

# *Color Recognition Educational Game using Fisher-Yates for Early Childhood Potential Development*

Muhammad Farhan Mahesa Ijlal<sup>1</sup>, Umi Chotijah<sup>2</sup>

Universitas Muhammadiyah Gresik, Jl. Sumatera No. 101, Kebomas, Gresik, Indonesia

Email: mfarhanmi25@gmail.com<sup>1</sup>, umi.chotijah@umg.ac.id<sup>2</sup>

**Abstract** - To continue basic education, it is necessary to develop potential abilities by learning color recognition in early childhood. However, learning in schools today still uses boring conventional learning methods. Based on these problems, there is a need for an introductory educational game that can be easily used and carried anywhere, anytime by applying the Fisher-Yates shuffle algorithm. The aim is that educational games are not monotonous and boring to play. In this study, in addition to using the Fisher-Yates algorithm, we use the Multimedia Development Life Cycle (MDLC) as the system development method. The results of tests performed using black box testing are as expected. Therefore, this educational game can be used by parents and educators as an alternative to traditional learning tools to further develop early childhood potential in preparation for basic education.

**Keywords** - Color Recognition, Early Childhood, Educational Games, Fisher-Yates Algorithm.

*Intisari* - Untuk melanjutkan pendidikan dasar, perlu dikembangkan potensi kemampuan dengan pembelajaran pengenalan warna pada anak usia dini. Namun, pembelajaran di sekolah saat ini masih menggunakan metode pembelajaran konvensional yang membosankan. Berdasarkan permasalahan tersebut, maka diperlukan sebuah game edukasi pengenalan yang dapat dengan mudah digunakan dan dibawa kemana saja, kapan saja dengan menerapkan algoritma pengacakan Fisher-Yates. Tujuannya agar game edukasi tidak monoton dan membosankan untuk dimainkan. Dalam penelitian ini, selain menggunakan algoritma Fisher-Yates, kami menggunakan Multimedia Development Life Cycle (MDLC) sebagai metode pengembangan sistem. Hasil pengujian yang dilakukan dengan menggunakan pengujian black box sesuai dengan yang diharapkan. Oleh karena itu, game edukasi ini dapat digunakan oleh orang tua dan pendidik sebagai alternatif alat pembelajaran tradisional untuk lebih mengembangkan potensi anak usia dini dalam persiapan pendidikan dasar.

**Kata Kunci** - Pengenalan Warna, Anak Usia Dini, Game Edukasi, Algoritma Fisher-Yates.

## I. INTRODUCTION

Currently, the use of information and communication technology is closely related to all activities of human life. The use of information and communication technology is widely used in all fields such as education. The application of information and communication technology in the educational environment must be applied to educational institutions, especially early childhood education. Early childhood education is responsive to technological developments. Early childhood education is the stage of education before continuing to basic education, which seeks to encourage learning for children from birth to the age of six [1]. This is done by providing incentives that support physical and mental growth and development by implementing child-centered and meaningful play-based learning strategies so that children are ready to continue learning. Educators can do that.

Early childhood needs to develop their potential to continue to the basic education level. One way to develop the potential of early childhood is through color recognition learning. The introduction of color to early childhood can hone the cognitive aspects of thinking [2]. The

development of each early childhood is very different so to measure the extent of cognitive development, children must be able to recognize colors well.

At the early childhood level, learning through easy-to-play games with eye-catching bright colors and animated pictures encourages students to become more interested in learning about colors. Most of the learning in schools today still uses applied learning methods. When learning traditionally, when the teacher gives the students exercises, the students listen carefully to the teacher's explanations to complete the assignments, which makes the learning process tedious and makes the students passive [3]. Therefore, we need to switch from traditional learning methods to modern learning methods by developing games using today's widely used communication devices.

The development of games is currently targeting users of communication devices such as smartphones. With the support of the rapidly growing android operating system, the use of smartphones can provide various conveniences, such as easy to use, and easy to carry anytime and anywhere [4]. In a game, it is also necessary to have rules so that it is not monotonous and not boring to play. Therefore this study uses the Fisher-Yates Shuffle algorithm to build color-recognition educational games for early childhood so that questions, colors, and object positions do not appear repeatedly and are not easily guessed. It is hoped that this color recognition educational game can be used by parents and early childhood education teachers as a substitute for conventional learning facilities by using games that are easy to play and fun and can be played anytime and anywhere to help develop the potential of early childhood in preparation for continuing to basic education.

A previous study by Muttaqim et al. Was Responsible for building his Android-based educational game of popping balloons using Fisher's algorithm [5]. The difference between this study and that study is the application of the system development method. This study uses the MDLC method and the study uses a waterfall flow. Another study by Wahyudinata and Dirgantara discussed the development of an android-based 2D educational game for sorting recycled waste [6]. The difference between this research and that research lies in the development of the system and application used. This study uses the GameMaker application to create the game and MDLC to develop the system. On the other hand, this study uses a Unity2D application to create the game and uses the Game Development Life Cycle (GDLC) system development. In addition, research by Rohmah et al becomes a reference in the use of the MDLC method to build an educational game [7].

## II. STUDY SIGNIFICANCE

### A. Literature Study

#### 1. Educational Games

Educational games are digital games that are specifically designed to teach users a certain lesson, guide them in practicing their abilities, and motivate them to play them using interactive multimedia technology. Educational games teach children or adults several forms of learning quickly and easily absorbed.

Various studies have proven the effectiveness of games in influencing players. The content or content in the game is easily understood by players, this is due to the interactivity in the game, as well as immersion (absorption of learning) provided by the game makes players in the most relaxed and open condition in receiving material. This is what some game developers use to influence players, in a positive or negative sense. The speed of the game in influencing these players is closely related to the development of early childhood in this technological era.

## 2. *Early Childhood*

The National Association for the Education of Young Children (NAEYC) states that early childhood or early childhood is a child who is at the age of zero to eight years. This period is a process of growth and development in aspects of the human life span. The learning process for children must pay attention to the characteristics possessed in the child's development stage.

This is different from the Sub-Directorate of Early Childhood Education which limits the understanding of the term early childhood to children aged zero to six years, that is until the child completes kindergarten. This means that it shows that children who are still in the care of their parents, and children who are in Child Care Parks, playgroups, and Kindergartens are the scope of the definition.

The use of the term early childhood in Early Childhood Education indicates a high awareness on the part of the government and education observers to handle children's education professionally and seriously. Handling early childhood, especially in the field of education, will determine the quality of the nation's education in the future. At an early age, a person's quality of life has tremendous meaning and influence on the next life. Therefore, at the time of child development when the golden age.

The early age period in the course of human life is an important period for brain growth, intelligence, personality, memory, and other aspects of development. This means that the inhibition of growth and development at this time can result in inhibition in the following periods.

## 3. *Android*

Android is a Linux-based mobile device operating system that includes an operating system, middleware, and several applications that have been provided. The progress of Android is getting faster as the number of users of this platform grows. This is due to the use of the Android platform which is very easy and complete. This is supported by very high support from the open-source community around the world, so the Android platform is still growing, both in terms of the technology used and in terms of the number of devices used worldwide [8]. The Android operating system is generally installed on mobile devices such as smartphones and tablets.

### *B. Research Method*

In this study, the Fisher-Yates shuffle method is used. Developed by Ronald Fisher and Frank Yates [9]–[11], this method is an algorithm used to obtain permuted results by randomization from a finite set. This study used the above method to randomize questions, colors, and object positions in color-recognition educational games. The Fisher-Yates Shuffle was chosen as a randomization algorithm method that is better than other randomization methods with fast execution times.

To develop a good system, we need a method that is easy to understand and implement. So this study applies the Luther-Sutopo version of the MDLC method. The Luther-Sutopo version of the MDLC method was developed by Hadi Sutopo. MDLC method was chosen in this study because it is easier to understand and implement, the stages are clear, easy to follow, structured and logically sequential, and can be used by small software developers [12]. MDLC has 6 stages as presented in Figure 1.

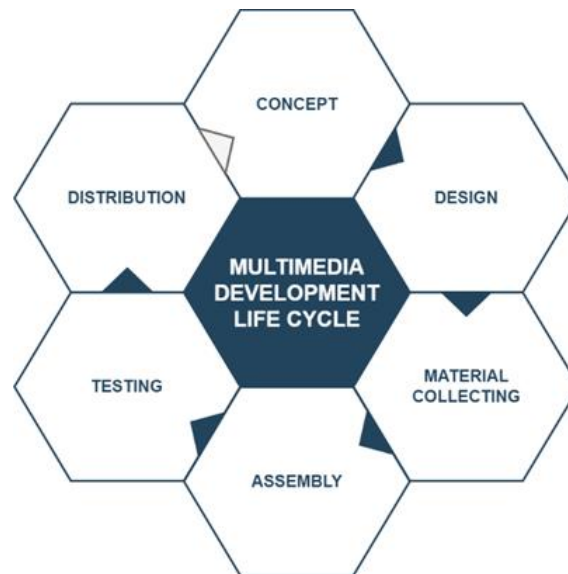


Figure 1. MDLC Stages

### 1. *Concept*

In this concept stage, the researcher determines who will play the game and the goals and benefits of making the game. This purpose and user identification are needed to determine user characteristics, including user skills, that affect design creation. At this stage, you also determine the type of application and the purpose of the application. This purpose and user identification are needed to determine user characteristics, including user skills, that affect design creation. At this stage, you also determine the material which is the type of application, application features, and application objectives.

### 2. *Design*

The stage of developing specifications related to program architecture, style, appearance, and material requirements. Early project work is often supplemented, but specifications detail what should be done and how the application should be built, so the next step is gathering and compiling materials. You don't have to make new decisions or reduced by part or other modifications of the application. In this phase, researchers create system and algorithm designs that are applied to applications.

### 3. *Material Collecting*

Researchers have gathered the necessary materials to create this educational game. A collection of all the materials you need for your application. Materials include buttons, backgrounds, photos, animations, audio, and more. This process is generally performed in parallel, ie in conjunction with the assembly process. However, it can also be done continuously between the material-gathering stage and the assembly stage.

### 4. *Assembly*

The resulting materials are then assembled according to the previously designed game design. At this stage, special skills are required so that the generated application applies the Fisher-Yates algorithm and can obtain good results.

### 5. *Testing*

After completing the assembly, the researcher performed internal tests to verify the functionality and performance of the game by running the application and checking for any errors. this test uses the black box method as a test method.

6. *Distribution*

At this stage, the game can be played and disseminated the game to parents and early childhood education teachers. According to Luther in Binanto, each stage does not have to be done sequentially, but the concept stage must begin first.

**III. RESULTS AND DISCUSSION**

1. *Concept*

This phase is the first to determine your goals for creating your game, who will play your game (identifying your audience), and the benefits of your game. The purpose of this game is to create an interesting and fun color recognition educational game for children from early childhood to six years old. This game is designed with a simple, attractive, and easy-to-use appearance, also added a cheerful background sound, there are several buttons including the play button, petunjuk, and keluar button. This educational game was created as an alternative to conventional learning facilities and is expected to help develop the potential of early childhood in preparation for continuing basic education.

2. *Design*

Two designs are performed in this phase: system design and algorithm design. A system design is used to outline a game system and is created in the form of a flowchart as shown in Figure 2. This flow chart will help researchers in designing this educational game so that users can easily understand the process.

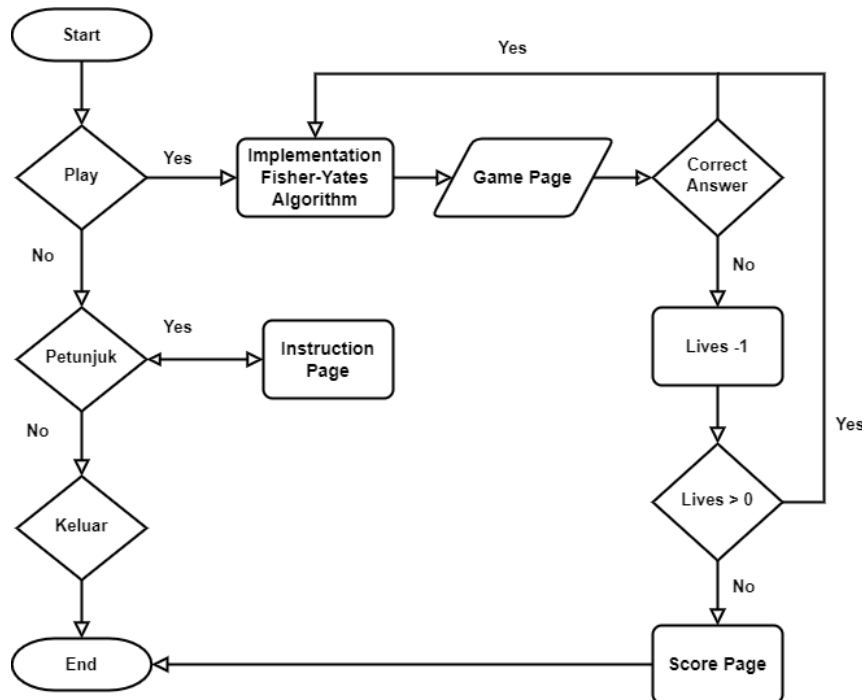


Figure 2. Flowchart of Color Recognition Educational Game

The Fisher-Yates Shuffle algorithm was used when developing the algorithm for this educational game. This algorithm performs a randomization process for in-game questions, colors, and object positions. The Fisher-Yates Shuffle can be divided into several methods, including the original method and a more recent method adapted and improved by Richard Durstenfeld in 1964 for computer systems. In the modern method, the number is no longer crossed out from the old number sequence, but the last digit is placed in the place of the number that has been moved to the new number sequence [13]. The following are the stages of the Fisher-Yates Shuffle which can be seen in Figure 3.

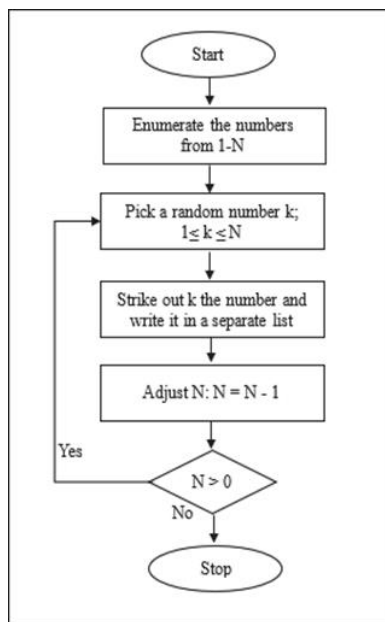


Figure 3. Flowchart of Fisher-Yates Shuffle [14]

According to Vinay Singh (2014), Fisher-Yates Shuffle with modern methods is considered capable of reducing the complexity of the algorithm to  $O(n)$ , compared to other methods such as sorting which are considered very inefficient due to nested loops [15]. using the sort method cannot do accurate and fast randomization.

The most recent method used in this study does not erase selected digits, but swaps their positions with unselected digits, as shown in Table 1. The range is the length of unselected numbers, the roll is randomly chosen numbers, and the scratch is the list. number. The result is what you get.

TABLE I  
EXAMPLE OF THE MODERN FISHER-YATES SHUFFLE PROCESS

Range	Roll	Scratch	Result
		12345678	
1 – 8	8	12345678	8
1 – 7	4	123567	48
1 – 6	1	23567	148
1 – 5	5	2367	5148
1 – 4	7	236	75148
1 – 3	6	23	675148
1 – 2	2	3	2675148
<b>Results obtained:</b>			<b>32675148</b>

### 3. *Material Collecting*

This phase is the gathering of materials suitable for the needs of creating an educational game application. Some of the necessary materials that will be included in this educational game include colored balloon objects, .jpg and .png format backgrounds, background sound instruments in .wav and .ogg formats, and some interesting animations.

### 4. *Assembly*

At this stage, all the needs and educational games are made. Game creation is based on the design stage using the GameMaker application. GameMaker is an application that functions as a game maker with interface features that are very understandable by users [16]. The implementation of the main page display of this color recognition educational game is presented in Figure 4. The main page display has several buttons including the play, petunjuk, and keluar buttons. Also added are pictures, backgrounds, and cheerful background instruments.



Figure 4. Main Page View

When the play button is pressed, the game will run by implementing the Fisher-Yates Shuffle in it, accompanied by entertaining background instruments. On this page, the Fisher-Yates Shuffle works to perform randomization from questions, and colors to the position of the balloon object as shown in Figure 5. On the display of this game page, the user will choose the color of the balloon according to the question command in the form of text or audio. If you choose the color of the balloon correctly, the score will increase by 50 points, but if the answer chosen is incorrect, it will decrease by one. If the available opportunities run out, then the game will be over.



Figure 5. Game Page View

Figure 6 shows the Score Page Display to display the most points earned during the game. This score page also has a main lagi button and menu utama button. The main lagi button is used to restart the game, while the menu utama button is used to return to the main page.



Figure 6. Score Page View

Figure 7 shows the Instructions Page Display to display the rules and procedures for playing color recognition educational games. On this manual page, there is an X button that functions to return to the main page, move animations, and also entertain background instruments.



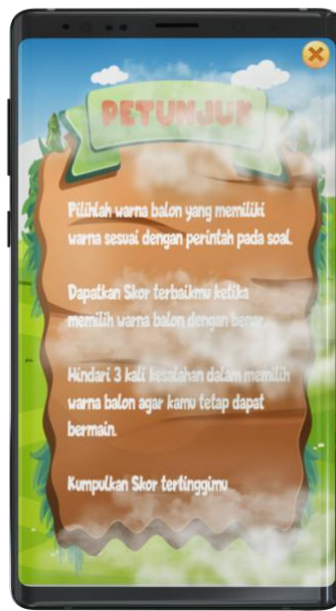


Figure 7. Instruction Page View

5. *Testing*

The purpose of this phase is to find flaws and bugs in the system and ensure that the created system meets the needs of the users. If it's not right, you can review it, fix it, and make it better than expected. Black box testing methodology applies when performing this test. Black box testing is a method of testing that focuses on the functional specifications of the game you are building [17]. A tester can run tests against a set of input conditions in a program specification. For the tests performed according to the black box testing method, the results obtained were in line with the expectations, which can be seen in Table 2.

TABLE III  
BLACK BOX TESTING RESULTS

Test case	Hope	Achievements	Results
Main page test	Show the main page	Showing the main page	✓
Test press the play button	Can redirect to the game page	The game page is successfully opened and the game is running	✓
Game page test	Can raise questions randomly	Show questions that appear randomly	✓
	Can bring up the color of the balloon object randomly	Displays the color of the balloon object that appears randomly	✓
	Can randomize the position of the balloon object	Displays the position of the balloon object that appears randomly	✓
	When choosing the correct balloon color, the score increases by 50 points	The score automatically increases by 50 points when the balloon object's color choice is correct	✓
	Lives will be reduced if the answer is not correct	Lives are automatically reduced by one when selecting an incorrect balloon object color	✓

Test case	Hope	Achievements	Results
Score page test	Show score page	Displays the score page and the best number of points earned	✓
Main lagi test again	Can start the game again	Display the game page to play again	✓
Menu utama button test	Can redirect to the main menu page	Redirect and display views to the main page	✓
Petunjuk button test	Show instructions page	Showing instructions page	✓
Keluar button test	Can quit the educational game application	Close the educational game app and quit	✓

## 6. Distribution

Distribution is the last stage in developing this color-recognition educational game application. This stage is carried out for the dissemination and delivery of educational games to parents and early childhood education teachers in the form of an Android-based Application Package Kit (APK) using CD/DVD storage media and via the Google Drive link.

## IV. CONCLUSION

Based on the results of this study, we conclude that this color recognition educational game can be used by parents and educators as an alternative to traditional learning tools to develop the potential of early childhood in preparation for basic education. The design of this Android-based educational game can be used by communication devices such as smartphones, so it can be used anytime and anywhere. The use of the Fisher-Yates Shuffle algorithm has been successfully implemented in this educational color recognition game so that the questions, colors, and positions of balloon objects can be randomly randomized quickly without repetition. At the time of testing, the results were in line with expectations, but this educational game still needs to be developed again so that it can be run not only on Android-based smartphones. Therefore, further research is needed to provide more features and updates and deploy this app on non-Android smartphones such as smartphones based on iOS, HarmonyOS, etc.

## REFERENCES

- [1] I. Wati dan R. R. Diana, "Improving early childhood creativity through calligraphy activity from coffee dregs," *Atfāluna J. Islam. Early Child. Educ.*, vol. 4, no. 1, hal. 49–67, 2021.
- [2] N. Kholidiyah, D. N. Adhani, dan S. F. Fitroh, "Pengembangan Lampu Warna terhadap Perkembangan Kognitif Anak Kelompok A di TK PGRI 1 Bancaran," *J. PG-PAUD Trunojoyo J. Pendidik. dan Pembelajaran Anak Usia Dini*, vol. 7, no. 1, hal. 47–51, 2020.
- [3] L. Nur, A. Hafina, dan N. Rusmana, "Kemampuan Kognitif Anak Usia Dini Dalam Pembelajaran Akuatik," *Sch. J. Pendidik. dan Kebud.*, vol. 10, no. 1, hal. 42–50, 2020.
- [4] M. F. M. Ijlal, U. Chotijah, dan D. Aditama, "Perancangan Aplikasi Katalog Produk PT Petrosida Gresik Berbasis Android," *J. Komtika (Komputasi dan Inform.)*, vol. 6, no. 1, hal. 39–48, 2022.
- [5] I. Muttaqim, S. Andryana, dan I. D. Sholihati, "Rancang Bangun Game Edukasi Pecah Balon Berbasis Android Menggunakan Algoritma Fisher-Yates," 2021. doi: 10.29100/jipi.v6i2.2020.
- [6] A. Wahyudinata dan H. B. Dirgantara, "Pengembangan Gim Edukasi 2D Pemilahan Sampah Daur Ulang Berbasis Android," *MATRIK J. Manajemen, Tek. Inform. dan Rekayasa Komput.*, vol. 20, no. 1, hal. 129–138, 2020.
- [7] W. A. Rohmah, A. Asriyanik, dan W. Apriyandari, "Implementation of the Algorithm Fisher Yates Shuffle on Game Quiz Environment," *J. INFORMATICS Telecommun. Eng.*, vol. 4, no. 1, hal. 161–172, Sep 2020.

- [8] D. Aditama dan R. P. N. Budiarti, "Aplikasi Media Pembelajaran Alphanumerik Dan Pengenalan Hewan Untuk Anak Usia Pra-Sekolah Dengan Memanfaatkan Teknologi Augmented Reality," *Community Dev. J.*, vol. 3, no. 2, hal. 58–70, 2019.
- [9] A. Y. Ananta, K. S. Batubulan, dan K. R. Z. Suwantoko, "Implementasi Game Kuis Tebak Tangga Nada Jawa Dengan Metode Fisher-Yates Shuffle dan Fuzzy Tsukamoto Berbasis Android," *Semin. Inform. Apl. Polinema*, hal. 410–416, 2020.
- [10] R. S. Putra, S. Andryana, dan R. T. Aldisa, "Perancangan Game Edukasi Pembelajaran Ilmu Tajwid dengan Mengimplementasikan Algoritma Fisher-Yates dan Flood Fill," *J. JTIK (Jurnal Teknol. Inf. dan Komunikasi)*, vol. 6, no. 2, hal. 304–312, 2022.
- [11] D. W. Wibowo dan M. S. Khairy, "Implementasi Fisher-Yates Untuk Pengacakan Objek Media Pembelajaran Hewan Nusantara Pada Virtual Reality Android," *Semin. Inform. Apl. ...*, hal. 366–370, 2020.
- [12] E. J. Purhita dan U. S. Wardani, *Perancangan Multimedia Pembelajaran Menggunakan Model Pengembangan Hmdm (Holistic Multimedia Development Model)*. 2021.
- [13] Y. Arviansyah, N. Nurfaizah, dan R. Waluyo, "Penerapan Algoritma Fisher Yates Shuffle Pada Aplikasi TOEFL Preparation Berbasis Web," *J. Buana Inform.*, vol. 11, no. 2, hal. 111, 2020.
- [14] I. Febriani, R. Ekawati, U. Supriadi, dan M. I. Abdullah, "Fisher-yates shuffle algorithm for randomization math exam on computer based-test," in *AIP Conference Proceeds*, 2021, vol. 2331, no. 1, hal. 60015.
- [15] A. Wijaya dan Y. Apridiansyah, "Penerapan Algoritma Fisher Yates Shuffle Pada Media Pembelajaran Mapel Agama Islam Berbasis Android," *J. Inform. Upgris*, vol. 6, no. 1, 2020.
- [16] J. Wahyudi, "Rancang Bangun Game Edukasi 3 Dimensi Perawatan Orang Utan Berbasis Game Maker: Studio," *Bitnet J. Pendidik. Teknol. Inf.*, vol. 6, no. 1, hal. 24–32, 2021.
- [17] E. T. Sihotang dan H. Yutanto, "Tata Kelola Organisasi Mahasiswa Melalui Pengembangan Sistem Informasi," *MATRIK J. Manajemen, Tek. Inform. dan Rekayasa Komput.*, vol. 21, no. 1, hal. 99–110, 2021.

#### ACKNOWLEDGEMENTS

Praise and gratitude the author goes to the presence of God Almighty who has given grace, love, health, and the opportunity to be able to complete this research. In the preparation of this research, many parties provided motivation, advice, and support to the author. On this precious occasion, the author would like to thank and respect the parties. First of all, the author would like to express my sincerest thanks to my dear parents, who have given their love, prayers, and endless support. The author expresses his sincere and highest appreciation to the dean of the Faculty of Engineering at the University of Muhammadiyah Gresik, the Head of the Informatics Engineering Study Program at the University of Muhammadiyah Gresik, and the examiner lecturers of the University of Muhammadiyah Gresik who have provided help, support, and guidance with patience in completing this research.