebon, Garut, Ciamis, and Jatibarang. Inventories of existing materials in this is not for resale. Inventories of existing materials at PT. PLN (Persero) UPT Cirebon is shown to support in carrying out operational programs and investment programs to generate or generate electricity. In this electricity company, there are problems and obstacles in recording the procurement of construction goods, because there are some activities that still use the manual system. To assist the power company in managing information in recording the procurement of construction goods so that it can be searched more quickly and accurately, it must have a system that can be used to help solve existing problems. This research produces a Construction Goods Procurement Recording Application that can manage any required information. The reports generated from this application are Material Mutation Data, Contract Letters for Routine SPPL and Non-routine SPPL, Proof of Cash Out and Cash Disbursement Journal. System procedures that apply in PT. PLN UPT Cirebon includes related parts, internal control system, and documents used. The analysis and system design stages are described manually using a flowchart accompanied by an explanatory narration, then computerized into context diagrams, relationship diagrams between entities, and relationships between tables used. After this stage is complete, the next stage is the design of the software system. The design uses Visual Basic 6.0 as the programming language and Microsoft Access 2003 as the database.

Keywords: Applications, Records, Construction Goods, PLN.

Abstrak— PT. PLN (Persero) UPT Cirebon perusahaan milik negara yang mengurus aspek kelistrikan yang ada di ULTG Cirebon, Garut, Ciamis, dan Jatibarang. Persediaan material yang ada pada PT. PLN UPT Cirebon bukan untuk dijual kembali. Persediaan material yang ada pada PT. PLN (persero) UPT Cirebon ditunjukkan untuk mendukung dalam melaksanakan program operasi dan program investasi guna menghasilkan atau membangkitkan tenaga listrik. Di dalam perusahaan listrik ini terdapat permasalahan dan kendala dalam mencatat pengadaan barang konstruksi, karena ada beberapa kegiatan yang masih menggunakan sistem manual. Untuk membantu perusahaan listrik dalam mengelola informasi dalam pencatatan pengadaan barang konstruksi agar lebih cepat di cari dan akurat maka harus memiliki suatu sistem yang dapat digunakan untuk membantu menyelesaikan permasalahan yang ada. Pada penelitian ini menghasilkan Aplikasi Pencatatan Pengadaan Barang Konstruksi yang dapat mengelola setiap informasi yang dibutuhkan. Laporan yang dihasilkan dari aplikasi ini adalah Data Mutasi Material, Surat Kontrak SPPL Rutin dan SPPL Non Rutin, Bukti Kas Keluar dan Jurnal Pengeluaran Kas. Prosedur sistem yang berlaku dalam PT. PLN UPT Cirebon mencakup bagian-bagian yang terkait, sistem pengendalian internal, dan dokumen-dokumen yang digunakan. Tahap analisa dan perancangan sistem digambarkan secara manual menggunakan *flowchart* disertai dengan narasi penjelasan, kemudian dibuat secara komputerisasi ke dalam diagram konteks, diagram hubungan antar entitas, dan relasi antar tabel-tabel yang digunakan. Setelah tahap ini selesai, tahap selanjutnya adalah perancangan sistem perangkat lunak. Perancangan tersebut menggunakan *VB (Visual Basic) 6.0* sebagai bahasa pemrograman dan *Microsoft Access 2003* sebagai *database*.

Kata Kunci: Aplikasi, Pencatatan,Barang Kontruksi, PLN.

INTRODUCTION

PT. The State Electricity Company (Persero) is a state/state-owned company that deals with all aspects of electricity in Indonesia. In 1972, in accordance with Government Regulation [1] NO. 17, the status of the State Electricity Company (PLN) is set as a State Electricity General Company and as the Holder of the Electricity Business Authority (PKUK) with the task of providing electricity for the public interest.

In carrying out its business PT. PLN (Persero) UPT Cirebon is responsible for carrying out maintenance of power distribution installations in its working area which includes functions: meter maintenance and protection, distribution installation maintenance, ScadaTel maintenance (maintenance of power supply which is part of the support system for telecommunication equipment), operation supervision, logistics and environmental management and electricity safety to achieve performance targets, manage Administration and Finance to support installation operations and maintenance activities. At PT. PLN (Persero) UPT Cirebon, material inventory is not shown or for sale and re-production. Inventories of existing materials at PT. PLN (Persero) UPT Cirebon is shown to support in carrying out operational programs and investment programs to generate or generate electricity.

One of them in getting a maximum construction goods at PT. PLN (Persero) UPT Cirebon is through the procurement of goods by direct appointment. In construction projects, procurement of construction goods is a very important job. However, until now there are parties who do not have a structured system at PT. PLN (Persero) UPT Cirebon to carry out their duties in a computerized manner.

With the procurement through a contract letter, the company requires an application for recording the procurement of construction goods. In the problems faced by PT. PLN UPT Cirebon in the logistics section has problems and obstacles in recording the procurement of construction goods, because there are some activities that still use the manual system. In research [2], the proposed system for recording receipt data on the object of this research is also one of the things that facilitates the performance of the research object, while in research [3] also discusses how important the proposal is in the system of shipping and receiving goods in a systemized manner.

In research [4] also discusses the aim of knowing whether the existing accounting information system causes logistics recording on effective and efficient objects and research [5] which applies information systems, especially in

terms of cash flow reporting, in recording and reporting, especially cash flow financial reports, should use computerization so that errors in recording or problems that are often faced can be resolved.

To assist the logistics department in managing information in recording the procurement of construction goods so that they are searched more quickly and accurately, a system must be created that can be used to help solve existing problems. Based on this, an application for recording the procurement of construction goods is made that can manage any required information. This study aims to produce a design application for procurement of construction goods carried out at PT. PLN (Persero) UPT Cirebon, and analyze the procedures for procurement of construction goods by direct appointment to PT. PLN (Persero) UPT Cirebon, also to find out what parts are involved, related in the application at PT. PLN (Persero) UPT Cirebon. And to test whether this system can be applied in internal control on the procurement system of construction goods directly.

Table 1 Research Literature

No	Literature Support	Result
1	Performance Analysis Using Balanced Scorecard Based on Analytical Hierarchy Process (AHP) Calculation Method At the Astanagarib Health Center, Cirebon City[6]	From the calculation results, it can be concluded that the performance measurement at the Astanagarib Health Center using the Balanced Scorecard method and the Analytical Hierarchy Process (AHP) calculation method indicates that the performance at the Puskesmas is good, assessed from three perspectives measured with a weight of 0.39 for internal business processes, learning and growth 0.22. The results of the Puskesmas performance evaluation were quite good with a score of 0.99. 5 Volt DC voltage stabilizer
2	Accounting Applications For Recording Cash Expenditures In PT. Yala Githa Tama Cirebon Transportation Services[7]	The analysis and system design stages are described manually using flowcharts, then computerized into level 0 and level 1 data flow diagrams accompanied by diagrams of relationships between entities, and relationships between tables. After this stage is complete, the next stage is the design of the software system. The design uses the PHP programming language (Hypertext Preprocessor) and the MySQL database (My Structured Query Language). This application produces work planning reports, general journals and cash disbursements reports.
3	Internal Control System for	Applications made with the PHP programming language and



No	Literature Support	Result
	Receivables Using the Aging Schedule Method On CV. AGS'NIE[8]	MySQL database. There are 2 application users, namely the accounting section and the manager. Age analysis of receivables groups their age based on the due date of receivables, which are divided into classifications: not yet due, reserved for 5%, past due 1-14 days, reserved for 10%, past due 14-20 days, reserved for 15%, Maturities of 20-30 days are reserved for 20%, and those that are past 30 days are reserved for 25%.

The table 1 is the basis for researchers to make applications needed by PLN, namely recording the procurement of construction goods that can manage any information needed. Because so far the logistics section of PLN UPT Cirebon does not yet have an application that can handle the problems faced. This application is to assist the logistics department in managing information in recording the procurement of construction goods so that they are searched more quickly and accurately.

The objectives to be conveyed by the authors of the research that has been carried out are to produce an application design for the procurement of construction goods carried out at PT. PLN (Persero) UPT Cirebon, to analyze the procurement procedure of construction goods by direct appointment to PT. PLN (Persero) UPT Cirebon. to find out what parts are related to the application at PT. PLN (Persero) UPT Cirebon. to find out how the implementation of the internal control system in the procurement system for construction goods is carried out directly at PT. PLN (Persero) UPT Cirebon.

MATERIALS AND METHODS

The method used in the development of this system is the waterfall method. The reason for using this method is because the waterfall method takes a systematic and sequential approach in building a system. The process of the waterfall method is that the workmanship of a system is carried out sequentially. The resulting system will be of good quality, because the implementation is gradual so that it is not focused on a certain stage. According to Pressman (2015: 42) [9][10], the waterfall model is a classic model that is systematic, sequential in building software. Name of this model is actually a "Linear Sequential Model". This model is often referred to as with the "classic life cycle" or the waterfall method. This model includes in the generic model of software engineering and the first introduced by Winston Royce around 1970 so often

considered ancient, but is the most widely used model in Software Engineering (SE). This model takes a systematic approach and sequentially. It is called a waterfall because of the stages that are passed must wait for the completion of the previous stage and run sequentially.

This waterfall method is also implemented in several studies, including research [11] who conducted the application of waterfall methods for the design of inventory information systems at bintang terang ceramic shop with the results proving that the resulting information system facilitates the process of checking or searching for the required data related to sales transactions, and purchase transactions and their effect on stock. Then in [12]research related to the Application of the Waterfall Model to the Wage Payment Accounting Information System with the research results that by applying the waterfall model to the accounting information system for the payment of web-based sap tapping wages can help ease and speed up the work process of paying laborers' wages. Furthermore, in [13] research which uses the waterfall method in contractor accounting application building with php programming.

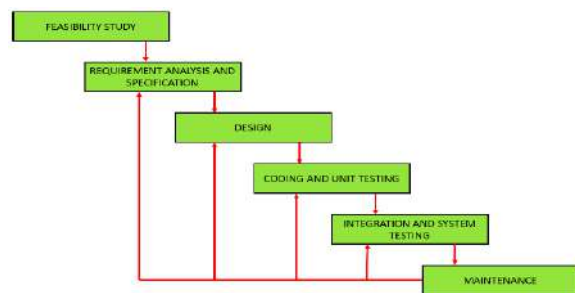


Figure 1. Waterfall Model (Pressman, 2015)[14] Research methodology is very necessary in a study to assist the implementation of research in obtaining the necessary data. The research methodology that the authors use is as follows [15]:

1. Field Research (Field Research)

Field research is a method of collecting data by observing directly the object being studied. In this case the author does:

 - a. Observation

That is by making direct observations of the object under study at PT. PLN (Persero) UPT Cirebon
 - b. Interview

That is done face to face and conduct questions and answers or discussions with people involved in the system.
2. Library Research (library study)

Literature research is a method of collecting data by looking for information through books as a reference medium.

Research Time and Implementation : This observation began on August 12, 2019 until September 13, 2019. This Accounting Computerization Project was carried out by the compiler with the research location in the logistics section of PT. PLN (Persero) UPT Cirebon, which is located at Jl. Brigjen Darsono No.198, Karyamulya Kec. Kesambi, Cirebon City, West Java 45131, Tel. 0231-481935, Fax. 0231-281940.

RESULTS AND DISCUSSION

A. Requirement Analysis

Hardware used in the implementation of the Application program for the Recording of the Procurement of Construction Goods.

Table 2. Minimum requirement Hardware Specification

No	Hardware Type	Specification
1	Processor	Intel® Celeron® N4000 CPU @1.10GHz
2	Memory	4.00 GB
3	Storage	500 GB
4	Desktop Resolution	1366 x 768

The software specifications used in the application of the Construction Goods Procurement Recording Application program are as follows:

Table 3. Minimum requirement Software Specification

No	Software Type	Specification
1	Operating System	Windows 10 Home 64-bit
2	Processor	Intel® Celeron® N4000
3	Web Server	Apache
4	Browser	Mozilla Firefox, Microsoft Edge, Google Chrome

B. Design

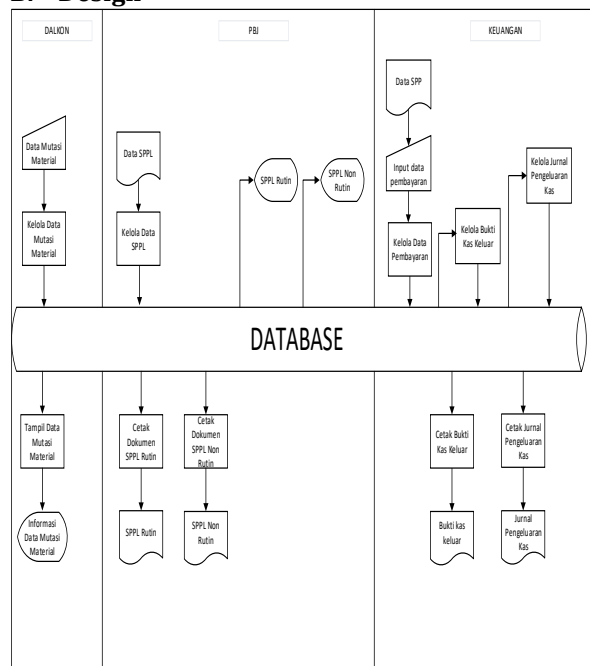


Figure 2. Flow map Design

Figure 2 describes the Dalkon section inputs and manages material mutation data based on the use of material mutations, then the Dalkon section displays material mutation data to provide material mutation information. Then the PBJ Section manages the SPPL data based on the SPPL letter and SPPL data, then the PBJ Section prints the Routine SPPL and Non Routine SPPL documents and displays the Routine SPPL and Non-Routine SPPL documents. Then the Finance Section inputs and manages payment data based on user payment data, then prints cash receipts. The finance section manages cash out receipts, then displays cash out receipts and manages cash disbursements journals, then the finance section prints cash disbursements journals.

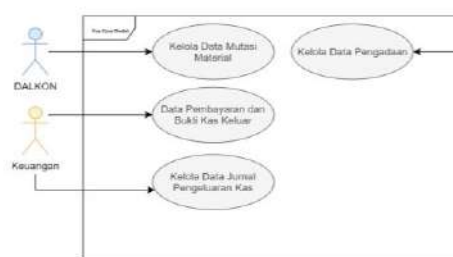


Figure 3. Use case Diagram Accounting Application Construction Goods procurement Recording Figure 3 describes the 3 actors involved in the transaction. Application for recording the procurement of construction goods

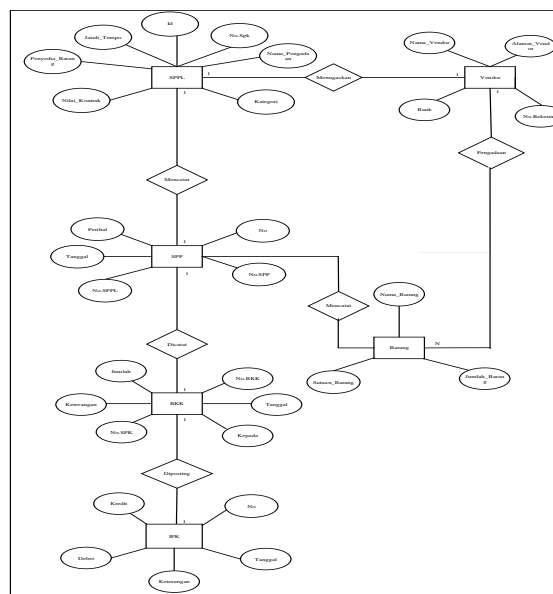


Figure 4. Entity Relationship Diagram

Figure 4 describes the relationship between tables is the relationship between one table and other tables that are interrelated in the database Application for recording the procurement of construction goods.

This research produced a list of daily mutations in Figure 6.

No	No TUG	No KATEG	No RA FAKS	Mutasi		Jumlah Sisa	ABR
				Jumlah Mutasi	Jumlah Pokok		
1	TUG-AC-00045-08-07-2019	00000001560107	TRF-ACC-SILICIDE	20	20	12	5, 6
2	TUG-AC-00045-08-07-2019	0000000350423	PO-00000000000000000000000000000000	36	3	33	5, 6
3	TUG-AC-00045-08-07-2019	00000003000007	SDI-AC-00000000000000000000000000000000	36	14	22	5, 6
4	TUG-AC-00045-08-07-2019	00000004150064	TRF-AC-00000000000000000000000000000000	11	0	11	5, 6
5	TUG-AC-00045-08-07-2019	00000004150067	TRF-AC-00000000000000000000000000000000	0	0	0	5, 6

Figure 6. Daily mutation list

Figure 6 describes Mutation Data Input Form is a design to add material mutation data.

1. Cash Out

Figure 7. Cash out

Figure 7 describes the Cash Out Data Form is used to display the Cash Out Proof Data.

2. Cash out journal

Figure 8. Cash Out Journal

Figure 8 describes the Cash Expenditure Journal Data Form is used to display the Cash Expenditure Journal Data.

C. Testing with Black Box

Black box testing is a test that focuses more on the functionality of a system. This method is used to find functional errors, interface errors, data structure errors, and system performance errors.

1. Testing Daily Mutation List

Table 4 below describe result testing menu from daily mutation list.

No	Test Type	Test Data	Expected results	Test Results	test results
1	Mutation menu	Click the daily Mutation menu	Display the Daily Mutation List page	page Show	valid

2. Testing Cash Out

Table 5 below describe result testing from Cash Out.

No	Test Type	Test Data	Expected results	Test Results	test results
1	Print Report Cash Out	Click print report menu	Display the cash out report page	page Show	valid

3. Testing Cash out journal

Table 6 describe result testing cash out journal.

No	Test Type	Test Data	Expected results	Test Results	test results
1	Print Report Cash out Journal	Click print cash out journal report menu	Display the cash out journal report page	page Show	valid

CONCLUSION

Based on the description above which has been discussed regarding the Application for Recording the Procurement of Construction Goods

at PT. PT PLN (PERSERO) UPT CIREBON, the compilers can conclude, among others, this Construction Goods Procurement Recording application works by storing and processing data, so that it can simplify and speed up processing time, the procedures that will be discussed are the procurement of construction goods in the purchase of goods and receipt of goods, the application for Recording the Procurement of Construction Goods for the PBJ section is an improvement from the manual work system in the field, and the finance department will record into the Cash Out Evidence and Cash Expenditure Journal, the use of this computerized system can help the Procurement Section of PT. PLN (PERSERO) speed up the processes of data processing, report generation and printing so that deficiencies in the old system can be resolved.

REFERENCE

- [1] Peraturan Presiden Republik Indonesia Nomor 4 Tahun 2015 tentang Perubahan Keempat atas Peraturan Presiden Nomor 54 Tahun 2010 tentang Pengadaan Barang / Jasa Pemerintah (Lembaran Negara Republik Indonesia Tahun 2015 Nomor 5).
- [2] A. B. A. Amrullah, W. J. Lestari, and W. Ilham, "Aplikasi Akuntansi Pencatatan Penerimaan Kas Pada Pt. Mega Vision Mandiri," *J. Digit*, vol. 11, no. 1, p. 101, 2021.
- [3] V. Islami and R. Oktaviani, "Analisis Sistem Pengadaan Barang Dalam Rangka Sistem Pengendalian Intern (Studi Kasus : Pt Lintas Nusantara Perdana)," *J. Adm. Bisnis*, vol. 2, no. 1, pp. 10–18, 2022.
- [4] Dian Puspitosar, "Analisis Penerapan Sistem Informasi Akuntansi Keuangan Untuk Keefektifan Dan Efisiensi Pencatatan LogistiK," *Glob. VOL 5 No 2*, vol. 5, no. 2, pp. 1–14, 2020.
- [5] I. Koerniawan, A. A. Aqham, S. Wahyuni, U. Sains, D. Teknologi, and K. Semarang, "Sistem Informasi Arus Kas Berbasis Multiuser Pada PT Xpresindo Logistik Utama Semarang," *Maret*, vol. 2, no. 1, pp. 73–79, 2022.
- [6] W. J. Lestari, M. Asfi, and F. Sihombing, "Analisis Kinerja Menggunakan Balance Scorecard Berdasarkan Metode Hitung Analytical Hierarchy Process (AHP) Di Puskesmas Astanagarib Kota Cirebon," *Ekono Insentif*, vol. 14, no. 2, pp. 110–119, 2020.
- [7] M. Fajrin, W. J. Lestari, and I. Syafrinal, "Aplikasi Akuntansi Pencatatan Pengeluaran Kas Pada Pt. Jasa Transportasi Yala Githa Tama Cirebon," *J. Digit*, vol. 10, no. 2, p. 136, 2020.
- [8] W. J. Lestari, M. Asfi, and A. Setiawati, "Sistem Pengendalian Internal Atas Piutang Menggunakan Metode Analisis Umur Piutang (Aging Schedule) Pada CV. AGS'NIE," *J. Digit*, vol. 9, no. 2, p. 215, 2020.
- [9] R. A. Runtu, G. C. Rorimpandey, Q. C. Kainde, and M. Kaluku, "Implementasi Sistem Informasi Penjualan Badan Usaha Milik Desa Berbasis Web," *Jointer-Journal Informatics Eng.*, vol. 02, no. 02, pp. 1–6, 2021.
- [10] M. Baharudin Maulana and M. Deni, "APLIKASI PEMESANAN TIKET TRAVEL BERBASIS ANDROID MENGGUNAKAN METODE WATERFALL," Vol. 1, No. 11, P. 6, 2021.
- [11] M. Badrul, "Penerapan Metode waterfall untuk Perancangan Sistem Informasi Inventory Pada Toko Keramik Bintang Terang," *PROSISKO J. Pengemb. Ris. dan Obs. Sist. Komput.*, vol. 8, no. 2, pp. 57–52, 2021.
- [12] L. S. Ramdhani, A. Luthfiyani, and Y. Afriani, "Penerapan Model Waterfall pada Sistem Informasi Akuntansi Pembayaran Upah Buruh Sadap Getah," *J. Teknol. dan Inf.*, vol. 10, no. 2, pp. 83–94, 2020.
- [13] S. Murni, L. Latifah, R. Sabaruddin, and Y. L., "Penerapan Metode Waterfall Dalam Pembangunan Aplikasi Akuntansi Kontraktor Dengan Pemrograman Php," *J. Teknol. Inf. MURA*, vol. 11, no. 1, pp. 54–65, 2019.
- [14] W. Harjono and Kristianus Jago Tute, "Perancangan Sistem Informasi Perpustakaan Berbasis Web Menggunakan Metode Waterfall," *SATESI J. Sains Teknol. dan Sist. Inf.*, vol. 2, no. 1, pp. 47–51, 2022.
- [15] V. Olindo and A. Syaripudin, "Perancangan Sistem Informasi Absensi Pegawai Berbasis Web Dengan Metode Waterfall," *OKTAL J. Ilmu Komput. dan Sci.*, vol. 1, no. 01, pp. 17–26, 2022.