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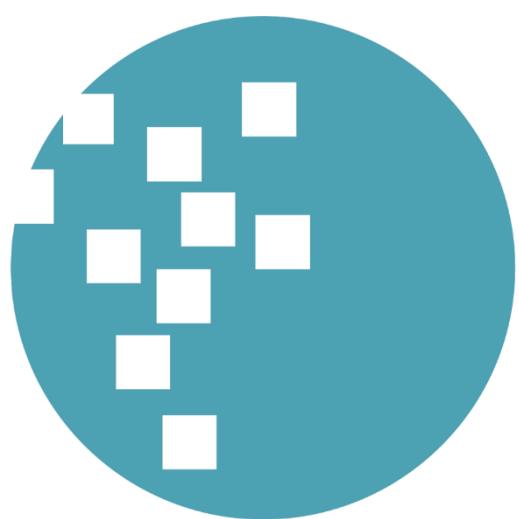
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A Prototype of Web-based Picture Cards Matching Video Game for Memory Improvement Training

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Abstract—This study aims to design an action-arcade web-based picture card matching video game for memory improvement. Picture cards to be matched are animals that usually exist in zoos and farms, like monkey, cow, dog, pig, chicken, zebra, elephant, owl, and mouse. This research uses the prototyping process model with the communication stage, quick planning, modeling, construction, and launching. The results of this study are web-based video games for memory improvement training. From the results of the user experience testing, 68% of respondents informed that they felt it was easier to remember.

Index Terms—action-arcade; memory improvement training; picture cards matching; prototyping; video game

I. INTRODUCTION

Video games are proven to increase social development and cognitive abilities. However, too much video game playing can cause some negative aspects, such as negative social traits, addictions, and health problems [1]. Research in [2], state that video games also give motivational benefits to the players. The action-arcade game could stimulate cognitive abilities. Action-arcade games are a type of game that is played without the need to think hard, but fast, so it requires specific techniques to solve problems. Arcade games can take place on one screen or several [3]. Research in [4] [5] [6], state that action-arcade games have the potential to train someone's cognitive abilities.

Arcade games have sub-genres including the maze, pong, shooter, puzzle, or platformers. Arcade games also allow players to unite visual vocabulary learning that can be used to train memory [7]. Arcade games are more interesting if they have a theme and adapted to the location of the players. This theme referred to as localization. Localization is a simple process, which translates text or terms into the local language where the game is released. Localization is also done to accommodate cultural differences in each place where the game is released [8].

Digital video games make learning more fun and exciting and help players to retain and recall information [9]. Video games could have a massive effect on living and learning [10]. Video games can trigger social development and cognitive abilities. Too much video game playing might result in negative social traits, addiction, even health problem [1] [11]. Web-based games are widely used to teach reading, mathematics, and science. Web-based games are games with a specific purpose [12]. The learners' motivation and confidence can be enhanced in the process of playing a game when they achieve learning goals in a relaxing environment [13], as cited in Temaja [14].

Cognitive abilities such as memory can be enhanced with video games, such as a memory matrix training game. In this game, players were shown a 3×3 matrix in which tiles lit up in a sequence [15] [16]. Players were then instructed to reproduce the series by touching the location of each tile sequentially in the matrix. There are four principles of memory improvement: process material actively, practice retrieval, use distributed practice and use metamemory [17]. Matching activities such as matching game improves language, concentration, and memory [18].

Based on this background, this research aims to build a web-based image matching video game for memory improvement. The game design in this research is based on the principles of memory improvement, especially practice retrieval and use distributed practice principles. The players must match the same image card to get a score. The position of the picture is initially closed, if the player chooses the card with the same picture, they will get a score, and the map will be opened. The image that will be used is the characteristic fauna in Indonesia. The game has four difficulty levels: easy, normal, hard, and extreme. This study uses prototyping model process because it requires suggestions from the users for further work and development.

II. LITERATURE REVIEW

A. Video Game

According to Salen & Zimmerman [19], the game is an activity with some rules engaged in for an outcome. The video game is the application of human and computer interaction [20]. Another definition of a video game is a game we play thanks to an audiovisual apparatus and which can be based on a story [21]. Every video game has “bricks” which are [22]): “game”: if the rule is directly related to the goal of the game, mainly as feedback within the rule effects and “play”: if the rule template is independent of the goal. The rule is then characterized by a trigger based on the video games input.

The video game has several goals: collect something, gain territory, get somewhere first, remove a series of obstacles, discovery, and eliminate other players [23]. A video game can be an integral of modern pedagogy [24]. There are three game elements in a working memory training: progress bar, level indicator, and thematic setting [25]. Video game training increases memory in different aspects, such as visuospatial, episodic memory short-term memory, and mnemonic discrimination [26].

B. Action-arcade Video Game

An action video game is a video game that offers the intensity of some action as the primary attraction and interaction [27]. Action game is a response-based video game [28] [29]. Action game involves lots of frantic button pushing [23]. An arcade game is a video game that are not focused on the game's storyline, but only for a moment of fun and chasing the highest score [30].

Action-arcade game is video games that require a fast reaction from the players and can be a useful exercise for cognitive improvement [31]. The focus of the action-arcade game is on the user's responses and reflexes. The game often features puzzle-solving, image matching, complex thinking, or strategy [32]. The action-arcade game has the potential to be an exciting learning tool by adding educational gameplay features. Playing an action-arcade game can improve cognitive abilities, improve visual-spatial resolution, and creativity [33].

C. Memory

Memory is the section of the brain by which data is encoded, stored, and retrieved when needed, then influencing future action [34]. Memory is defined as the application of learning over time [35]. There is four principles memory improvement defined broadly as follow [17]:

- Process material actively. It means to emphasize and elaborative processing,

sometimes also known as a meaningful process [36].

- Practice retrieval. It means to learn by recalling information from memory. Retrieval practice can lead to more learning than restudying [37] [38].
- Use distributed practice. It means the learning process is spread out across relatively long periods. The distributed practice may be the most powerful method for people to improve their memory without changing the amount of time spent studying [39].
- Use metamemory. It refers to judgement and decisions about learning and memory [40] [41] [42].

D. Matching Game

A matching game, as cited in [43] is a game that the player turns over two cards at the same time to turn over a matching pair by using their memory [44].

E. Prototyping Model Process

Prototyping model process can be used to develop software or game. According to Pressman [45], the prototyping model process consists of five stages:

- Communication. In this stage, we define the overall game objectives and identify the requirements.
- Quick plan. We are planning the game feature briefly and quickly.
- Modelling quick design. Performing game design using modelling tools such as flowchart and mockup interface design.
- Construction of prototype. Coding the game prototype and testing the game.
- Deployment delivery & feedback. The game is launched to the user and asks for feedback.

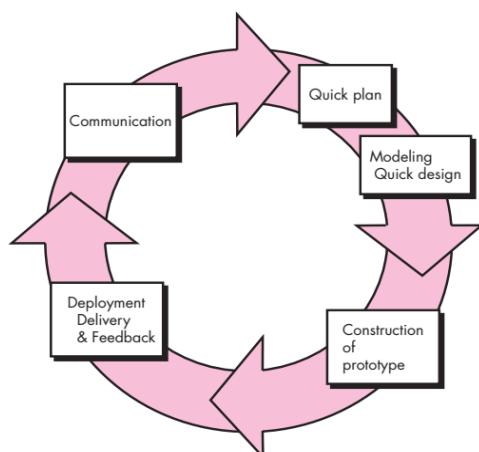


Fig. 1. Prototyping model process [45]

F. Related Works

There are some similar works that form the foundation of this research. Research by Temaja [14], the result is an e-matching game can be used for creating fun and productive learning activity for young learners. The study by Dirgantara & Marselino [46], the result is a web-based learning media that is accessible to the public. Based on this research, 97% of respondents stated the learning media is succeeding for study.

Research by Khenissi et al. [47], the result is a memory match game to render the learning experience with more fun, to engage learners and to keep them motivated. Research by Dirgantara et al. [11], the result is a quiz video game for learning mathematics with the theme of wizard battle. The theme makes a fun and pleasant learning environment. These research are the foundation of this research to develop a web-based game for learning media.

Research by Buschkuehl et al [48] and Loosli et al [49] as cited in Deveau et al [50], state that if animal pictures are presented sequentially and participants respond to the each of image would be a good training approach to promote learning. This research is the reason to using animal object as game assets.

Research by Hartshorne [51], state that the speed in processing information reaches its peak at the age of 18-19 years old, then gradually decreases thereafter. Short-term memory continues to develop and builds up until around age 25, then starts to stagnate and eventually declines slowly starting at age 35. This research is the reason why the respondents are 18 years old or older.

III. RESEARCH METHODOLOGY

A. Communication Stage

At this stage, it was carried out between the research team and prospective respondents. Communication is carried out to obtain input features or displays that are easy to use. From the communication results obtained by the user requirements as follows:

- The player who correctly matches the picture gets a score.
- The player who correctly matches images at least 2 times in a row will get an additional bonus score.
- The game consists of 4 difficulty levels.
- High score leaderboard menu.
- There are sound effects.
- Help menu.

- Cards are arranged randomly each time the game starts.
- The main target audiences for the game is the general public aged 18 years or older.

The gameplay derived from the user requirements is adapted to use distributed practice principle for memory improvement. The system requirements to be able to play this game prototype are as follows:

- The latest browser application, preferably Google Chrome or Mozilla Firefox.
- It is connected to the internet.
- Minimum of 2GB RAM.

B. Quick Plan Stage

At this stage, resource planning and features in the designed game are carried out. The flow of this game is displayed in Fig. 2. The game starts with the player choosing the difficulty level of the game: easy, normal, hard, or extreme. At the easy difficulty level, the number of picture cards is 16 with 4 rows and 4 columns. At the normal difficulty level, the number of picture cards is 24 with 4 rows and 6 columns. At the hard difficulty level, the number of picture cards is 32 with 4 rows and 8 columns. At the normal difficulty level, the number of picture cards is 40 with 4 rows and 10 columns.

If the cards are not all open, then the player can choose a card to be matched if the cards opened are matched, then the player gets ten scores. If the cards are not matched, the player does not get a score. If the player managed to match the picture cards, then the player will get a score by calculating the formula: (consecutive matches * 10). When all the cards have been opened then the game is finished and will be directed to the high score menu.

The resources used to design this game are Game Maker Studio 1.4 and various open-source assets that are used as game objects. The list of assets is shown in Table I. The assets used are pictures and sound.

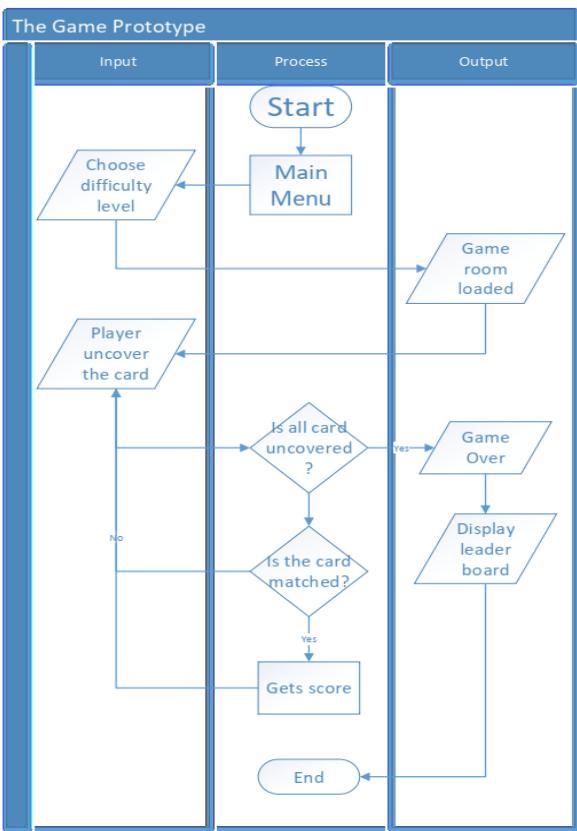


Fig. 2. The game prototype flowchart

		Theme background
sound_dog sound_chicken sound_pig sound_elephant sound_cat sound_monkey sound_owl sound_cow sound_mouse sound_zebra sound_bgm		Sound effect
sound_fantastic sound_mantap sound_wow		Consecutive match sound effect

The game assets consist of images and sounds. The images are divided into four categories: menu button image (credit, easy, normal, hard, extreme, help, menu, quit, and restart) credit to Poconk Game Artist [52], back picture of the card image credit to Get4art [53], front picture of the card image (dog, chicken, pig, elephant, cat, monkey, owl, cow, mouse, and zebra) credit to Dansie [54], and the game theme background image. The sounds are divided into two categories: the sound effect (dog, chicken, pig, elephant, cat, monkey, owl, cow, mouse, zebra, and background music) credit to Soundbible [55] and the consecutive match sound effect that will sound if the player manages to match the card in a row credit to amateur voice actress Benedikta Prava Krista Galuh Jiwantari.

C. Modelling Quick Design Stage

At this stage, the application modelling is carried out using Balsamic application to illustrate the application's display design. The interface designs of the game are shown in Fig. 3 to Fig. 5.

Assets	Description
	Menu button
	back picture of the card image
	front picture of the card image

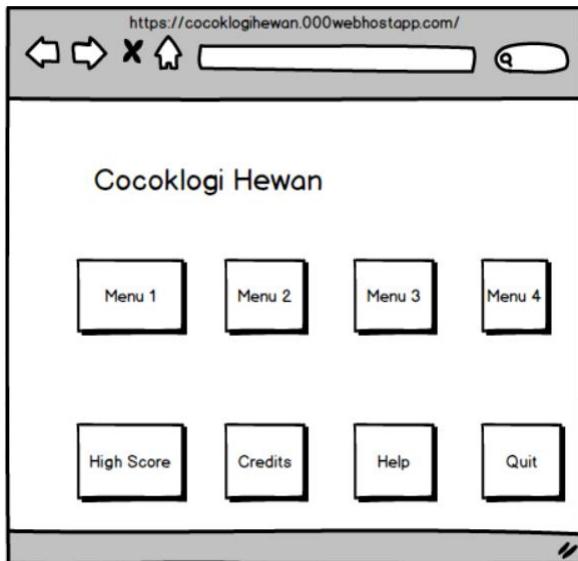


Fig. 3. The game main menu

Fig. 3 shows the initial game layout design contains menus that can be selected by the player. There is menu 1 - menu 4, which is the choice of difficulty level, high score menu, credits, help and quit. After the player chooses one of the difficulty level menus, it will be directed to the game screen.

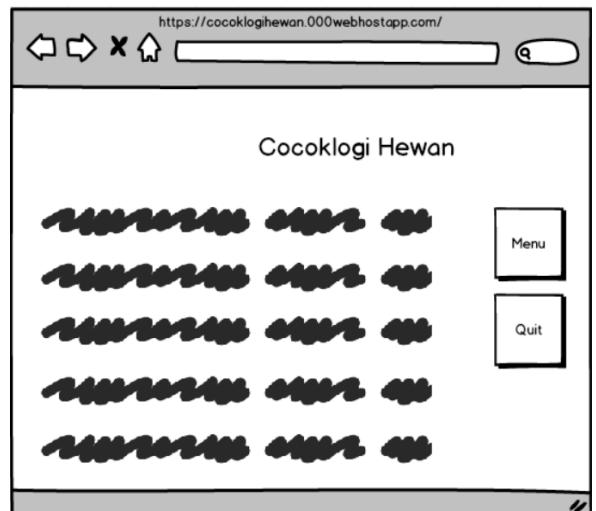


Fig. 5. The high score screen

D. Construction Stage

At this stage, the game development is carried out. Coding is done using Game Maker Studio 1.4. The game construction used the Drag n Drop (DnD) method and programming using the Game Maker Language (GML). This application development requires six rooms. These six rooms are used to execute the code that has been created. The rooms list is shown in Table II.

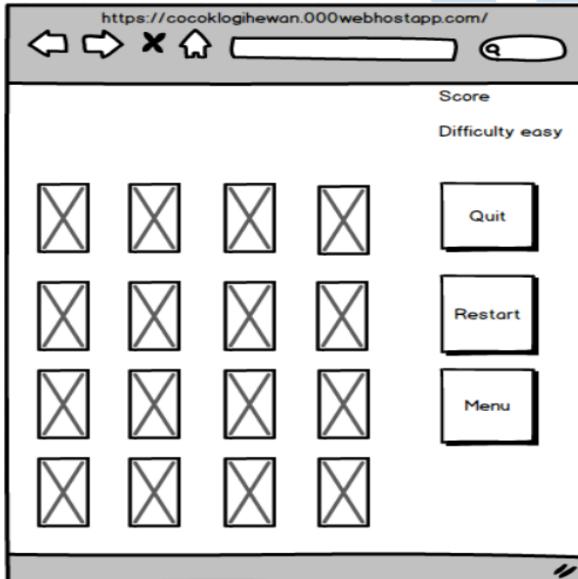


Fig. 4. The gameplay screen

Fig. 4 displays the appearance of the game page on the easy difficulty level. 16 cards are still closed, and players can start to open cards to be matched, if they are matched, they will get a score of 10. Fig. 5 displays a high score screen that contain the player's name and the score.

TABLE II. THE ROOM LIST

Room name	Description
Room_start	The game main menu
Room_help	The game description
Room_game_easy	The game room of easy difficulty level
Room_game_normal	The game room of normal difficulty level
Room_game_hard	The game room of hard difficulty level
Room_game_extreme	The game room of extreme difficulty level

The game rooms are shown in Fig. 6 to Fig. 11. Fig. 6 shows the game's main menu. It consists of six lists: Easy, Normal, Hard, Extreme, Help, and Quit. Fig. 7 shows the game description and how to play the game.



Fig. 6. Main menu



Fig. 9. The normal difficulty



Fig. 7. The help menu



Fig. 8. The easy difficulty



Fig. 10. The hard difficulty

Fig. 8 to Fig. 11 shows the playroom for each difficulty level. The easy difficulty level has 16 cards to match which arranged in 4 rows and 4 columns. The normal difficulty level has 24 cards to match which arranged in 4 rows and 6 columns. The hard difficulty level has 32 cards to match which arranged in 4 rows and 8 columns. The extreme difficulty level has 40 cards to match which arranged in 4 rows and 10 columns.

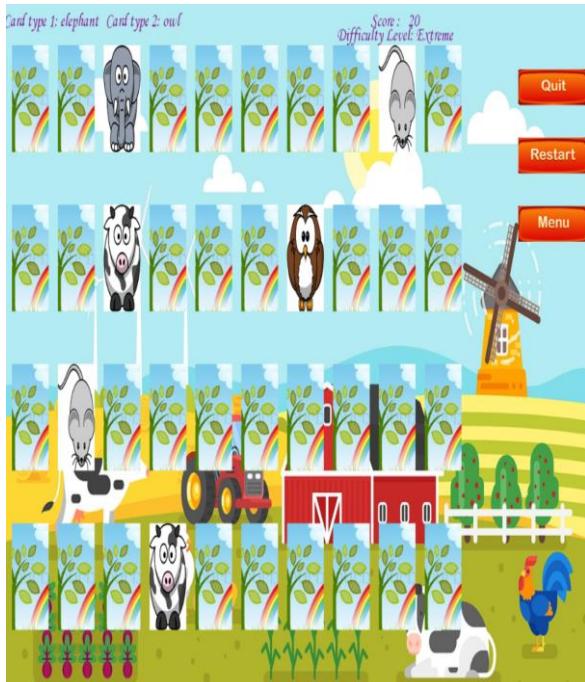


Fig. 11. The extreme difficulty

Fig. 12 shows the notification “You Win!” after all the cards opened.



Fig. 12. Win notification

E. Deployment Delivery and Feedback Stage

At this stage, delivery and application execution is carried out to prospective computer game users. The specific testers are asked to provide feedback. The tester criteria is familiar with playing a game. The respondents are aged 18 to 20 years old. There are 31

respondents to test the game prototype. The list of user experience testing questions is shown in Table III.

TABLE III. USER EXPERIENCE TESTING QUESTION

Number	Question
1	Is the game easy to understand?
2	Are the images in the game clear and easy to distinguish from other cards?
3	After playing this game, do you find it easier to remember?

The user experience participants were the first year Informatics students. The user experience testing results shown: all of the respondents stated that the game is easy to understand, easy to understand images, easy to distinguish from other cards, 21 respondents said that after they play the game, they felt it was easier to remember.

IV. CONCLUSION AND FUTURE WORKS

This study can be concluded as follows:

- Based on the game prototype, 21 respondents (68% from 31 respondents) stated that after they play the game, they felt it was easier to remember.
- If this game is accessed using Google Chrome, sometimes the sound effect doesn't work according to its function, whereas in Mozilla Firefox, the sound effects run according to its purpose.
- The matching game activities are aligned with the use distributed practice principles to enhance memory.
- There are four difficulty levels add challenges to the game.

The future works of this study are to add a timer in each difficulty level, combining the variation of the card, adding punishment system, release the game to the public and add public respondents to measure the memory enhancement.

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IoT Based Housing Area Portal with NodeMCU, Web and Android Applications

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Abstract—The access time of using the portal in certain blocks in a residential area can be a problem for some residents. Another problem that arises is if the officer holding the portal key is not in place. The purpose of this study is to create a system to regulate access rights to a particular block within a residential area so that the opening and closing of the portal can be done at any time by residents in the intended area. There are several blocks of this system, namely the NodeMCU controller block, ESP32CAM, Android applications, and web applications that are built using the PHP and MySQL programming languages. NodeMCU is used as the main controller to manage servo motors, send and receive data to and from the server, receive input related to open and close portals from the android application. The web application is used to register users, view the portal usage log, and verify the login process of the application. This system has been running well based on the results of tests that have been carried out, where the registration process, login, opening and closing portals, log usage is in accordance with the objectives to be achieved.

Index Terms—Android; ESP32CAM; nodeMCU; portal; web application

I. INTRODUCTION

This research explains about making hardware models, web applications, and Android applications that are intended for the use of portal systems in a residential area. Generally, the inside area of the housing uses portals on each block. The permitted access time to pass through the portal varies. It is intended for security in the area. However, there is a problem if residents in the area arrive outside the specified access time and the officer holding the portal key is not in place. Very inefficient if the occupants have to look for officers and get out of the car just to open the portal to be passed.

Other researches related to this portal have been carried out, such as research conducted in 2017 in which the gate system has been running by utilizing Bluetooth communication [1]. However, in that study, there was no log usage gate, user details, and photos of gate users at that time. Another study was conducted

in 2018 where the gate security system has been running well [2]. However, in that study, there were no logs related to gate usage and no photo features related to users entering the area at that time. Other studies conducted in 2018 related to gates have also been conducted where the research system has been running well by utilizing RFID and IoT [3].

However, previous studies [1-3] were less efficient from an economic perspective. Using an RFID card costs more for both the reader and the RFID tag. In addition, there are no features related to user details, log usage, and no image capture features. Whereas in this study utilizing Android applications installed on the smartphones that are generally owned by users and providing detailed user information, user logs, and the ability to take pictures.

In general, none of the above studies have aimed at regulating access rights to a block of residential areas and there is no photo-taking feature regarding who uses the portal. So to solve this problem an automatic portal should be created where the portal can be opened at any time by the occupants by utilizing a smartphone that is owned but still pays attention to security where there is a portal usage log on the web application that contains the user's name, time of use of the portal and the actual photo posted at that time.

Regarding the flow of access to residential areas, the use of RFID cards on the portal system may be faster than the Android application. However, the advantage of the system that is designed using Android and web application is when guests come to the residential area and need access to the portal. Guests can contact the owner of the house. After that, the home owner will log in and open the portal through the application without having to go to the portal and tap the RFID card. In this process, it is still known who is logged in to open the portal and guests who come can be seen through the image capture feature. Taking pictures will be done before the portal opens. The data will be stored in the system database log. Meanwhile, if we use RFID, only cardholders can open the portal.

In principle, all residents will be registered by the head of the local RT through the web application. The head of the RT here acts as an admin. From the hardware side, there is NodeMCU which acts as the main controller of the system. NodeMCU is used to receive information related to verified users related to the login process, set the portal open and close according to the input provided by the user, give commands to take photos. Regarding the login process, there are two options for using this tool, namely by using Bluetooth connectivity or online logging in through the Android application, which will later be verified in the built web application. Bluetooth mode can be used when the user does not have an internet quota or does not get a 4G signal on the smartphone being used. NodeMCU will move the servo motor to move the portal. Closure of portal doors can be done manually or automatically. In manual mode, the user simply presses the close button on the application. In automatic mode, NodeMCU will close the portal in accordance with the input values sent from the metal detector to NodeMCU. In this study, the number of portals made is modeled as much as one.

II. METHODS

The experimental method was used in this study, where a series of experiments were directly conducted in accordance with theoretical studies. The overall block diagram of the system built is shown in Fig. 1.

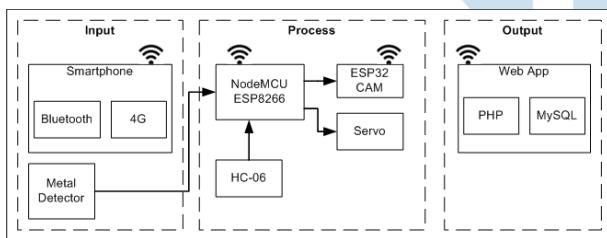


Fig. 1. Portal controller block diagram

In this system, NodeMCU is used as the main controller. NodeMCU is an open-source platform that can be used for IoT projects. In NodeMCU there is already firmware running on the ESP8266 WiFi module from the Expressive System and the hardware is based on the ESP-12E module [4]. This SoC NodeMCU ESP8266 is equipped with TCP / IP protocol that can provide access to WiFi networks,

The programming language used on the server-side is the PHP programming language. This programming language is included in the type of server-side scripting [5]. PHP can be used for a web interface [6]. In this system, the data is stored in a MySQL database. MySQL is a DBMS that is open source and is designed and optimized for web applications. Also, MySQL can be run on various platforms [7]. MySQL is also in accordance with the needs of the IoT project, which supports up to one

million simultaneous users. [8]. The actuator used in this system is a servo motor where this type of motor uses a feedback mechanism to improve motor performance. To move the servo motor we can change the time of the given pulse [9]. DC servo motors usually contain a DC motor, potentiometer, gear, and electronic control [10]. This model uses a SG90 servo motor. PWM signal is used to control this servo motor. NodeMCU will provide a HIGH pulse of 0.5ms to move the servo motor to position 0° and provide a HIGH pulse of 1.5ms to move the servo motor to the 90° position.

The users of this system are citizens. Citizens can control the portal via online mode and Bluetooth mode. With online mode, users must log in first to be able to open and close portals. The user opens and closes the portal through the button available in the application. NodeMCU will receive commands from the server according to the input it receives via the button presses. NodeMCU will read the string from the server. If the received string is "open", then NodeMCU will move the servo motor to open the portal then give HIGH logic to ESP32CAM to take photos and send them to the server. ESP32CAM is a module that can be used to take pictures as well as a WiFi module [11]. This photo feature becomes one of the advantages of the system. The photos can be seen all back on the log page on the web.

If the user uses Bluetooth mode, then NodeMCU will receive a code format that contains the Bluetooth name and the portal open and close code. The Bluetooth module used in this system is the HC-06 module. This module is included in class 2 slave which is designed for wireless serial communication [12]. The operating voltage required by HC-06 is from 3V DC to 6V DC [13]. If the received code is an "open" string then NodeMCU will move the servo motor to open the portal then provide HIGH logic to ESP32CAM to take photos and send them to the server and send username related to users who open and close the portal at that time.

After the user passes the portal, the next process is the closing part of the portal. Closing the portal can be done automatically or manually through the button on the Android application. This built system utilizes a metal detector related to closing automatically. This metal detector is widely used for parking systems, landmine detection, and weapons detection especially in airports [14]. Metal detectors will detect nearby metals using electromagnetic induction [15]. The portal will close automatically when the NodeMCU receives input from the metal detector.

III. RESULTS AND DISCUSSION

At this stage, it was carried out between the research team and prospective respondents. Communication is carried out to obtain input features or displays that are easy to use. From the

communication results obtained by the user requirements as follows:

Fig. 2 shows the flowchart regarding the workings of NodeMCU. In this picture, it appears that NodeMCU will wait for input from the server. NodeMCU will read the response from the server. If there is a response from the server that contains the string "open" to open the portal then NodeMCU will buy ESP32CAM to take pictures and send them to the server. Next, NodeMCU will execute the command to move the servo motor to the 0-degree position. At this point, NodeMCU will continue to wait for the change conditions that are read by the metal detector. NodeMCU will wait for the metal to be detected until the condition of the metal is not approved. After no metal has been removed, NodeMCU will execute the command to close the portal and move the servo to the 90-degree position. The mode is part of closing the portal automatically.

If the received string is a user-approved "close" that is approved by the close button on the application, then NodeMCU will first discuss whether there are cars in the portal closure area by reading the metal detector. When no metal is transferred, NodeMCU will execute the command to close the portal ie move the servo to the 90-degree position. This is the part of the portal manually.

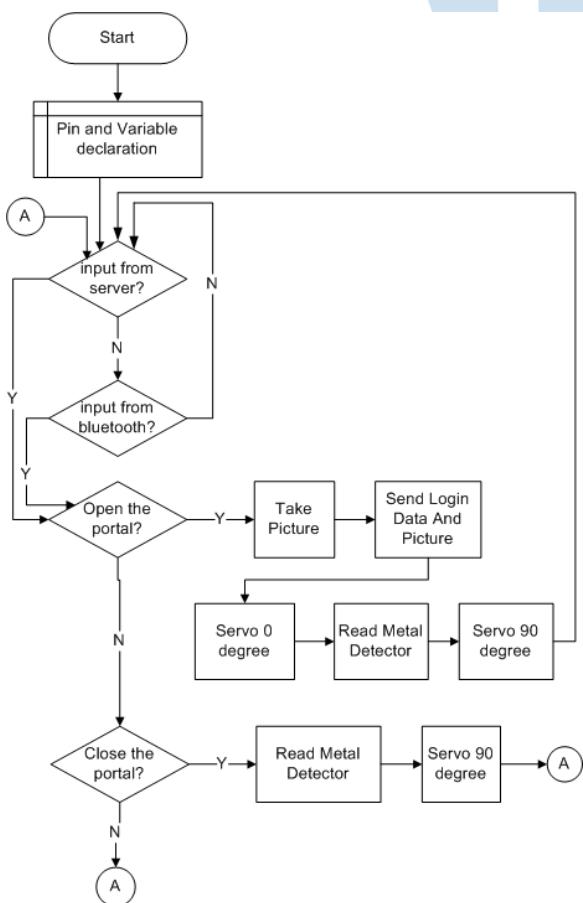


Fig. 2. NodeMCU portal controller flowchart

NodeMCU can accept input via Bluetooth in serial mode. When the user presses the open button on the Android application, the "open" string will be accepted by NodeMCU. Next, NodeMCU will instruct ESP32CAM to take pictures and send them to the server. Next, NodeMCU will execute the command to move the servo motor to the 0-degree position. At this point, NodeMCU will continue to wait for the change conditions that are read by the metal detector. NodeMCU will wait for the metal to be detected until the condition of the metal is not approved. After no metal has been removed, NodeMCU will execute the command to close the portal ie move the servo to the 90-degree position. The section is automatically closed portal mode.

When the user presses the close button on the application, NodeMCU will accept the string "close". Next, NodeMCU will check the conditions of any cars in the portal closure area by reading the conditions of the metal detector. When no metal is detected, NodeMCU will execute the command to close the portal ie move the servo to the 90-degree position. This is the portal close mode.

Fig. 3 shows the login screen display of the Android application that has been created. In this process, the user must enter a username and password where the password uses md5 hash encryption. On the screen, there are two usage options, namely online login to the server and Bluetooth mode. Bluetooth mode is very useful when users don't have an internet connection on their smartphones.

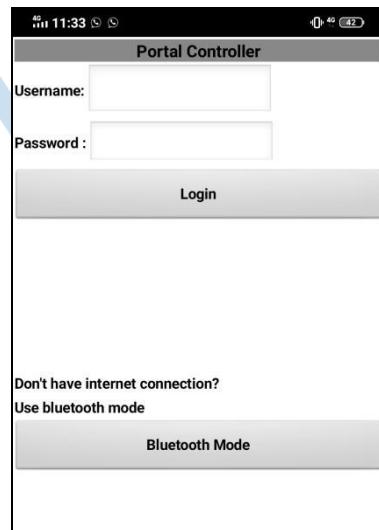


Fig. 3. Login screen android portal controller

Fig. 4 shows the screen related to the controls that can be performed by users that are opened and close the portal by online login to the server or Bluetooth mode. In Bluetooth mode, the user must enter a username and must also activate Bluetooth on the smartphone they have.

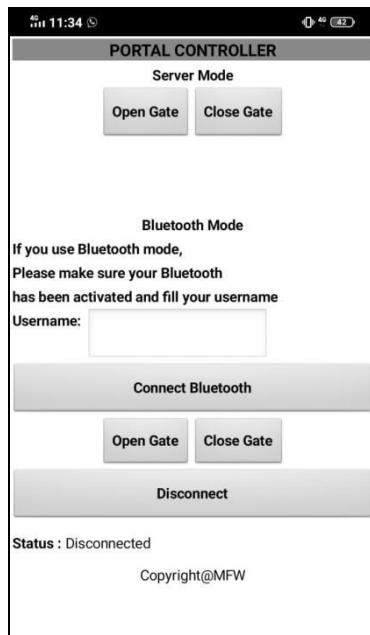


Fig. 4. Control interface android portal controller

The results of the web application that have been made are shown in Fig. 5 to Fig. 10. Fig. 5 shows the start page or index.php. On that page, users can only see the log.php page, the about_us.php page, and the contact.php page.



Fig. 5. Web interface index.php

In Fig. 5, you can see the "Login" button. The button is intended for Admin. When the button is pressed, a login modal will appear as shown in Fig. 6. In the modal, Admin must username and password to be able to log in. Just like the citizen user account, the admin account uses MD5 encryption in the password.

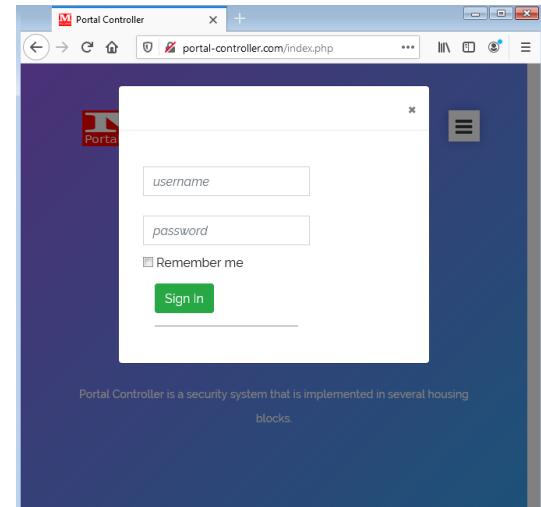


Fig. 6. Login modal for admin

When the login process is successful, the admin.php page can be seen. On that page, the admin can register new users and can see a list of users who are already registered. This admin page is shown in Fig. 7.

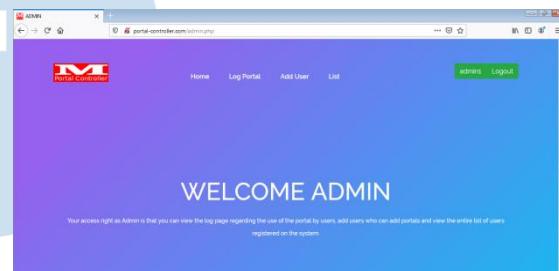


Fig. 7. Admin page

Fig. 8 shows the adduser.php page. This page is used by Admin to add new users. Some information needed for new user registration is a username, name, NIK, address, Bluetooth name, and password.

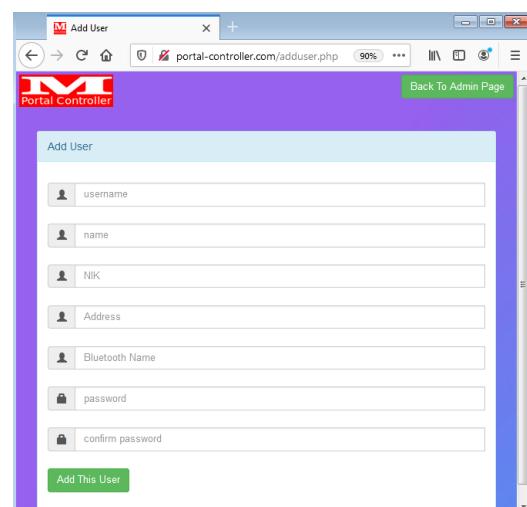
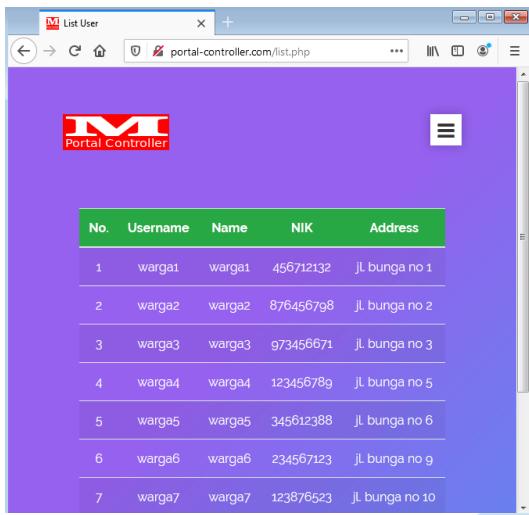


Fig. 8. Add user page

On the list.php page, the admin can see the users who have registered. Username, name, NIK, and address information are presented on that page. The list.php page is shown in Fig. 9.



The screenshot shows a web browser window titled "List User". The URL is "portal-controller.com/list.php". The page has a header "IMC Portal Controller". Below the header is a table with columns: No., Username, Name, NIK, and Address. The table contains 7 rows of data:

No.	Username	Name	NIK	Address
1	warga1	warga1	456712132	Jl. bunga no 1
2	warga2	warga2	876456798	Jl. bunga no 2
3	warga3	warga3	973456671	Jl. bunga no 3
4	warga4	warga4	123456789	Jl. bunga no 5
5	warga5	warga5	345612388	Jl. bunga no 6
6	warga6	warga6	234567123	Jl. bunga no 9
7	warga7	warga7	123876523	Jl. bunga no 10

Fig. 9. Page list.php page

Fig. 10 shows the log.php page. On this page, the admin can see the portal usage log. The information presented on this page is the user's username, name, the time the portal was used, and the photos that were successfully taken. The photo in Fig. 10 shows an example of images taken from ESP32CAM that have been successfully saved on the server.

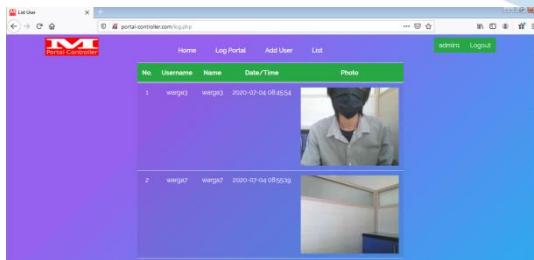


Fig. 10. Log.php page

After everything is done, the next step is testing. This test is conducted to test the performance of the system both in terms of hardware and software (Android App and Web App). Both online mode and bluetooth mode tests were carried out ten times. Each test is summarized in Table I and Table II. Table I shows the test results on a system controlled by NodeMCU where the user uses the login mode directly to the server and gives an open or close command via the Android application.

TABLE I. ONLINE MODE TESTING

Controller	Command and Action (online)		
	Received Command	Action	Status
NodeMCU	Receive String "open" from server	ESP32 CAM Take picture	OK
		Send login data and picture	OK
		Servo move to 0°	OK
		Read Metal detector	OK
		Servo move to 90°	OK
	Receive String "close" from server	Read Metal detector	OK
		Servo move to 90°	OK

Based on the results of the online mode test in Table I, it can be concluded that the system works in accordance with the test scenario. The next test is carried out in Bluetooth mode. With Bluetooth mode, users can open and close portals without logging into the server. The test results in Bluetooth mode are shown in Table II.

TABLE II. BLUETOOTH MODE TESTING

Controller	Command and Action (Bluetooth mode)		
	Received Command	Action	Status
NodeMCU	Receive String "open" and username from Android app.	ESP32 CAM Take picture	OK
		Send login data and picture	OK
		Servo move to 0°	OK
		Read Metal detector	OK
		Servo move to 90°	OK
	Receive String "close" and username from Android app.	Read Metal detector	OK
		Servo move to 90°	OK

Based on the results of the Bluetooth mode test in Table II, it can be concluded that the system works in accordance with the test scenario.

IV. CONCLUSION

The portal control system is working properly. Users can use online mode or Bluetooth mode to open and close portals. With this the right of access to housing can be maintained in accordance with the objectives of this study.

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Student Seating Position and Their Academic Performance in Computer Science Major

Observational Study and Student Perspective

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Abstract—A number of studies regarding the correlation between student seating position and their academic performance have been conducted. However, only a few of them focusing on computer science major, which is argued to be unique in terms of teaching style and classroom layout; as the discipline puts more emphasis on hands on activity like programming, system and network configuration. Further, among those works focusing on that major, none of them specifically address undergraduate students. This paper presents an observational study involving 426 computer science undergraduate students. The study covers student activity over one academic semester. A questionnaire survey measuring student awareness about that correlation in their seating preference was also performed, with 126 students as the respondents. In general, the correlation only exists on some circumstances like student major and lecture time. Further, the seating preference can be driven by the awareness of that correlation with some motivating factors like friends, whiteboard position, and personal habit. Per occasion, it is suggested to analyse the class circumstances and the student motivating factors prior performing further actions.

Index Terms—academic performance; computing education; observational study; seating position; survey instrument

I. INTRODUCTION

Within academic institutions (including Indonesia), there is a common assumption that academic performance of a student is influenced by their seating position in a classroom [1, 2]. Front row seating is often classified as seating positions for high performer students, whereas rear seating preferences are associated with low performing students.

A number of studies measuring and investigating the correlation between students seating position and their academic performance have been conducted, some of the notable works are reported in [3, 4, 5, 6, 7, 8]. Although majority of the studies confirm the existence of the correlation, some studies argue that the correlation is relatively weak [7, 8]. One of the possible reasons is that both seating position and academic performance are influenced by numerous

factors, including teaching material, teaching style, demographic, learning style, learning motivation, and available seat.

Two studies investigating that correlation [1, 3] are focused on students in computer science major — which is argued to be unique in terms of teaching style and classroom layout; as the discipline puts more emphasise on hands on activity (e.g., programming, system and network configuration) [9, 10, 11]. The first study focuses on postgraduate students [3] while another focuses on the combination of undergraduate and postgraduate students [1]. However, none of them are primarily focused on undergraduate students though they cover the largest proportion of university students.

In response to the aforementioned gap, this paper observes the correlation among undergraduate computer science major. To the best of our knowledge, this is the first one of its type, and the findings are expected to complement the two existing works [1, 3]. Student awareness about that correlation in selecting their seating position is also observed to suggest further necessary actions. If the correlation exist and the students are already aware about it, therefore no need to take further action. This also applies in the situation where the correlation does not exist and the students are not aware about it. In contrast, if the correlation exist and the students are unaware about it, an awareness campaign is required. A counter awareness campaign is also required if such a correlation does not exist but the students falsely perceived that their seating position has impact on their academic performance.

Our research questions are:

RQ1 Is there any correlation between student seating position and their academic performance (SP-AP correlation)?

RQ2 Do student seating position driven by the awareness of SP-AP correlation?

II. RELATED WORKS

Student seating position in a classroom is often associated with student's motivation in attending the lecture [12, 13, 14, 15] where front-seated students are perceived as students with higher motivation when compared to rear-seated students. Some even may jump into a conclusion that high performer students tend to seat in front rows whereas low performer students prefer rear rows. Such assumption, if not handled properly, might unintentionally lead to a bias perspective among the lecturers [1, 16]. A lecturer may interact or make eye contact limited to the front-seated students only, neglecting the rest of the class. This could demotivate other students in learning, as interaction and contact could play a significant role in maintaining student engagement in a classroom [1, 2, 4, 17].

A number of studies have been conducted to investigate the correlation between students seating position and their academic performance [1, 2, 3, 4, 5, 6, 16]. These studies confirm that seating position correlates with students' academic performance. However, even though they are all agreed that such correlation exist, their arguments are divided into two groups. First, those who argue that high performer students prefer front row position therefore such correlation exist [2, 16]. Second, those who argue that students' academic performance is influenced by their seating position [1, 3, 4, 5]. Factors such as better vision, better hearing of the lecture, better attention and greater eye contact are identified as favouring factors which benefit students who are sitting at the front rows [1, 4]. In contrast, other study reported that student performance is not significantly influenced by seating position [7, 8]. This case could be found in a smaller classroom size (compared to the number of students); clearly not every student could occupy the front rows.

In our literature survey, we also identified other notable works related to students seating position in a classroom. The study reported in [18] suggested that students seated at the front experience less daydreaming. Their study also indicated that the increase in daydreaming frequency leads to poorer academic performance. Classroom seating structure is formalised in [19], where seating position in a classroom is classified into four zones (e.g., front, rear, central, and side). The structure is aimed to promote consistency among studies related to seating position in a classroom. Lecturer perceptions of students may also be influenced by student seating choices, as reported in [16]. The study raises a concern that the seating position could affect the formation of lecturers' evaluative judgements toward their students. A study presented in [20] utilises the seating position to identify plagiarism on in-class individual programming assignment.

The majority of the studies in investigating the correlation between student seating position/arrangement and academic performance were conducted in the context of primary and secondary schools [21, 22, 23]. However, there is also a growing number to replicate a similar study at the university level. A study reported in [1] was conducted in engineering and computer science department at a university in Spain. For data collection purposes, they employed a software tool to automate the process. The study was mainly focusing on three parameters: average mark of a chair (i.e., seating position), times a chair was used, and times a chair was used by students who gave up the course. Their investigation lead to a conclusion that seating position in a classroom influences academic performance. Another notable investigation related to seating position at the university level was reported in [3]. Their study was conducted over a period of twelve weeks in a programming course.

III. METHOD

Two research questions discussed in the introduction (RQ1 and RQ2) were addressed in twofold. RQ1 was answered via an observational study involving the seating position and the academic performance of 426 computer science undergraduate students, collected within one academic semester. RQ2 was answered based on a questionnaire survey, responded by 126 computer science undergraduate students.

A. Addressing RQ1: The Observational Study

To address RQ1, whether there is any SP-AP correlation, an observational study was performed on 426 computer science students who were enrolled in the department of the first author from August to December 2017. The students came from two undergraduate majors - Information Technology (IT) and Information System (IS) - with total number of students 311 and 115 respectively. Their enrolment years are ranged from 2011 to 2017 but most of them are from 2014 to 2017. Over the period of one academic semester, student seating position and their academic performance were recorded. We focused our observation only on the seating position in the laboratories. Such a decision was made considering most courses in our faculty are delivered in the laboratories, including the lecture session. In total, there were 92 class sessions delivered in twelve different laboratories (denoted as LAB-01 to LAB-12). As suggested in [19], the seating position was mapped into four regions: Front, Centre, Side, and Rear. The mapping for each laboratory can be seen on Fig. 1, while the number of teaching sessions can be seen on Table I.

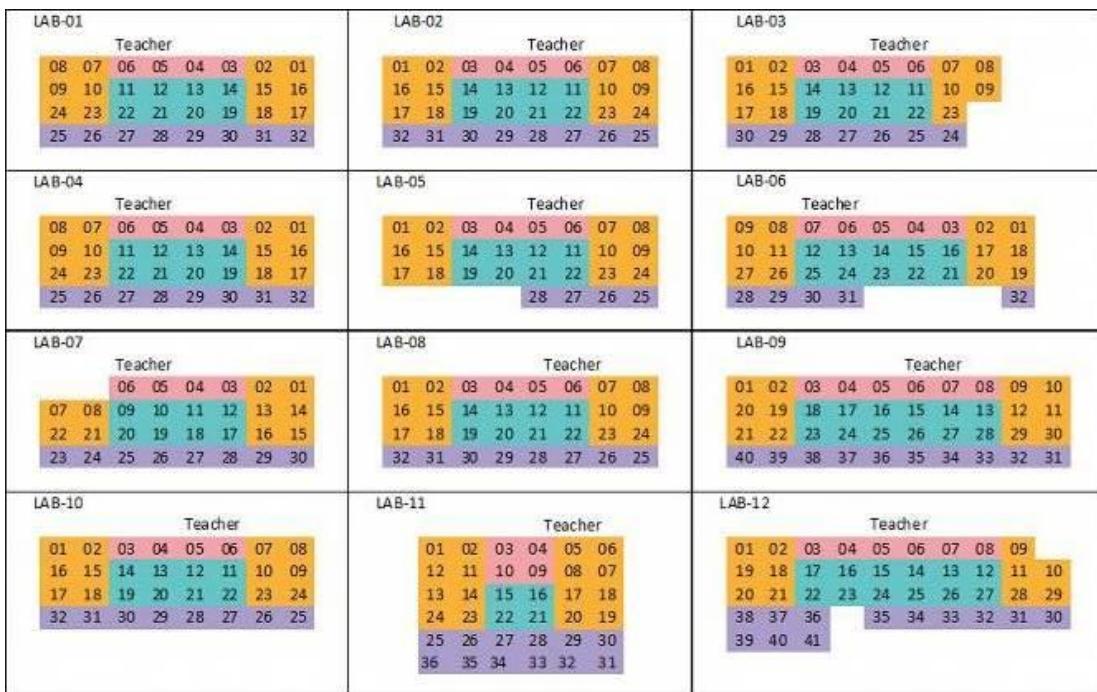


Fig. 1. The mapping of seating position in laboratories. Front seats are pink-coloured; centre seats are blue-coloured; side seats are orange-coloured; and rear seats are purple-coloured

TABLE I. NUMBER OF TEACHING SESSIONS PER LABORATORY

Laboratory	IT Sessions	IS Sessions	Total
Lab-01	11	2	13
Lab-02	7	0	7
Lab-03	0	0	0
Lab-04	6	6	12
Lab-05	8	2	10
Lab-06	9	0	9
Lab-07	0	13	13
Lab-08	5	2	7
Lab-09	6	1	7
Lab-10	2	3	5
Lab-11	2	0	2
Lab-12	7	0	7
Total	63	29	92

In this study, we measure academic performance for each student based on their achievement (i.e., score or mark) in accomplishing their mid-term exam, final exam, and course assignment. We are also taking account the aggregate score (final score) which calculated based on the mid-term exam, final exam, and assignment with the weight of 25%, 25%, and 50% respectively.

We divided our observational study into five stages (as illustrated in Fig. 2). At first, we limited our observation only within the courses which final score is yielded from in-class activities. Few courses which did not match this criterion, such as thesis, Certified

System Administrator). Secondly, three kinds of data were collected: student internship, and certification-based courses (e.g., Certified Ethical Hacking, RedHat seating position, student grades, and seating layout in each laboratory (i.e., seating layout has been fixed for the semester). Student seating position was recorded in a paper format as part of student attendance recording system applied in our department. Fig. 3 shows the paper sheets which were used to record student seating position in this study; each sheet holds a record of weekly students seating position in each course that they were enrolled in. The data was digitised at the third stage.

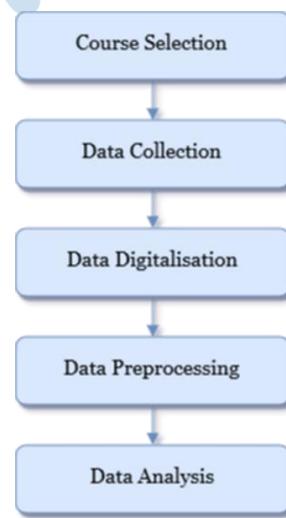


Fig. 2. The observational study was performed with five consecutive stages. It started with course selection and finished with data analysis.

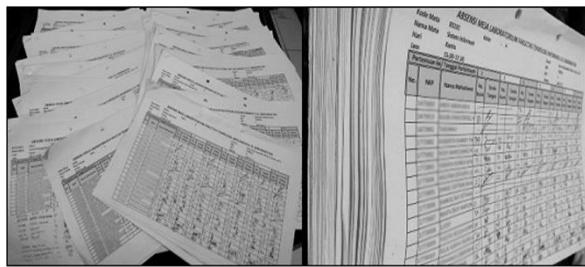


Fig. 3. Physical paper sheets depicting student seating position. Horizontal axis represents sessions while the vertical one represents student IDs. Each cell contains a number representing a desk ID where a student is seated for a particular session.

At the fourth stage, the data was then converted to a particular format for analysis. Each student per course was converted into one data entry, representing student seating position for one semester and their academic scores. It is possible that occasionally, some students did not choose their seating position based on their preference. For example, a student who was regularly seated at a front row might be seated at the back when they are late (as the front row had been taken by other student). Hence, to exclude such cases from consideration, the seating position was replaced with three fields. fh and eh refer to the most frequent seating region for the first and second half semester respectively. f is similar to the first two except that it covers the whole semester. In total, this phase results in 1,546 data entries.

Finally, the analysis was then performed by correlating student academic performance with their seating position. Mid test score was correlated with student seating position before the test (from week one to week seven). Final test score was correlated with student seating position between the mid test and the final test (from week eight to week fourteen). Assignment and final score were correlated with student seating position for the whole semester.

Three dimensions are considered for the analysis in this study (i.e., major, teaching type, teaching session time). Major refers to whether the students came from IT or IS major. Teaching type refers to whether the session is mostly about lecture session or lab session. Typically, the former occurs on non-programming courses while the latter occurs on their counterparts. Teaching session time refers to when the session was conducted. To reduce the variants, the time was categorised to four groups which details can be seen on Table II; all class sessions were aligned to one of these groups based on the largest session proportion.

TABLE II. TEACHING SEASON TIME

Group Name	Start Time	End Time	Number of Sessions
Morning	07:00	12:00	46
Afternoon	12:00	15:00	19

Late Afternoon	15:00	17:30	23
Night	17:30	21:00	4

These dimensions are converted to filtering scenarios, starting with one dimension at a time (the most general) to all dimensions (the most specific) [24]. The analysis would not be continued with more dimensions once interesting findings are shown; as general findings are preferred to the specific ones. For each filtering scenario, the data was analysed through three graphs:

- Box plot is utilised by considering seating regions as the horizontal axis and student academic scores as the vertical one. It visualises the tendency of seating regions to be correlated with a particular student grade range. An example of box plot can be seen in Fig. 4.

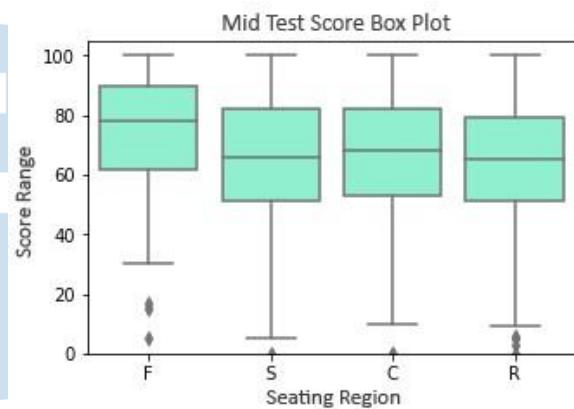


Fig. 4. A sample box plot for mid test score. Horizontal axis represents the seating regions while the vertical one represents the score.

- Stacked bar chart is used in twofold. At first, student academic scores are grouped to three categories: high, medium, and low. High means that the score is higher or equal to 73 (a minimum threshold to get B+ or A in our faculty). Average means that the score is higher or equal to 55 but not in High category (which depicts C, C+, and B grades). Low refers to the score that is not in High or Medium range. Secondly, by considering seating regions as the horizontal axis, the chart is generated. This visualises the numbers of student academic score categories per seating region; where the highest and lowest value can be further analysed. Fig. 5 shows an example of stacked bar chart.

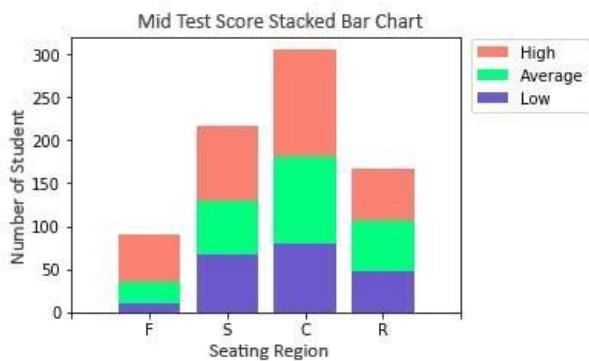


Fig. 5. A sample stacked bar chart for mid test score. Horizontal axis represents the seating regions while the vertical one represents the score.

- Stacked bar chart with relative frequency is similar to the stacked bar chart except that the frequencies are treated as percentage. It aims to see the largest or smallest proportion of student academic score categories per seating region. An example of this can be seen in Fig. 6.

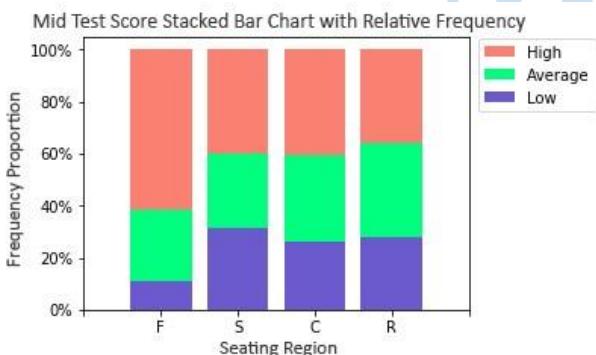


Fig. 6. A sample stacked bar chart with relative frequency for mid test score. Horizontal axis represents the seating regions while the vertical one represents the score.

B. Addressing RQ2: The Questionnaire Survey

In order to answer RQ2, whether student seating position is driven by the awareness of SP-AP correlation, a survey was developed with three sub research questions on board:

- RQ2A What is student preference on seating position in a classroom? If most of the responses prefer the front region compared to others, it might be stated that the seating position is driven with an awareness of that correlation.
- RQ2B What factors motivating students to choose the position? If most of the factors are related to the distance between student seating position and the front of the classroom, the seating preference might be derived from the awareness of that correlation.

RQ2C Do students consider that seating position in a classroom may have influence on their academic performance? This is the only direct question asking the students' perspective about that correlation.

RQ2A was also converted to one survey question: *among the four regions (see the following figure) which seating region is the most preferable for you?*

As proposed in [19], student seating position on the attached figure (Fig. 7) was classified into four regions: front, centre, side, and rear. SP-AP correlation might be considered in selecting the region if front is the most preferred, followed by centre/side, and rear.

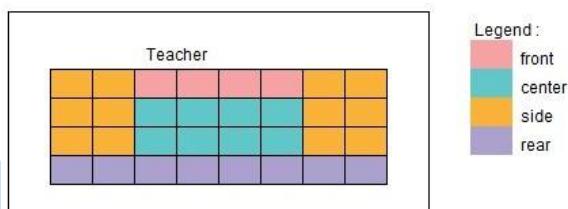


Fig. 7. Displayed figure for R2, depicting seating positions in a classroom. Each colour represents one seating region.

RQ2B was converted to a survey question: *"What are the motivating factors for you in choosing seating position in a classroom?"*. This question is accompanied by some predefined factors to choose from. In which some of them are related to the distance between student seating position and the front of the classroom. The factors were classified into three categories: internal physical, internal non-physical, and external factors. Internal physical factors are derived from respondent's physical state (e.g., hearing and vision limitation). Internal non-physical factors are derived from respondent's mental state (e.g., interest toward the subject or teaching style). External factors are derived from instances around the respondent (e.g., position of white board, lecturer, window, and door). The detail of these factors (for each category) is summarised in Table III, including whether the factors relate to the distance between student position and the front of the classroom. F1-F4 are the internal physical factors, F5-F8 are the internal non-physical factors, and F9-F14 are the external factors. Apart from the predefined factors, our respondents were also allowed to provide some other motivating factors which were not covered in the survey.

TABLE III. PREDEFINED FACTORS FOR RQ2A

ID	Factor	Description	Distance Relation
F1	Height proportion toward other students	Respondent is shorter or taller than other students	Yes
F2	Vision limitation	Respondent's vision is limited	Yes
F3	Hearing limitation	Respondent's hearing is limited	Yes
F4	Fatigue level	Respondent's tiredness prior entering lecture session	Yes
F5	Course interest	Respondent is interested with given course material	Yes
F6	Teaching-style interest	Respondent is interested with how lecturer teaches	Yes
F7	Friend	Respondent's preference is affected by their friend	No
F8	Unexplainable routine	Respondent always chooses the same position without knowing their clear reason	No
F9	Door position	Respondent's preference is affected by door position	No
F10	Window position	Respondent's preference is affected by window position	No
F11	Air conditioner position	Respondent's preference is affected by air conditioner position	No
F12	Whiteboard position	Respondent's preference is affected by whiteboard position	Yes
F13	Projector view position	Respondent's preference is affected by projector position	Yes
F14	Lecturer position	Respondent's preference is affected by lecturer position	Yes

Unique to RQ2C, it was covered by two survey questions: *do you agree that seating position affects academic performance?* and *what is your opinion on the relationship between students seating position and academic performance?*. The first question is followed by a Likert scale to choose from: strongly agree, agree, neutral, disagree, and strongly disagree. The second one is an open-ended question which allows our respondents to express and elaborate their opinion on the relationship between seating position and academic performance.

We released the questionnaire as an online survey, and it was opened for two weeks. The targeted audiences for the survey are undergraduate computing students. There were 126 students participating in the survey. Our respondents were quite diverse in terms of enrolment years, ranging from 2014 to 2017. The respondents are arguably representative given that the total enrolled students for such range is about 500 students. Further, they are arguably balanced in terms of enrollment years given that the survey was offered on at least one compulsory course for each enrolment year.

IV. RQ1 FINDINGS: CORRELATION BETWEEN STUDENT SEATING POSITION AND THEIR ACADEMIC PERFORMANCE

This section summarises findings from the observational study to answer RQ1, whether there is

any correlation between student seating position and their academic performance. Findings from one-dimension filtering will be discussed first, followed by findings from two-dimension filtering. The analysis for three-dimension filtering was not performed as some interesting findings had been discovered on the two-dimension filtering. At the end of this section, all findings are generalised to answer RQ1.

A. Findings from One-Dimension Filtering

According to our observation, no distinctive findings can be gained from one-dimension filtering; the data shows no patterns. One of the possible reasons is that the student characteristics included per analysis is too broad.

B. Findings from Two-Dimension Filtering: Major and Teaching Type

This subsection covers findings resulted from applying major and teaching type as the filter. It results in four groupings: IT-lecture session, IT-lab session, IS-lecture session, and IS-lab session. In general, according to the seating distribution, all of them shows that centre region is preferred by the students. The centre region is always fully seated in most sessions.

On IT major groupings (IT-lecture session and IT-lab session), it is clear that high-performance students are seated in the front region. That region is correlated

with the highest score in all score metrics (mid test, final test, assignment, and final score) regardless of teaching type and used graph for analysis. The rear region, on the contrary, is packed with the low-performance student. It has more low-performance students compared to other seating regions.

On IS major, no findings can be gained on lecture session type (IS-lecture session). However, analysis on lab session teaching type (IS-lab session) shows that high performance students are commonly seated at the centre. Further, centre region is more packed after the mid test; some students move from the side region to that region.

C. Findings from Two-Dimension Filtering: Major and Teaching Session Time

This subsection covers findings resulted from applying major and teaching session time as the filter. It results in eight groupings: IT-morning, IT-afternoon, IT-late afternoon, IT-night, IS-morning, IS-afternoon, IS-late afternoon, and IS-night. Generally speaking, all students prefer to be seated in centre except at the night session where the side region is preferred.

An analysis toward morning sessions and IT students (IT-morning) shows that students who are seated in front tend to achieve high score regardless of the score metrics. Further, students on the side region tend to achieve the low one.

On the late afternoon sessions (IT-late afternoon), the number of IT students who are seated in front is lower than other seating regions'. However, these students commonly have the highest score compared to other students.

Taking the context of IS students, on afternoon sessions (IS-afternoon), front seating region is filled with low performance students instead of the high one. High performance students prefer to be seated on the rear region.

When the sessions are changed to the late afternoon ones (IS-late afternoon), such high performance students are often found in the centre region. Even though its proportion is still lower than those who are seated on the side.

D. Findings from Two-Dimension Filtering: Teaching Type and Session Time

This subsection covers findings resulted from applying teaching type and session time as the filter. It results in eight groupings: lecture session-morning, lecture session-afternoon, lecture session-late afternoon, lecture session-night, lab session-morning, lab session-afternoon, lab session-late afternoon, and lab session-night. In general, the centre region is preferred by most students regardless of teaching type and session time.

In the morning (lecture session-morning and lab session-morning), students who seated in the front region tend to get high score (B+ or A) for all score metrics, regardless of teaching type. Further, those who seated in the side region tend to have the low score (lower than C).

At afternoon session time (lecture session-afternoon and lab session-afternoon), high performance students are grouped on the side region on lab session while being seated on the centre region on lecture session.

An analysis on late afternoon session in both lecture session and lab session teaching types (lecture session-late afternoon and lab session-late afternoon) show that high performance students are often seated in front on that time session; three of four score metrics show the same phenomenon. In terms of quantity, the centre region is preferred on lecture session while the side region is preferred on lab session.

In the night session (lecture session-night and lab session-night), the front region is still occupied by high performance students while the rear one is packed with low performance students. However, this does not mean that the front region is seated by many students. Most of them prefer the centre region, followed by the side and rear regions.

E. Generalised Findings

In general, the correlation between student seating position and their academic performance occurs in some cases. In addition, three other findings can be deducted:

- IT students who are seated in front commonly have higher score compared to students seated on other regions. This also applies on IS students on morning sessions.
- In the afternoon, high performance students tend to be seated on side region.
- Centre region is preferred by most students according to 59 of 80 analyses.

V. FINDINGS: STUDENT AWARENESS TOWARD SP-AP CORRELATION

This section summarises findings from the questionnaire survey to answer RQ2, whether student seating position is driven by the awareness of SP-AP correlation. RQ2A and RQ2B findings will be discussed first, followed by RQ2A findings revisited with RQ2B findings on board. After that, RQ2C findings will be discussed and finally, the generalised findings will be discussed.

A. RQ2A Findings: Student Seating Preference

Fig. 8 shows that centre is the most preferred seating region. It is preferred by 67 of 126 respondents. In contrast, front is the least preferred one with 14 of 126 respondents. We could confirm that these findings were match with our teaching experience; where the centre region is frequently filled first and the front region is mostly empty (except the lecturer asks the students to move forward or no other seating regions are available for latecomers).

This means that based on RQ2A, student seating preference might not be driven by the awareness of SP-AP correlation. Front region is the least preferred, while the rear one is the second-most preferred.

B. RQ2B Findings: Motivating Factors in Seating Preference

The frequency distribution of the motivating factors in classroom seating position among our respondents is presented in Fig. 9. From the figure, we can identify that friend (F7) is the most influential factor for the students in choosing their seating position; it was voted by 83 respondents out of 126. This could indicate that social aspect has a significant contribution toward seating distribution in a classroom. Other factors, such as air conditioner position (F11), projector screen position (F13), white board position (F12), and personal habit (F8) were also have significant influence in classroom seating position; there were more than 60 respondents voted for these factors. The position of air conditioner in a classroom was quite a surprising factor for us as we never really expected that such factor would be highly influential. Further investigation explained that most of our students tend to avoid seating nearby the air conditioner as often the air temperature was too cold for them. Among the predefined factors, window position (F10) was the least influential factor where only two respondents voted for it. Such finding was not surprising in our study since most windows in our classrooms were covered with curtains.

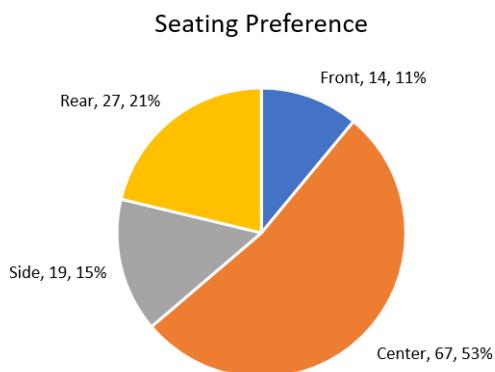


Fig. 8. Seating preference according to our respondents. Centre is the most preferred one, followed by rear, side, and front.

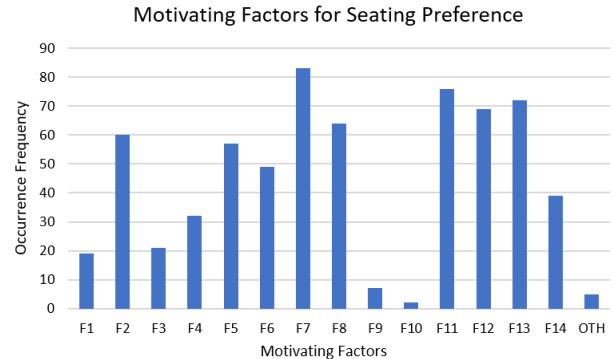


Fig. 9. Occurrence frequencies of motivating factors for seating preferences. The most frequently mentioned factor is friend (F7) while window position (F10) is the least frequently mentioned one.

Apart from the predefined motivating factors, three additional factors were promoted by our respondents: seats availability, previously-saved data on computer, and nervousness. The first two factors fall on external factor category while the last one falls on internal non-physical factor category. All of them are not related to the distance between student position and the front of the classroom. In other words, they are not driven by the awareness of SP-AP correlation. Seats availability was mentioned by two respondents; they argued that seating position in a classroom was influenced by the availability of the seats. Sometimes their preferred seating position was taken by other students and they had to choose other seats. Previously-saved data on computer is mentioned by two respondents. They choose the same seating position each week so that they could use their previously-saved data on the computer that is assigned to such position. It is important to note that this factor only occurs when given classroom is a computer laboratory where each seating position is featured with a computer. Nervousness is mentioned by one respondent, claiming that they cannot focus when lecturer pays attention to them. They choose seating position that is rarely focused by the lecturer.

External factor category yields the highest occurrence frequency, followed by internal non-physical and physical factor category (see Fig. 10). In other words, it can be stated that students' seating preference is heavily affected by the position of instances around them. Internal physical factors (such as fatigue level) play a small role on such preference. This finding opened a possibility for us to alter our classroom environment in such a manner which potentiality could reshape the distribution of seating position in the class. Further investigation is required to better understand this phenomenon.

If the factors were grouped based on their relation to the correlation between student seating position and their academic performance, more factors with such a relation were discovered (see Fig. 11). Nearly two thirds of the discovered aspects (418 of 655) are

related to the correlation. Hence, it can be stated that, based on RQ2B, the awareness of that correlation might drive the student seating preference.

C. Revisiting RQ2A Findings with regard to RQ2B Findings

Having RQ2B findings enables deeper understanding of RQ2A findings. The seating preference per motivating factor can be observed. As depicted in Fig. 12, centre is still the most preferred one. It was voted by most respondents in all factors except F10 — where front and side seating region are preferred. In other words, it can be stated that all motivating factors except window location (F10) lead students to sit on centre region.

In contrast, the least preferred seating region varies among considered factors. Front is least preferred when respondents consider height proportion toward other students (F1), fatigue level (F4), friend (F7), door position (F9), or air conditioner position (F11). Centre is least preferred when window position (F10) is considered. Side is least preferred when respondents consider teaching-style interest (F6), unexplained routine (F8), air conditioner position (i.e., as our study is conducted in a tropical country) (F11), whiteboard position (F12), projector view position (F13), or lecturer position (F14). Rear is least preferred when vision limitation (F2), hearing limitation (F3), course interest (F5), teaching-style interest (F6), door position (F9), or window position (F10) is considered.

This revisit shows that, regardless of the considered factors, RQ2A still shows that the student seating preference might not be driven by the awareness of SP-AP correlation.

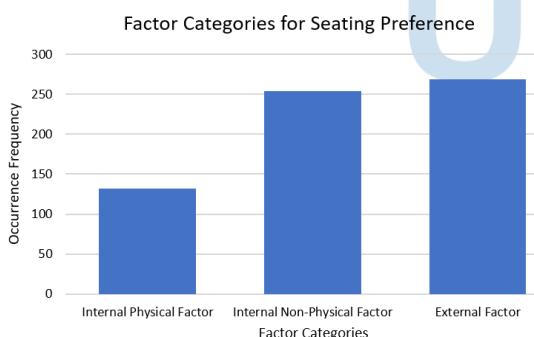


Fig. 10. Occurrence frequencies of factor categories for seating preference. The frequency of each category is resulted by summing all frequencies of covered factors.

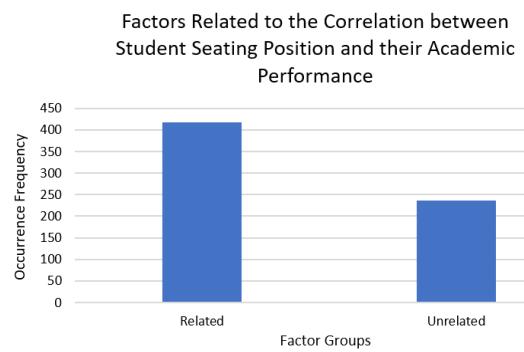


Fig. 11. Occurrence frequencies of factors, grouped based on the relation to the correlation between student seating position and their academic performance. The frequency of each group is resulted by summing all frequencies of covered factors.

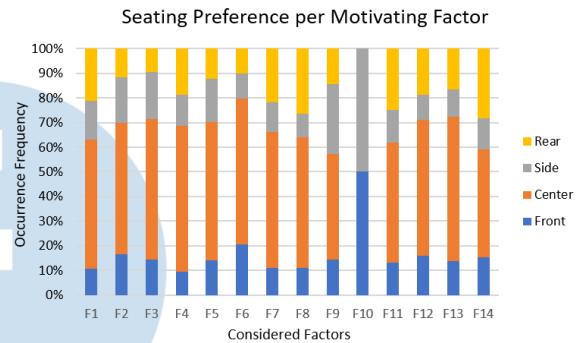


Fig. 12. Seating preference per motivating factor. The proportion of each seating region is resulted by dividing its occurrence frequency with total frequencies of all regions (where only respondent answers that consider such factor are included).

D. RQ2C Findings: Student Perspective Regarding Seating Position Affects Academic Performance

Fig. 13 shows that most respondents (46 of 126) prefer to be neutral toward a statement that claims seating position affects academic performance. Such neutral opinion is also supported by the fact that, when each option is converted to scale (where strongly agree = 2, agree = 1, neutral = 0, disagree = -1, and strongly disagree = -2), mean score from respondent answers (0.0158) is still extremely close to neutral (0).

The statement claiming that seating position affects academic performance is agreed according to six rationales, which summary and occurrence frequency can be seen in Table . For convenience, those rationales are sorted in descending order according to their frequency. In most occasions, students argued that being closer to the front of classroom enhances concentration and the position of external factors affects student concentration.

Student Perspectives Regarding Seating Position Affects Academic Performance

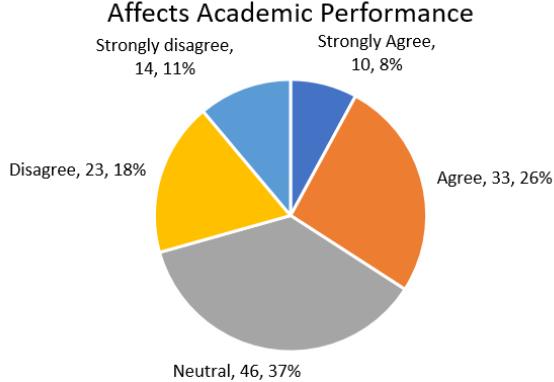


Fig. 13. Student perspectives regarding seating position affects academic performance. Most of them prefer to be neutral.

TABLE IV. RATIONALES BACKED UP RESPONDENT AGREEMENT

ID	Rationale	Frequency (agree + strongly agree)
A1	The more ahead you are, the more focused you will be.	15+5
A2	The position of external factors affects student concentration.	12+2
A3	Avoiding lecturer's focused region is necessary to boost concentration performance (since those students are shy).	2+1
A4	Convenient seating position leads to better learning performance.	2+0
A5	The learning performance of each student is affected by various factors related to seating preference.	2+0
A6	Fengshui (i.e., Chinese belief about the relation between luck and position).	0+1

Some respondents disagree with the effect of seating position toward academic performance according to five rationales.

Table summarises those rationales, including their occurrence frequency. Generally speaking, most of them argued that academic performance depends on students' effort instead of seating position.

E. Generalised Findings

Findings from the three sub research questions (RQ2A, RQ2B, and RQ2C) show no clear generalised findings; each of those questions leads to different direction. However, we can say that student seating position can be driven by the awareness of SP-AP correlation with some motivating factors on board.

VI. CONCLUSION AND FUTURE WORK

This paper measures the correlation between student seating position and their academic performance via an observational study involving 426 computer science students over one academic semester. Further, a questionnaire survey regarding student awareness about that correlation in selecting their seating position is also performed to suggest further necessary actions. Our research shows that the correlation only exists on some circumstances and the seating preference can be driven by the awareness of that correlation with some motivating factors on board. Hence, it is important to analyse the class circumstances and the student motivating factors prior performing further actions.

Our study has two limitations and those can result in further research. First, the findings are based on only a dataset and thus might not be generalisable. We plan to replicate our study on other datasets and revalidate the findings. Second, some students might be seated in a particular position due to the unavailability of their first preferred seating region, and this might affect the findings. Another study without such a constraint is necessary to strengthen the current findings.

TABLE V. RATIONALES BACKED UP RESPONDENT DISAGREEMENT

ID	Rationale	Frequency (disagree + strongly disagree)
D1	Academic performance purely depends on students' effort, not seating position.	18+9
D2	The learning performance of each student is affected by various factors but those factors are not related to seating position.	2+2
D3	Seating position only affects student convenience. Yet, such convenience is not related to academic performance.	1+1
D4	Teaching method is far more prominent to determine academic performance than seating position.	1+1

This study inspires other project within our department to record student attendance in a classroom in a form of photograph [25, 26]. With the assistance of advancements in face recognition and row detection, we envision to automate the procedure in recording student seating position.

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Development of Motion Graphic as Education Material for Promoting Shipping Industry Using EPIC Model Testing

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Abstract—Education related to problems in the shipping industry to the general public who have no background in the shipping industry and activities when ships dock at the port becomes a challenge to conduct research. This research develops multimedia motion graphics to combine graphic design, animation, text, and sound in visualizing materials and activities in the shipping industry. Stages of making multimedia start from ideas, narration, storyboard, tracing, editing, rendering, and testing. The research uses the EPIC Model testing by paying attention to aspects of empathy, persuasion, impact, and communication. The results of testing the effectiveness of the EPIC model obtained an EPIC rate of 4.15, which means that the resulting motion graph falls within the effective range criteria.

Index Terms—effectiveness; EPIC model; motion graphic; multimedia

I. INTRODUCTION

Maritime shipping is a prime example of an increasingly globalized industry [1]. Maersk Line is a transnational company that has become the world's leading container carrier. Mr. Ib Kruse, one of a person in charge at Maersk Line, explained how the company's competitiveness rested on a service 'second to none, realized through the combination of modern and effective company-owned ships with sophisticated equipment developed in-house, a global network of own company offices and high-level communication, and sophisticated documentation and control systems [2]. Maersk Line is an example of a modern company in the shipping industry. There are still many shipping companies that still using the traditional system and wasting my time and cost to do one Port of Call. A promotion media needed to show and educate everyone that in this modern era we need to use technology to minimize costing and wasting time, especially in the shipping industry.

Education needed to tell other people how the shipping industry works. History learning became problematic currently, because of the lack of

utilization, imagination, and state-oriented textbooks and curriculum [14]. Nowadays, technology is an important thing to have. Government, researchers, the education system, or researchers now considering technology an important thing for education [13]. To improve education quality, learning media is used to optimize the learning process and teaching strived to be able to grow motivation and creativity [15-17]. The education/learning media is using a promotional video.

Promotion is an marketing mixed element that focused on giving information, persuading, and reminding customers about the company brand and product [3]. In this modern era, promotion can be done so easily. We do not need to meet in person because we can just spread it via the internet. Promotional media plays important role in determining rating access in search engines by using SEO, SEM, and SMO technic [4][5]. Everyone who is connected to the internet can easily find every promotion on the internet. By creating this promotional media, hoping that can give education to people out there about the shipping industry.

In this research, promotional media that will be used is a video in the form of motion graphics. Video media has one of the advantages that video can overcome the limitations of time and space, is more realistic, and can be repeated [6]. Motion graphics are a combination of illustrations, photos, or other forms of digital art that are visualized into a video and accompanied by musical instruments [7]. After creating the video we also needed to know about its effectiveness for conveying to people about the shipping industry.

Based on the background above, the objective of this research is to create promotional media in a form of motion graphics and will be analyzed for the level of effectiveness using the EPIC Model to find out whether the promotional video is effective or not.

II. METHOD

The research method that is used in this research is using EPIC Model to find the level of effectiveness from the motion graphic that was created. EPIC model is a measure of advertising effectiveness developed by AC Nielsen, a leading market research company using a communication approach [9]. There are 4 critical dimensions in EPIC Model, there are empathy, persuasion, impact, and communication [10]. Roscoe in the book research methods for business (1982: 253) suggests a decent sample size in a study with a distance between 30 to 500 respondents [11].

The measuring instrument will be used in the form of a questionnaire distributed via Google Form. Target respondents addressed to 30 respondents including 10 people aged 17-25 years, 10 people aged 25-35 years, 10 people aged 35-60 years

The analysis phase is divided into 2 parts, alpha testing, and beta testing. The alpha testing will be tested for validity and reliability. The data obtained can be said to be valid if obtained from measuring instruments that are valid [11] [16]. Furthermore, in beta testing, EPIC Model analysis will be performed. A chart of the research stages is shown in Fig. 1 Research stages.

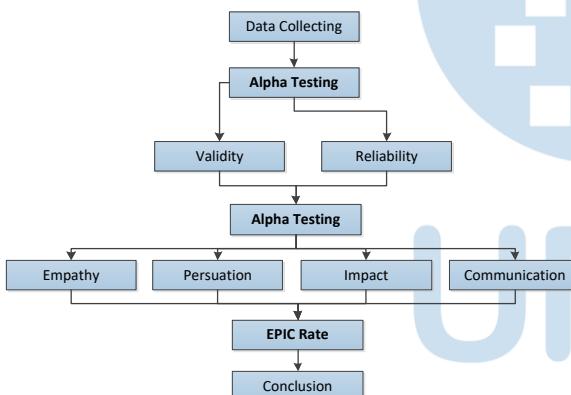


Fig. 1. Research stages

Before we reaching to the analysis, a draft for producing the motion graphic is needed. You can find below the full draft of creating the motion graphic from brainstorming about the idea to the final product, which is a motion graphic video in MP4 format.

A. Idea Development

The process that is carried out at this stage is to develop ideas and concepts that exist in making motion graphics that will be implemented as promotional media. The idea of making promotional media that applies motion graphics was initially carried out with interviews. The results of interviews in the form of ideas in making motion graphics on activities when the ship is anchored at the port,

problems commonly experienced in the shipping industry.

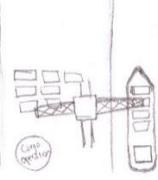
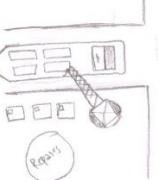
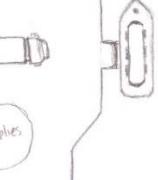
The duration of this motion graphic will be made in 1-2 minutes so that the video will run faster with the amount of information provided, this motion graphic will combine several elements such as graphic design, text, narration, and music.

B. Narration

Narration will help convey the message in the video. The narration in the motion graphic will be in the form of sound that accompanies the motion graphic running and in the form of text that is located in several scenes in the motion graphic. The voice narration will be adjusted back to the visual video when the motion graphic has entered the scene merging stage in Adobe Premiere Pro CS6.

TABLE I. NARRATION

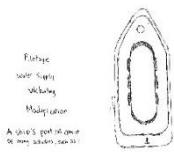
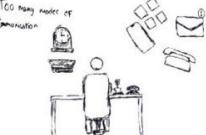
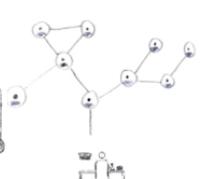
Scene	Voice narration	Visual narration
2	Many activities take place when a ship enters the port, such as crew changes cargo operations inspections and surveys repair and maintenance supplies and victualing bunkering, and many more.	A ship's port call consists of many activities such as modifications, victualing, water supply, pilotage, towage, spares supply, shore leave, crew training, cash to master, dry docking, hull cleaning, surveyors, bunkering, supplies, repair, inspection, cargo operations, crew change.
3	Meanwhile in the ship management onshore.	Meanwhile in the ship management onshore.
4	We are using too many modes of communications Email is overloaded And coordinating with so many stakeholders is complicated No data is collected from each port call for optimization And no live overview of ship activities is available onshore And the single point coordinator of the entire port call is a point source of failure.	Too many modes of communication Email overload is real! It's complicated coordinating with so many people! And at the end of the day, no data is collected for analysis No live overview of ship activities Point Source Of Failure

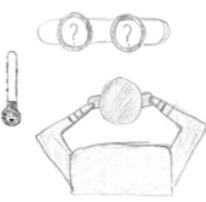
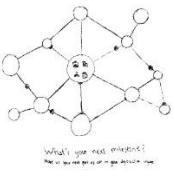
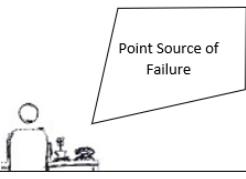
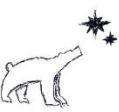
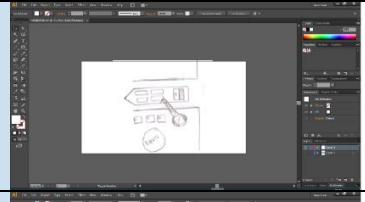
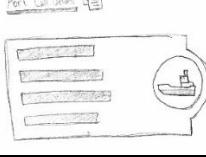
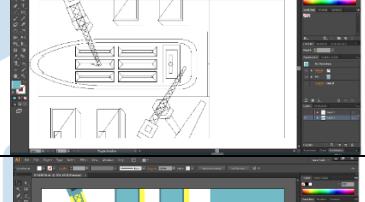
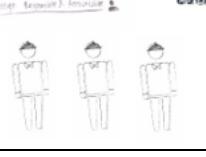
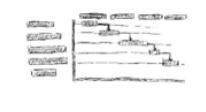
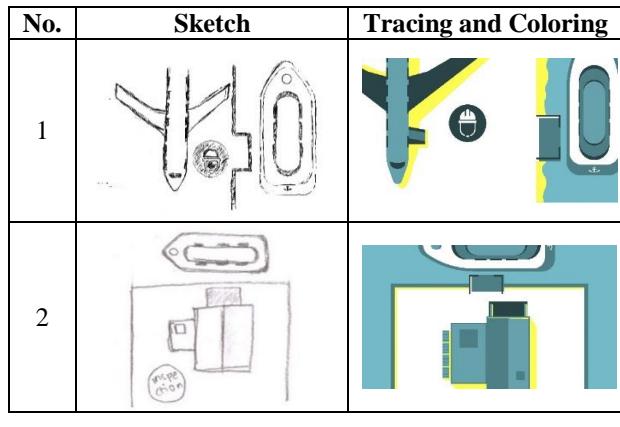
5	But Now, There is a better way Introducing constant bearing port call planning tool	But now, there is a better way Introducing <logo> port call planning tool		Shows cargo operation activity Framing : Bird Eye View BGM : upbeat music no copyright SFX : wave sound effects
6	A simple 5 step workflow that captures key information, such as activities for this port call and stakeholder involved a schedule is generated that can be edited and published This allows for easy collaboration between stakeholders and data collection for further improvement What's your next milestone? Make Constant Bearing your next port of call in your digitization voyage	- What's your next milestone? Make us your next port of call in your digitization voyage.		Shows inspection activity Framing : Bird Eye View BGM : upbeat music no copyright SFX : wave sound effects
				Shows repair activity Framing : Bird Eye View BGM : upbeat music no copyright SFX : wave sound effects
				Shows supplies activity Framing : Bird Eye View BGM : upbeat music no copyright SFX : wave sound effects
				Shows bunkering activity Framing : Bird Eye View BGM : upbeat music no copyright SFX : wave sound effects

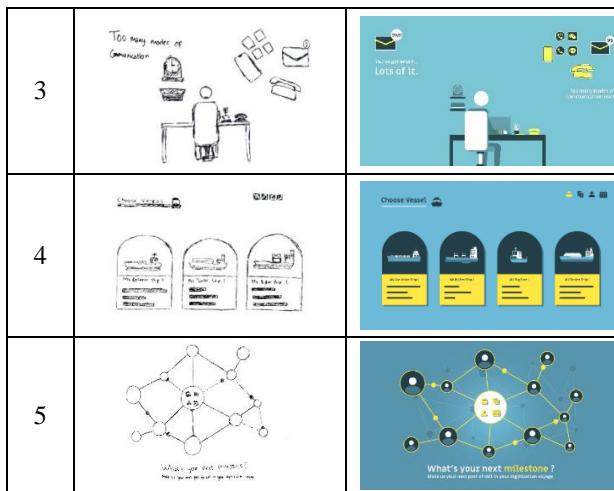
C. Storyboard

At this stage, a storyboard is created to sketch out a depiction of a story from a motion graphic that will be implemented as promotional media.

TABLE II. STORYBOARD

Scene : 1	Sequence : 1	Information	
		Logo at the opening of video Framing : Full Shot BGM : upbeat music no copyright SFX : wave sound effects	
Scene : 2	Sequence : 1 - 7		
		There are a ship object that move forward beside a moving text Framing : Bird Eye View BGM : upbeat music no copyright SFX : wave sound effects	Transition to problem scene Framing : Full Shot BGM : upbeat music no copyright SFX : -
		Shows crew change activity Framing : Bird Eye View BGM : upbeat music no copyright SFX : wave sound effects	Shows a person that have so much work to do Framing : Normal Angle, Long Shot BGM : upbeat music no copyright SFX : -
			Camera zoom out showing that so many coordination happening Framing : Normal Angle, Extreme Long Shot BGM : upbeat music no copyright

	<p>SFX : -</p> <p>Camera zoom in shows the person using binocular to keep tracking the ships</p> <p>Framing : Normal Angle, Medium Close up BGM : upbeat music no copyright SFX : -</p>		<p>See every stakeholder involve is collaborating</p> <p>Framing : Full Shot BGM : upbeat music no copyright SFX : -</p>
	<p>Camera zoom out shows the person is being the point source of failure</p> <p>Framing : Normal Angle, Long Shot BGM : upbeat music no copyright SFX : -</p>		<p>Showing logo at the end of the video</p> <p>Framing : Full Shot BGM : upbeat music no copyright SFX : -</p>
Scene : 5 Sequence : 1	Transition to solutions.	D. Tracing and Coloring	
	<p>Framing : Full Shot BGM : upbeat music no copyright SFX : -</p>	The process carried out at this stage is to create objects from sketches that have been made into digital form using the Adobe Illustrator CS6 application.	
Scene : 6 Sequence : 1 - 6	Shows 5 step workflows : Choose Vessel	TABLE III. TRACING AND COLORING PROCESS	
	<p>Framing : Full Shot BGM : upbeat music no copyright SFX : -</p>		Import the scanned sketch to adobe illustration.
	<p>Create port call details</p> <p>Framing : Full Shot BGM : upbeat music no copyright SFX : -</p>		Trace the sketch using pen tool
	<p>Assign involved people</p> <p>Framing : Full Shot BGM : upbeat music no copyright SFX : -</p>		Choose the shape and then give it color.
	<p>Scheduling</p> <p>Framing : Full Shot BGM : upbeat music no copyright SFX : -</p>	TABLE IV. TRACING AND COLORING RESULTS	
	<p>Publish</p> <p>Framing : Full Shot BGM : upbeat music no copyright SFX : -</p>		



E. Animating

After going through the Tracing and Coloring stage, the next step is Animating. At this stage, the objects from the Tracing will be animated using the Adobe AfterEffects CS6 application. Visual effects that are given to objects that change the Scale, Rotation, Position, and Opacity. This study also used the 3D Movement Camera technique. 3D Movement Camera is one of the features in Adobe AfterEffect CS6. How to use the Camera in Adobe AfterEffect CS6 is to click on Layer then select New then select Camera, adjust the camera settings as needed. The animating stage is shown in Fig 2. Animating.

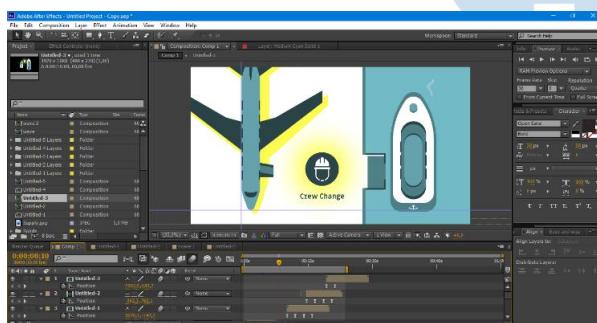


Fig. 2. Animating

F. Editing

After finishing animating, the next thing to do is editing. At this stage what is done is to combine Audio and Animation that has been made into a video. The software used at this stage is Adobe Premiere Pro CS6. The editing stage is shown in Fig. 3. Editing.

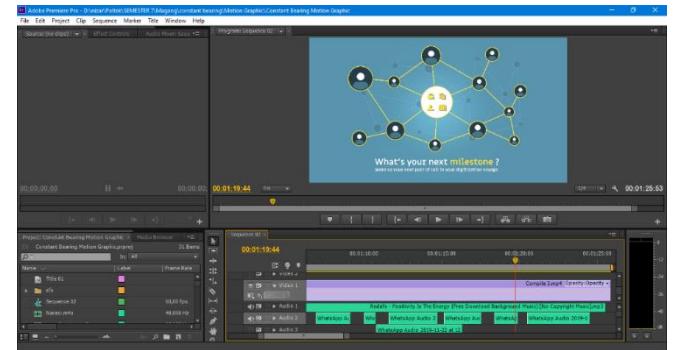


Fig. 3. Editing

G. Rendering

This stage is the last stage of the production process, namely rendering. Rendering is done after the Editing stage is finished, then Render will be done using the same software, namely Adobe Premiere Pro CS6. The Rendering stage is shown in Fig. 4. Rendering.

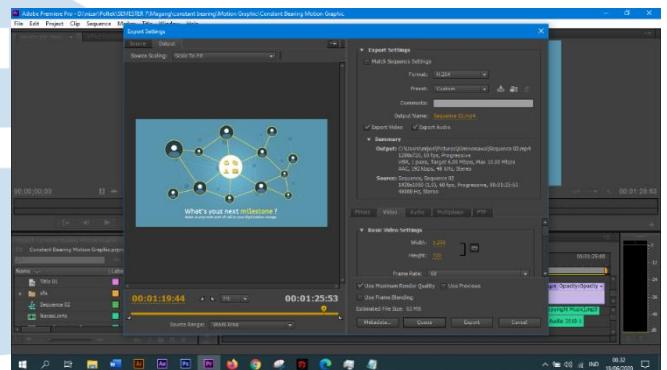


Fig. 4. Rendering

H. Questionnaire

Here is the questionnaire that used in this research.

TABLE V. QUESTIONNAIRE

No.	Statement/Question
Empathy	
1	Promotional video that are displayed are easy to remember
2	Promotional videos that are displayed give an impression to the company.
3	I like the promotional videos that are displayed.
Persuasion	
4	The solution offered in the promotional video gives confidence to use the company's services.
5	The information provided in the promotional video gives trust to the company.
Impact	
6	Promotional videos provide an understanding of the problems faced at port and solutions that must be done.
7	Promotional video that are displayed give me interest to use the service
Communication	

8	The information conveyed in the promotional video is clear.
9	Promotional videos that are displayed give curiosity about the company
10	The information in the promotional video is easy to understand.

III. RESULT AND DISCUSSION

A. Alpha Testing

In alpha testing will be tested for validity and reliability. The results of the measurement of the validity test that have been carried out are valid for all items contained in the questionnaire. Validity test results can be seen in Table VI. Validity Test.

TABLE VI. VALIDITY TEST

No.Item	Pearson correlation	Sig. ($\alpha=0,05$)	Results
<i>Empathy</i>			
1	0,680	0,361	Valid
2	0,612	0,361	Valid
3	0,642	0,361	Valid
<i>Persuasion</i>			
4	0,407	0,361	Valid
5	0,395	0,361	Valid
<i>Impact</i>			
6	0,616	0,361	Valid
7	0,771	0,361	Valid
<i>Communication</i>			
8	0,621	0,361	Valid
9	0,642	0,361	Valid
10	0,654	0,361	Valid

After obtaining the validity level of the statement item, the next step is to measure the level of consistency of the questionnaire by conducting a reliability test using the Cronbach's Alpha method. If Cronbach's alpha value is greater than 0,60 then the questionnaire used is declared reliable but if otherwise the questionnaire is considered unreliable [11]. After being calculated, the questionnaire used in this study proved to be reliable. The reliability test results can be seen in Table VII. Reliability Test.

TABLE VII. RELIABILITY TEST

Cronbach's Alpha	N of Items	Results
0,808	10	Reliable

B. Beta Testing

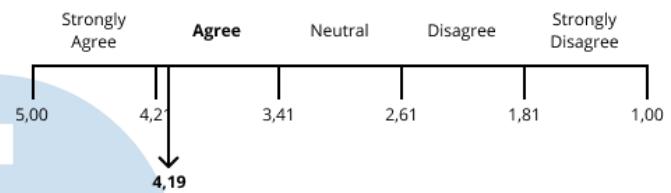
After getting that each statement is valid and the questionnaire used is reliable, the next step is to look for the value of the effectiveness of the EPIC Model and calculate the EPIC Rate. The effectiveness scale of the EPIC Model will be shown in Table VIII. EPIC Model Scale.

TABLE VIII. EPIC MODEL SCALE

Category	Scale
Strongly Agree	1,00 – 1,80
Agree	1,81 – 2,60
Neutral	2,61 – 3,40
Disagree	3,41 – 4,20
Strongly Disagree	4,21 – 5,00

1. Empathy

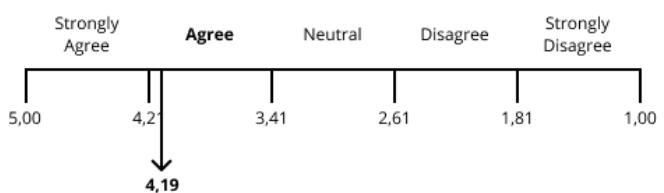
Three statements represent the empathy dimension. The first statement gets a value of 4,13, the second statement gets a value of 4,2, the third statement gets a value of 4,37. The three values obtained will then be calculated on average to determine the value of the empathy dimension. The value obtained for the empathy dimension is 4,19, so for the empathy dimension, it is considered effective.



This indicates that promotional videos that are created can make consumers interested in promotional videos and can give an idea of how consumers see the relationship between themselves and the videos are shown.

2. Persuasion

Two statements represent the empathy dimension. The first statement gets a value of 4,3 and the second statement gets a value of 4,07. The two values obtained will then be calculated on average to determine the value of the dimension of persuasion. The value obtained for the dimension of persuasion is 4,19, so the empathy dimension is considered effective.

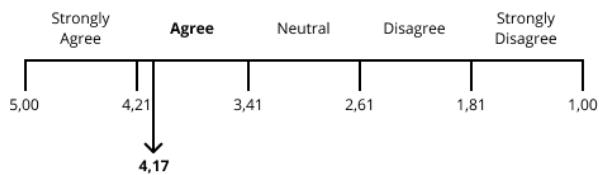


This indicates that promotional videos created can be used to persuade someone in a variety of different circumstances.

3. Impact

Two statements represent the impact dimension. The first statement gets a value of 4,17 and the second statement gets a value of 4,17. The two values obtained will then be calculated on average to determine the value of the impact dimension. The

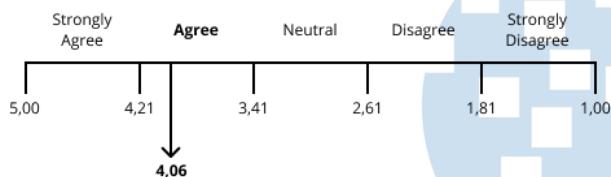
value obtained for the impact dimension is 4,17, so the empathy dimension is considered effective.



This indicates that the promotional video displayed provides new knowledge about the shipping industry.

4. Communication

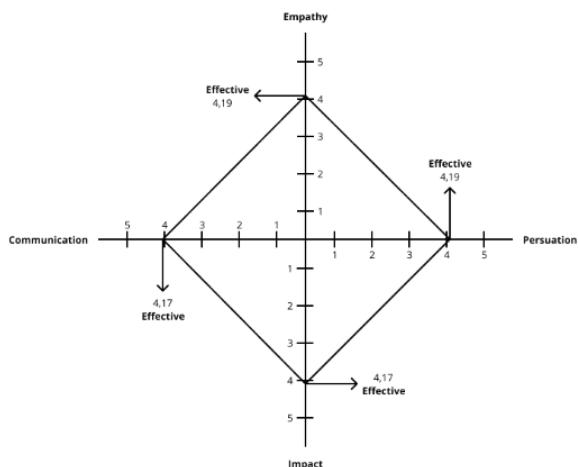
Three statements represent the communication dimension. The first statement gets a value of 4,03, the second statement gets a value of 4,2, the third statement gets a value of 3,93. The three values obtained will then be calculated on average to determine the value of the empathy dimension. The value obtained for the empathy dimension is 4,06, so the empathy dimension is considered effective.



This indicates that the message conveyed and the information contained in the promotional video displayed is clear and easy to understand.

5. EPIC Rate

Next is to determine the EPIC Rate by calculating the average value of each dimension. The EPIC Rate obtained is 4,15, thus the promotional video created is effectively used as promotional media.



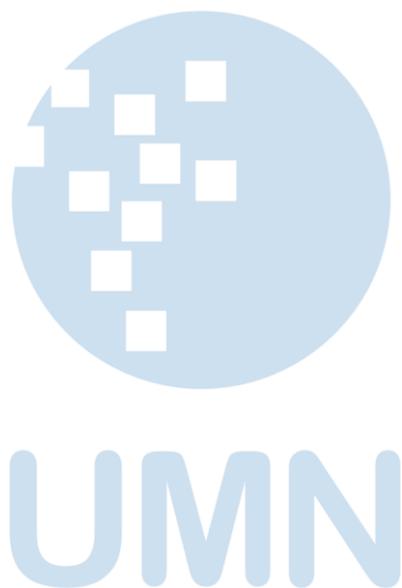
IV. CONCLUSION

Based on the result and discussion above, we can have a conclusion that: (1) promotional media in a form of motion graphic has been successfully made, in MP4 format and have a duration of 1 minute 25 seconds; (2) The challenge faced at the production stage is having to load a lot of information into a video that has a short duration so that there are some sentences in the video that cannot be read because of the short video duration and the video tempo is fast, but sentences that are not legible can be helped by their existence voice over. (3) promotional videos that created can make consumers interested in promotional videos and can give an idea of how consumers see the relationship between themselves and the videos shown; (4) promotional video that created can be used to persuade someone in a variety of different circumstances; (5) promotional video displayed provide new knowledge about the shipping industry; and (6) the message conveyed and the information contained in the promotional video displayed is clear and easy to understand.

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Stay at Home Reservation: The Mitigation Step in Covid-19 Pandemic

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Abstract—The Covid-19 pandemic condition that has hit the world has had a significant impact on various sectors. Health facilities need information system support in their services. Breaking the distribution chain can be done by maintaining a physical distance. However, in reality, people are still indifferent. There is a possibility that the patient is infected but shows no symptoms or is lying to the point of endangering medical personnel. In addition, there is a stigma in the community so that they are afraid to go to health facilities. Even though it cannot be denied that in certain conditions patients should still have their conditions checked by a doctor. The development of this online registration system aims to reduce the risk of contact between patients and medical personnel. The real-time queue monitoring feature helps patients to wait in line anywhere, so they are not in the patient's waiting room. This system is able to provide real-time queues for examinations in all polyclinics. This can reduce public anxiety about coming to health facilities.

Index Terms—Covid-19; health facilities; online reservation; pandemic; realtime queues

I. INTRODUCTION

Coronavirus or COVID-19 is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 or SARS-CoV-2 [1]. This virus was first identified in Wuhan, China in December 2019. Based on a report from the World Health Organization (WHO) states that the risk assessment at the global level for this pandemic is very high. This virus pandemic has affected almost all countries with a total of 2,078,605 confirmed cases as of April 17, 2020, with 139,515 deaths [2]. In Indonesia, the first case was identified on 2 March 2020 [3]. Since then cases have continued to increase until April 17, 2020, reaching 5,923 confirmed positive cases [4].

The government has done many ways to break the chain of spread and mitigate the effects of this pandemic. One of the policies chosen is social restrictions or social distancing. The implementation of social distancing began in mid-March 2020. Since then, the government has urged its citizens to worship,

work, and learn from home. Social distancing is a non-medical action taken to prevent the spread of infectious diseases by keeping a distance. This method is done to minimize the transmission of viruses that cause infectious diseases [5]. Reducing the number of people in a location, regulating queuing spacing, giving the distance in waiting chairs, canceling the agenda for activities that involve many people are steps in limiting distance. Kerkhove [6] prefers to use the phrase physical distancing rather than social distancing because these two things are different. The spread of infection is prevented by limiting physical contact not social contact. Currently, technology has supported the existence of adequate social activities or relationships without having to make physical contact.

In the context of tackling the COVID-19 pandemic, health workers continue to work as closely as possible. The use of Personal Protective Equipment (PPE) is maximized to prevent transmission. This social restriction has an impact on the number of people returning to their hometowns from the Red Zone area. This raises obstacles faced by health workers in the regions. The results of an interview in April with one of the medical personnel at Puskesmas Kulati, Tomia Island, Southeast Sulawesi, until now they have not received logistics either in the form of PPE or vitamin supplements. Health workers who are members of the Ministry of Health's program are raising donations for the procurement of PPE. The logistical distribution process that has not yet touched remote areas can be due to several factors, such as limited PPE so that the distribution process is prioritized for zones that are more in need or the unavailability of an integrated information system infrastructure regarding data collection from health centers in Indonesia.

In April, there were cases of 46 medical personnel at the *Rumah Sakit Umum Pemerintah* (RSUP) dr. Kariadi, Semarang which contracted the COVID-19 virus [7]. Transmission of the Covid-19 virus to medical personnel can be infected from the hospital environment and from outside the hospital. However,

the chances of these medical personnel being infected when they are treating patients. The possibility of a patient who is dishonest at the time of initial screening in the examination procedure increases the risk of medical personnel being exposed to infection so that more optimal screening tools are needed. Several hospitals have developed an information system for this screening but the puskesmas do not yet have an adequate system so that screening is carried out manually by interview. This could endanger medical personnel who are very limited in the area.

In rural areas, puskesmas are at the forefront of public health services. Local health centers have many limitations, making it impossible to handle infected patients. If a patient is infected, the nearest referral hospital is needed. Information as of April 15, 2020, there were 800 referral hospitals and locations for Covid-19 testing [8]. The large number of people moving from cities to regions carries a bad possibility, so an information system that can be updated at any time is needed as a means of information for subscribing to COVID-19 patients. In addition, the screening process with various scenarios is designed so that medical personnel do not have direct contact with infected patients because there is a trend that infected patients do not show symptoms of the corona.

Patient registration at the First Level Health Facility or *Fasilitas Kesehatan Tingkat Pertama* (FKTP) is still done manually, patients come to register. Furthermore, the patient immediately waits in the patient's waiting room for medical services. In this registration process, there is contact between the patient and the administrative staff at the *Puskesmas* or Clinic. When a patient is in the waiting room before getting service, it is possible to have contact with other patients even though health protocols have been carried out, such as wearing a mask, maintaining distance, and washing hands. This risk can be minimized by developing an online queue registration and review information system. The development of this system is expected to be used by puskesmas and health facilities in Indonesia.

Apart from aiming to mitigate a pandemic, the design of this system is different from most systems in Puskesmas. This web-based application development aims to make it easier for users so that they do not need to download and install applications. Web-based systems are seen as more user-friendly with all devices that the user has. There is an online queue feature which is the second answer to the need for new normal conditions to deal with this pandemic. The real-time online queue monitoring feature allows users to monitor queue numbers anywhere. Patients do not have to be in a health care center so that it can reduce the risk of transmission in health facilities.

II. RESEARCH METHOD

The development of this information system can be used by puskesmas in Indonesia to provide accurate and real-time data to patients regarding doctor's examination schedules and polyclinic queues. The existence of an initial screening feature in the online registration process can contact patients with infections. This early screening feature can also be used by the community to carry out early detection. The socialization of the use of the online registration system was carried out using a media banner in front of the Puskesmas registration counter.

The development of this application uses an agile software development methodology. The Covid-19 pandemic has made the situation very dynamic. This method is able to accommodate application development in dynamic and unpredictable environments [9]. This method is a short-term system development which is a rapid adaptation of the developer for changes. The choice of this method is expected to be able to cut system development time so that applications can be immediately used to mitigate conditions due to the Covid-19 outbreak.

System analysis was conducted to obtain information about the patient registration cycle that has been carried out so far. This process analyzes what data is needed in the cycle. This analysis is followed by designing a new system. This design produces the necessary diagrams, namely Context Diagrams, Data Flow Diagrams (DFD), User Diagrams, and Entity Relationship Diagrams (ERD). In addition, the design is also equipped with a Data Dictionary, Menu Structure, File Structure, and input and output design. This initial process requires systematic steps so that the application is made according to the needs. The system analysis process also focuses on user requirements, both functional requirements, and non-functional requirements. This user-focused system development uses a Software Process Improvement (SPI) framework which is expected to increase the success of implementing information systems.

Software development is costly. Software Process Improvement (SPI) is the main strategy used by software developers to reduce development costs or to increase production speed and quality. SPI is closely related to user, environmental, social, and organizational factors. The motivation for all related elements must be managed properly so that SPI can run optimally [10], [11].

Goldenson, et al. [12] conducted a survey on software process improvement to understand how its benefits and what factors affect the SPI process. Factors associated with a successful SPI effort include:

1. Employees in organizations involved in SPI are respected employees or hold important positions so that other staffs involved are willing to work better together.

2. Technical staffs are more involved in the SPI process, starting from mapping conditions because technical staffs are the ones who best understand the information technology needs of their organization.
3. The management of staff resources and working time has been re-managed when the staff is asked to be involved in SPI activities so that the staff does not feel that they are getting additional work without compensation for their daily work.
4. The objectives of carrying out SPI and their objectives have been well explained and understood within the organization, especially for those who are directly involved in the process as well as for its users.

The process begins with the determination of goals. Then a measurement feasibility analysis is carried out so that it can be measured whether the development process is feasible, if not, it will be returned to the initial goal determination [13]. Software Process Improvement (SPI) is a series of activities that go through several stages and involve many parties. Support from personnel in the organization plays an important role so that the objectives, implementation schedule, and division of work must be well understood.

The next stage is the database design and interface design. The context diagram in Fig. 1 shows the system's interactions with external entities, namely admins, patients, doctors, and service staff.

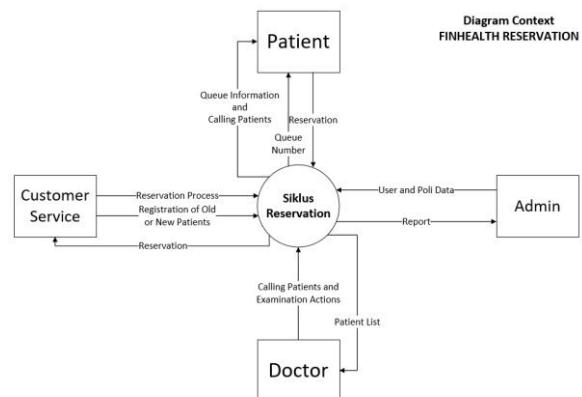


Fig. 1. Context diagram

Admin has full rights over the system and data management. The patient in the diagram has the authority to manage his profile. Doctors in this system have limited rights to the patient list on the reservation, while service staff can make on-site reservations and register patient data. The next diagram is a Level 0 Data Flow Diagram (DFD) which shows the subsystem of this reservation application.

Fig. 2 shows the login process by patients, doctors, admins, and service staff. The next process is to find the appropriate poly and schedule for the patient. Patients make reservations and enter the poly queue according to the selected health service schedule.

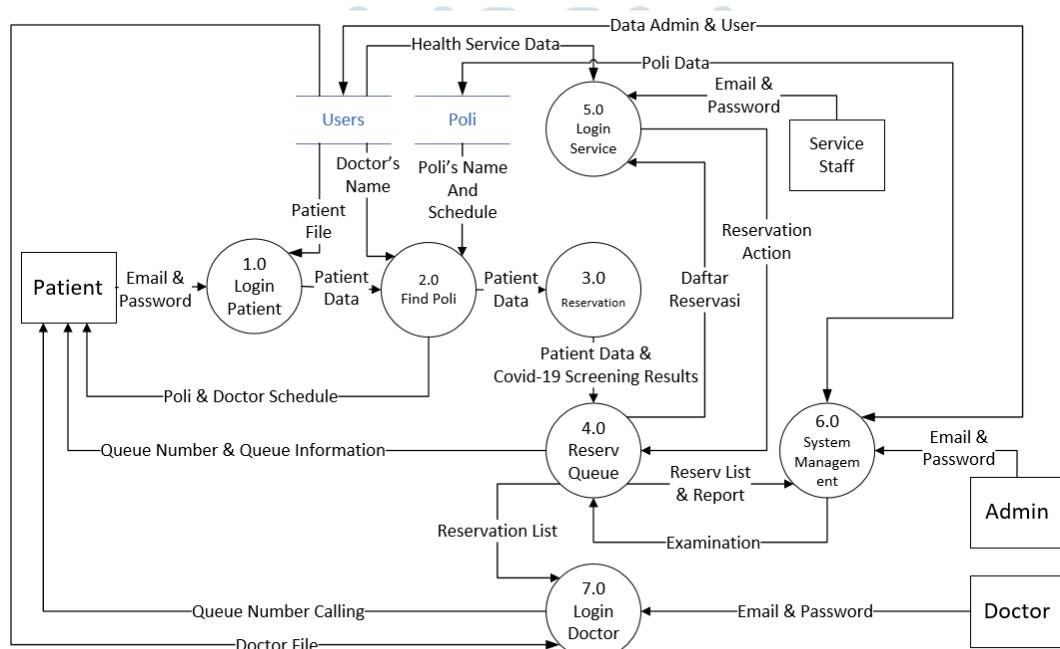


Fig. 2. DFD level 0

DFD level 0 shows the process in detail. Patients are described as being able to make profile changes, make schedule selections, and submit medical service reservations. Doctors only have limited authority, which is to see the queue list on the police and call patients according to the order. Service staff can help patients who have not used this application to register on the spot. In addition, service staff can add new patient data, manage old patient data, and change the status of patients in the queue.

Fig. 3 shows that the admin can manage patient, doctor, schedule, and poly data and can generate reports. Admin enters the email address and password to enter the system. After entering the system, the admin can see the polyclinic schedule. If there is a new poly schedule or doctor's schedule change, the admin can manage it through the schedule management feature. The admin can get queue data from all the reservations carried out in all polyclinics. In this system, the admin will create a report that shows the number of patient registrations that were carried out, cancellation of health services, and the results of Covid-19 screening.

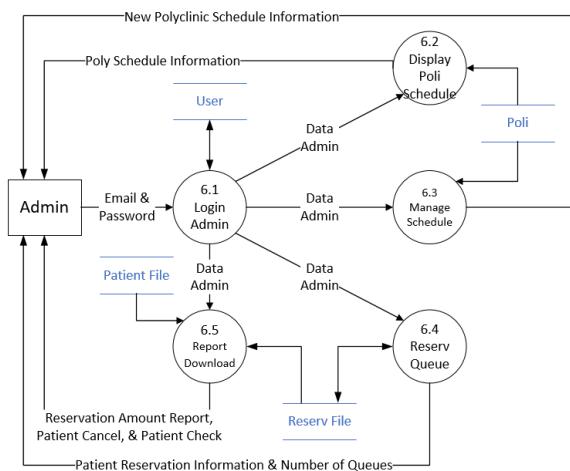


Fig. 3. Context diagram

An entity-relationship diagram is a form of arrangement of tables in a database, including relations between one table with another table. This model that combines some semantic information is introduced as a tool for database design. Also, the entity relational model can be used as the basis for unifying various data views: the network model, the relational model, and the entity-set model [14]. The theory of normalization is easy to understand, but in practice, small-scale application developers do not use this theory in database implementation on their systems. One of the causes is a lack of understanding of the normalization process. Arini, et al. [15] found that ERD becomes a bridge that simplifies the database normalization verification process because it can be seen the representation of the same number of entities in the ERD with the number of tables in the database schema.

Cagiltay, et al. [16] found that detecting defects in the types of missing information in ERD was more difficult than detecting other types of defects. ERD designs are used to better represent information and to minimize development errors for these designs, which in turn lowers the cost of the software project. This software was developed using data correspondence with the Kulonprogo Health Office. This project employs 2 Health center or Pusat Kesehatan Masyarakat (PUSKESMAS), namely Puskesmas Panjatan I and Puskesmas Panjatan II as locations for User Acceptance Test (UAT).

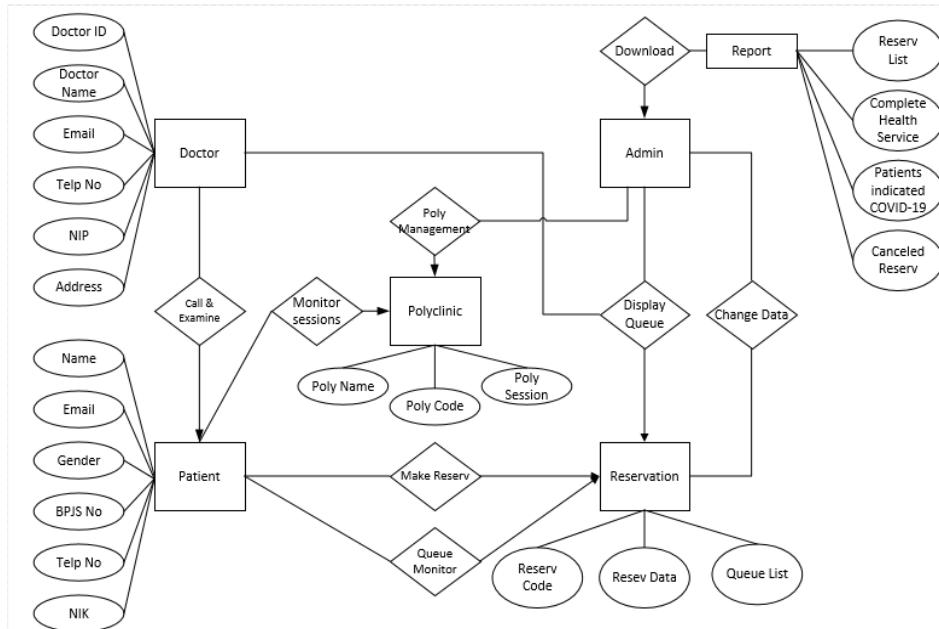


Fig. 4. Entity relational diagram

III. FINDING AND DISCUSSION

This application can be operated using personal computers, laptops, and other smart devices connected to the internet. Users can use any web browser. Users can start using it by entering the address of each health facility according to the area. Based on the design in the previous chapter, this system has been successfully developed and has been registered with the Ministry of Law and Human Rights, Directorate General of Intellectual Property with registration number 000195166. Fig. 5 shows the initial view of the user. The login menu is used to enter the application using an email address and password while the register menu is used to enroll a new account. Users can immediately make a reservation by clicking the Reservation button. The last button on this display functions to monitor the queue in real-time.

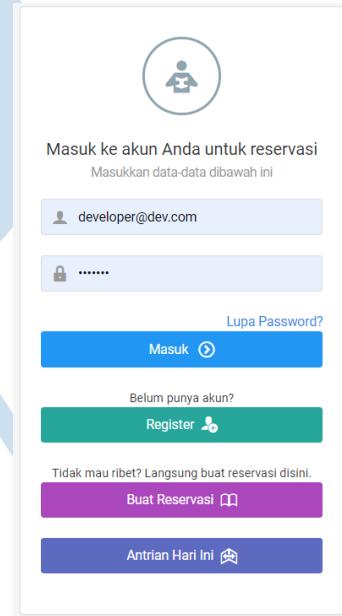


Fig. 5. Welcome page

The following are examples of the displays from the submenu in the application. Fig. 6 shows the instant reservation menu display. Patients are asked to enter their name, telephone number, NIK, Health Insurance Number, and choose the poly they will go to. The picture shows a number of polys which are owned by the health center. This policy can be adjusted by each user according to their conditions.

As a follow-up step, the developer can consolidate with the local Communication and Informatics Office of the District to be able to create a domain for each Puskesmas. The database can be drawn from the Department of Population and Civil Registration data,

although the home base of the patient is still adjusted to the area of residence.

The form consists of several input fields: 'Nama *' (Name), 'Nomor Telepon *' (Phone Number), 'NIK *' (NIK), 'Kartu BPJS / Kartu Sehat *' (BPJS / Health Card), which has options 'Ada' (Yes) and 'Tidak Ada' (No); and 'Poli *' (Clinic) which lists 'Umum' (General), 'Gigi' (Dental), 'KIA' (Inhalation), 'UGD' (Emergency Room), 'Fisio' (Physiotherapy), and 'KB' (Contraception).

Fig. 6. Reservation menu

In the admin menu, there is full control over this application. Admin can make changes to data both patient data, doctor, schedule, to poly. The admin is in charge of managing the doctor's practice time and the length of service for each patient. Admins also get access to reports that can be generated by this application. Some of the existing reports include patient registration reports, dependent patients, patients who canceled treatment, and patients who are indicated by Covid-19. Based on this report, health facilities can make various decisions in order to manage their health facilities in the midst of this pandemic.

Doctors have a limited menu on this application in the hope that this application does not add to the workload. The doctor only presses the patient's call button according to the order in the application. The doctor can monitor the number of patients enrolled in each session. While the service staff is tasked with backing up patients who have not used this application to register. Service staff can add new patient profiles, modify patient data, and make reservations. During this service, the staff urges patients to monitor the queue via the application site and come after their turn so there is no need to stay in the patient waiting room.



Fig. 7. Real-time queue

The target users of this application are puskesmas patients who live in the working area of the puskesmas. Fig. 7 shows the queue number being checked by the doctor and the next queue number that will be called immediately. At the bottom, there is a list of registration numbers so that patients can monitor where the queue is. Furthermore, there is information on patients who were missed or did not come when called and a list of patients who had received health services. This real-time queuing feature is expected to be fully utilized in the current pandemic conditions. Using this feature allows patients to wait at home until the queue is nearby.

IV. CONCLUSION AND FUTURE WORKS

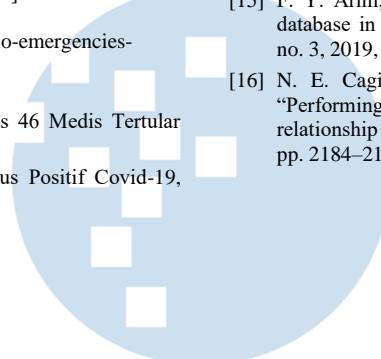
This pandemic is an extraordinary condition that must be faced together. Health workers struggle to cure infected patients. As good citizens, we must also be able to look after Indonesian medical personnel by implementing health protocols. In addition, the use of this online registration system also provides various benefits for both patients and health workers. The use of this system can reduce contact between patients and patients with health staff so that it is expected to play a role in mitigating the various impacts of the Covid-19 pandemic.

This research has a practical impact, health facilities throughout Indonesia can use the concepts and designs that have been described to develop similar applications. This system can be developed on a large scale so that it can reduce the level of transmission of pandemics and other diseases. This study has several limitations. First, the results of the development and application of this software cannot be measured with exact numbers because the number of patients exposed until this paper was written could not be controlled. However, it is hoped that the development of this system can be one of the factors capable of mitigating the current transmission of Covid-19 and the transmission of other infectious diseases in conditions after the Covid-19 pandemic ends. Further research can measure the level of success of this information system by comparing the

level of effectiveness and efficiency of business processes in health facilities. Second, this software is designed in Indonesian with the hope that it will be easier for users to understand, namely people in rural areas who still have difficulty accessing health services to hospitals. Further research can develop other applications that can use English if indeed the target user uses English as their daily language.

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UMN

Designing a Blockchain-based Pemilu E-Voting Information System

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Abstract—Data is an important thing as a base of an analytic or a hypothesis for concluding participant vote data in the Indonesian General Election. The data needs to be processed and secured, so the integrity of the data is in good condition. It also needs to protect the participant voting rights, so the information is correctly displayed. The research problems include creating a system that protects the integrity of election data and creating a system that protects election rights for each voter. Based on the problems, this research discusses a blockchain-based electronic voting information system that would secure the integrity of data and also protecting the participant voting rights in a General Election. The system uses Ethereum as a blockchain with Solidity as a programming language to build a smart contract and is built in Microsoft Windows platform. In this research, consortium blockchain and biometric fingerprint authentication are used as a problem-solving method, and waterfall steps are used as a system development method. The result of this research is a proposed design of the e-voting system. The conclusion based on this research is a blockchain-based e-voting system that secures the integrity of the data in a selection process and ensures protection to each vote right.

Index Terms—authentication; blockchain; data; e-voting; integrity; system

I. BACKGROUND

Data is a beginning form of an event, activity, or object that has been recorded in large scale volume [1]. For example, a vote data from each participant. According to Komisi Pemilihan Umum (KPU) in 2019, voting is a method in General Election [2]. Voting is a method to make a decision in public, politic, or a social scope from a group or some of the individuals [3]. The integrity of the result is an essential principle in the voting process [4].

Kompas news reported an event during the General Election that several ballots were already stabbed in voting field number 42 at Gowa, North Sulawesi [5]. As stated before, the data integrity is an important thing in terms of keeping the originality or changes of data. The result of the General Election will be wrong if the integrity of a vote data is broken or not according to the origin. The conventional voting

process leads to a broken vote paper, or human error where individual does not stab or point properly when choosing the candidate. All of these issues can be resolved by using electronic voting (e-voting) [6].

Implementing an *e-voting* system has some of the side effects in the range of outsider attackers, that can be from another country [7]. As an example, Estonian e-voting system which has a centralized database system, has a vulnerability in denial of services attack (DoS) [8]. This attack would change the integrity of the data that is being processed during the voting and data loss would potentially occur[8]. Centralized systems have been considered as a problem, and with blockchain technology, the problem can be resolved [9].

Blockchain is a public ledger or transaction notes that are copied to all connected computers in the global network [10]. After the data is committed and verified in the blockchain, it cannot be reversed [11]. Using blockchain technology helps to secure the integrity of the data [12].

The research problems based on the previous situation are to create a system that's covering each individual voting rights and to keep the data integrity when being processed and stored. Based on the problems, the objectives of the research are to design an e-voting information system with voter's authentication that is integrated with static voters list database or Daftar Pemilih Tetap (DPT) in Indonesia and to design blockchain-based e-voting information system as data storage for General Election. The DPT server is simulated in the local environment database as a separate device, and the e-voting system will be built in Windows desktop platform. Ethereum will be used as the blockchain platform.

II. LITERATURE REVIEW

Electronic Voting is a way to collect and process votes digitally using electronic device [13]. When running the electronic voting, some entities need to work together as a principle of the system [14]. When we plan into the development of a system, the waterfall system development method can be used and

viewed as a linear or sequential approach [15]. Here, the system platform i.e. the hardware, operating system and the environment must be determined, so the software that is developed can be installed and run in this platform [16]. The e-voting system needs to authenticate the eligibility of the individual that's casting a vote, comparing the data against the DPT database. This is a process to ensure individual that claims a resource is the correct person [17].

One of the methods in an authentication process is using biometric authentication, by using the uniqueness factor of each individual [18]. Fingerprint, which is located on the epidermis layer of human skin is structured with a unique pattern to each finger that can be identified as a uniqueness factor so it can be used as an authentication method [19]. One of the principles of the e-voting system is the end to end verifiable. This is a process to identify whether the voter has done the voting or not without revealing his/her identity [20].

To prevent an unauthorized entity accessing the content of the data, Advanced Encryption Standard should be implemented in the system with the symmetric key system that helps to reduce operation time during encrypting and decrypting processes with the fast-paced system [21]. To prevent data alteration from an unauthorized entity, the system should be built with blockchain technology, because the data is saved within a block, that has a timestamp, and the integrity is stated as a hash in a form of hexadecimal string from the previous block, and so on [22]. Due to the nature of blockchain decentralized networks, all data are replicated across all computers that are connected to each other or across all computers that implement peer to peer networks in a blockchain protocol. As a result, it would be extremely difficult for the attacker to tamper the data [23].

Ethereum is one of the blockchain platforms with a decentralized nature and has a smart contract capability with a high success rate [24]. A smart contract is like an electronic treaty, the contract is generated in a programming language to run a set of agreed rules that are stored in a decentralized manner to write or retrieve data inside the blockchain. To control the blockchain networks and data writing consensus to a network, the consortium blockchain method in developing the architecture of the blockchain is needed, so the selected device is needed to have permission to read and write the data in the blockchain network with a private system model [20]. One of the implementations of ethereum blockchain inside a computer client is geth, a tool that helps in managing the consensus write, node network authorization, and commanding the smart contract data from the JSON Remote Control Procedure protocol API (RPC) [25].

To build a new system based on the existing one, a general flow of an existing system is needed to be

represented as a standard format in Business Process Diagram, that helps to visualize the activity [26]. As the existing system is visualized in a general process, modeling to the new system is needed by visualizing the system as an object that is participating in forms of Unified Modeling Language Diagrams (UML) [27].

The Existing system is based on a centralized architecture that has many risks in failure of services that threatens the integrity of the data, but the problem can be resolved by using the blockchain system i.e. decentralized peer to peer network. So when one computer fails, the availability of the data isn't absent in the system, as it will be retrieved from another available computer in the network. This will also prevents data manipulation [28]. In the case of using biometric authentication in the system, it increases the security inside the authentication process that is invoked by the user of the system [19]. Implementing the e-voting system based in an election makes the collecting and counting faster and increasing the participation of the voters to use their right [6]. When a system is going to be built, using the waterfall method will ensure each phase is completed properly, preventing a mistake in the next phase process, as such it will produce a robust and stable system [29].

III. RESEARCH METHODOLOGY

The object of this research is to explore the blockchain-based e-voting information system. The system will use a blockchain as a General Election data store, and use the authentication to the voters to prevent ineligible voters to cast a vote. The literature study is used to evaluating the existing e-voting system, and the General Election or Pemilu voting process in the year 2019. The candidates data are collected by using convenient sampling method from the official android application "KPU RI PEMILU 2019". The candidates that are participating in the general election according to the Undang-Undang No 7 Tahun 2017 are political party with DPR, Province DPRD, City or regional DPRD, individual DPD, and the president and the vice president of Indonesia.

A. Problem Solving Method

A.1 Consortium Blockchain

The Consortium Blockchain is used as a problem-solving method in developing a blockchain-based system architecture. The advantage of consortium blockchain over the public blockchain in terms of nodes control in development and the verified node preventing malicious node or unauthorized device entering the network with a structured attack scenario [30]. Besides, according to terms of regulation in Indonesia, KPU is the organization that executes the General Election, so the consortium blockchain is most suitable for this situation. For the authentication of the system, the biometric authentication method will be applied because of the individual physical

uniqueness [18]. The biometric data type that will be used in the proposed system is fingerprint because it can give a convenient factor to the users. After all, the biometric fingerprint authentication itself can be found in much wide variety of modern common smartphones [18].

A.2 System Development Method

The system development method that will be used to build the proposed system is the waterfall over the Rapid Application Development (RAD). Waterfall gives an advantage over RAD in a structured development phase and preventing iteration from the previous steps [31]. The e-voting system needs to be consistent in the beginning because the existing Pemilu 2019 system will be the references or the static foundation during the process of the development. There's five-phase during the system development process according to Pressman when using the waterfall method. The phases are communication, planning, modeling, construction, and deployment [32].

B. System Development

B.1 Communication

In the communication phase, the principle and the requirements gathering are implemented. The literature study has been done by examining the process of the Pemilu or general election system that stated in General Election 2019 Implementation, called "Buku Panduan Pelaksanaan Pemungutan dan Perhitungan Suara Pemilu Tahun 2019" in Indonesian. The information gathered from the literature study helps in creating the proposed system flow or process-based from the existing Pemilu 2019 process. The candidate sources as stated before will be shown on the e-voting system based on "KPU RI 2019" app with the following criteria scopes:

- Banten III Election Field (Dapil) for DPR election with 148 candidates.
- Banten VII Election Field for DPRD Provinsi or Province DPRD region with 146 candidates.
- South Tangerang III Election Field for DPRD Kabupaten/Kota or City DPRD Region with 110 candidates.
- Banten Province for DPD election with 26 candidates.
- 16 political parties.

There is some problem in the existing system:

- The pending process in the system, affect the data integrity issue to the ballot. The issue can appear because the voting process or collection of participant vote will be done without the other group beside KPPS (Kelompok Panitia

Pemungutan Suara) if the time is above the 7.30 AM. If there is any mistake that was done, it cannot be controlled.

- For registered voters that reside outside their registered address, they cannot cast a vote to the nearest voting place location or TPS.

Considering the difficulty from the existing system, the proposed system flow will be developed with some changes below:

- Exclude the pending process to not waste the voting time and the activity can be recorded in a device.
- System Log feature that can help KPPS, ballot keeper (pengawas TPS), and witness (saksi in Indonesian) to keep the record and analyze the events.
- Digital document printing with a digitized signature with the biometric fingerprint.
- End to End verifiable feature for each of the voting participants so they can check the vote correctly recorded to the system anonymously.

B.2 Planning

In the planning phase, estimating principle resources was implemented for the development of the system by determining the hardware and software.

A desktop, laptop, and raspberry pi used as a computation device during development. The hardware and the software can be seen in Table I below.

TABLE I. DEVELOPMENT DEVICES

Computation Device	Specification
Desktop	Intel Core i5 2500 3.4 GHz, AMD Radeon RX 570 4GB DDR5, 256 GB Adata SSD, Windows 10 Education 64 bit, 8GB DDR3 RAM
Laptop	Intel Core i3 5005u, 2.0 GHz, AMD Radeon R5M330 2GB DDR 3, 120 GB Adata SSD, 8GB DDR3L RAM, Windows 10 Home Single Language 64 bit.
RaspberryPi 3 b+	ARM Cortex a53 1.2 GHz, Linux Raspbian 32 bit ARM, 1GB LPDDR2

As stated during the previous phase, the fingerprint scanner device is used to record each individual unique pattern to the system during the authentication method. The fingerprint scanner is SecuGen Hamster Plus type HSDU03P.

B.3 Modeling

The next phase is modeling that implements analysis and design to make a blueprint of the system

as references. Use case diagram, activity diagram, class diagram, and sequence diagram will be built in this phase to visualize the system users, objects, and process flow.

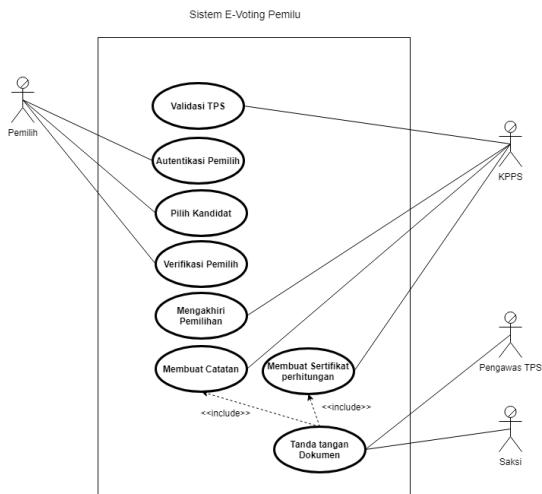


Fig. 1. Proposed system use case diagram

Fig. 1 shows the proposed system use case diagram with 4 actors which consist of the voter (pemilih), KPPS, TPS Keeper (Pengawas TPS), and witness (saksi). The role of the voters actor is to exercise their vote right to choose their preferred candidates. The role of the KPPS actor is to start the collection process, close the collection process, calculate the votes, capturing an event in the information to their notes, creating a voting result certificate, and sign the event notes and vote result certificate (sertifikat perhitungan suara). The role of the TPS Keeper is to sign the event notes that are generated based from their analysis to the event in the TPS. The role of the witness actor is to sign the event notes generated by KPPS, and sign the vote result certificate that has been signed by KPPS actor.

After the abstraction of the system object with UML has been done, the overall system architecture can be represented in Fig. 2.

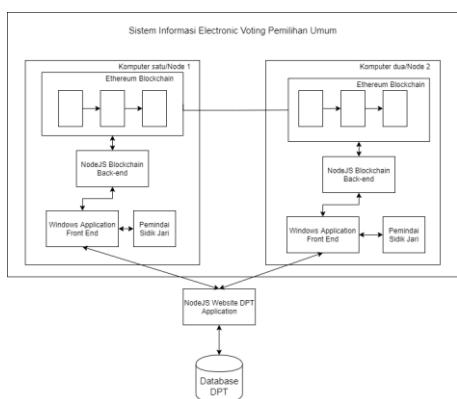


Fig. 2. The proposed system architecture

The architecture of the system proposed is using 2 decentralized nodes that are connected together to keep the ethereum blockchain data updated for each node in Fig. 2. Every computer or node has a front end Windows Application to display the data, connect the fingerprint scanner during the authentication process, and as an interface that helps the user to interact with the system. Because of the limitation of the resource, the system only uses one fingerprint scanner and can be used interchangeably.

The front end application is connected to the static voter list (DPT or Daftar Pemilih Tetap) simulated server to get the identity of the eligible voters during the authentication process. The NodeJS Runtime environment is needed in the back end area, so the front end application can communicate to the ethereum blockchain data layer. When a node wants to update the blockchain data, the proof of work must be done. In the ethereum blockchain, mining or proof of work process can only be granted to the node that has permission. Any changes to the ethereum blockchain data are stated in a form of transaction. When the system does a data query, the node doesn't need to do any proof of work. When a node wants to write data to the blockchain, an ethereum address is needed to indicate the transaction creator in 42 hexadecimal characters.

$$A(pr)=B96...255(KEC(ECDSAPUBKEY(Pr))) \quad (1)$$

The creation of an ethereum address starts from the creation of a private key with a 256-bit length by EVM (Ethereum Virtual Machine). After the private key has been created, the next step is creating a public key derived by the private key and hashed by using the Keccak 256 Algorithm [33]. The final result of the address is formed by taking the 160 bit from the most right of the result of keccak in 256-bit length and converted to the hexadecimal format with 0x prefix in the front. The ethereum address will be used as a proof in e2e verification to the voters with base 32 character encoding, so the hexadecimal character can be shortened to more readable form in 32 characters.

Inserting the data in form transaction or make a data query from the blockchain, the system uses 4 smart contracts which consist of "nik_autentikasi" contract, "pemilu" contract, "catatan" contract, and "sertifikat_suara" contract. The "catatan" is an ethereum smart contract that contains the instruction to write Indonesian nationality identity number or NIK (Nomor Induk Kependudukan) in form of SHA 256 hash and to check the existing NIK in the blockchain. The "pemilu" is an ethereum smart contract, that contains the instruction to write and store the voter choices of the candidates, to check the eligibility of the vote, to prevent duplication of the vote and to prevent a reversion of the transaction. "Catatan" is an ethereum smart contract that contains the instruction to write and retrieve all system event logs that has been created by the system, signed to the blockchain.

“sertifikat_suara” is an ethereum, smart contract that contains an instruction to write and retrieve vote result certificate that has been signed, digitized and recorded inside the blockchain.

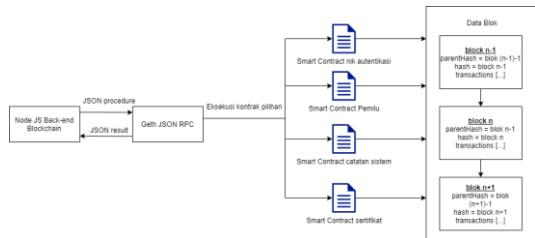


Fig. 3. blockchain structure in the proposed system

The user interfaces from the system are created based from the actor's role in the system. The voter interface consists of an authentication page, lists of candidates page, also verification of the voter page. In the KPPS interface, there is voting place system validation page (TPS Validation), closing the vote system page, system event log page, vote result certificate creation page, and authentication digital document sign. For the TPS Keeper, there is the same event log page as KPPS actor, and event logs authentication digital document sign page. For the witness actor, there is some interface that consists of the same event log page as KPPS, and TPS keeper actor, and the digital document event log and vote result certificate sign page.



Fig. 4. TPS validation interface



Fig. 5. The candidates user interface

B.4 Construction

In the construction phase, the preparation and code principle is implemented to build the proposed system based on the blueprints in the previous phase. The preparation principle is divided into two sections which consist of the front end and the back end section. The front end section's purpose is to show the user interface, managing the fingerprint authentication of the voters. The back end section's purpose is to respond to the request from the user in terms of data that will be displayed to be added to the ethereum blockchain. The front end area of the system is developed using Microsoft .NET Framework with C# Programming language with SecuGen Software Development dynamic linking library (DLL) Kit to communicate with the fingerprint scanner.

The back end area of the system is developed using the expressJS framework with JavaScript programming that can run inside the NodeJS runtime environment using the web3.js library. For the DPT database, MySQL RDBMS is used as the simulation to store the NIK and fingerprint identification record data for the authentication process. The Truffle framework is used as the ethereum blockchain environment development. The solidity programming language is used for smart contract creation. Geth is used as a Remote Procedure Call (RPC) server to communicate amongst the blockchain nodes in the same network and run the RPC method instruction from the NodeJS Environment. In the code implementation, the source code is generated based on the previously accepted system design so the system can be operated.

B.5 Deployment

The deployment phase is to implement the feedback and delivery principle. The delivery principle purpose is to get the system up and running properly based on the previously accepted design and to make the system accessible for the user with the latest compiled binary executable. For the feedback principle, we will perform the black-box test, penetration testing to the data integrity, and authentication reliability. The user acceptance test will also be performed to get the user insights to make a better system in the future.

IV. DISCUSSION

A. Delivery

The compilation has been done in the system front end area with some additional changes. The changes are to extend the vote collection time and to disable the fingerprint feature in the authentication process. The process that needs the fingerprint scanner operation will be skipped to the next process in the system. The changes must be done due to the government force major or PSBB in Indonesian

regulation global COVID 19 virus pandemic based on “Undang-Undang No 21 Tahun 2020”.

B. Feedback

In the feedback section, the black box testing is done by the user based on the system actor. The black box testing steps are based on the use case and the defined actors that were made before [34]. For the use cases that will need to do the fingerprint authentication process, the test has been done internally. Based on the force major situation, the testing was done by 1 former general election 2019 KPPS as KPPS, witness, and TPS keeper actor, also 5 college students with 17 years old and above. In the UAT, the user responses from in a form of Likert Scale Question in Table II.

TABLE II. UAT QUESTIONNAIRE

Questions	Answers				
	1	2	3	4	5
Can the blockchain-based e-voting system that stores the general election data separated amongst the connected computers provide the data integrity?			1	2	3
Can this blockchain-based e-voting system protect the vote rights while the biometric fingerprint authentication is active in the system?			3	3	
Is the proposed system easy to use?		1	2	3	

B.1 Authentication Reliability

The authentication reliability is done internally with fingerprint identification record (FIR) data from 4 people that registered each finger 3 times in their left and right hands [35].

The False Rejection Rate test can show the rate of false detection done by the scanner where the real result should actually be true [35]. The sum of collected fingerprint sample from each person was 120 samples FIR’s.

$$FRR = \frac{N(\text{false detection})}{M(\text{stored Fingerprint samples})} \times 100\% \quad (2)$$

The result of FRR by referencing the formula is 25%. Based on this FRR result, voters would need to try up to 3 times when the fingerprint is detected as false while it should actually be true.

B.2 Data Integrity Analysis

During the data integrity analysis, penetration testing should be implemented. One of the classification of penetration testing attack is a modification attack, changing the cyber assets that will affect the data integrity [36]. The penetration testing is done by changing the blockchain transaction data to reduce the total participant during the vote

collection scenario with saved signed vote result certificate data and the saved logs that's already written. In this scenario, the attacker has gained access to node 1 that's used by the user in the vote collection process with the SSH access. The attacker gains the copy of the blockchain data and did the self mining in the attacker node so the data are malicious or not match with the main proposed system canonical one.

The data integrity can be checked by using the checksum of the hash by comparing the stored one with the data that had been taken or retrieved from the storage [37]. The comparison of hash value from a transaction inside the block in form of boolean that will resulting with true if matched (1) or false (0) if the hash is not matched. Based from the boolean value that contains only two values or binary based, it can be represented with the boolean matrix [38]. The transaction hash value is checked and the results are respresented in a boolean matrix in Fig. 6 at the node 1.

```
function()
> matriksBinerHash(); //node 1
undefined
> printMatriks();

1, 1, 1, 1, 1, 1, 1
1, 1, 1, 1, 1, 1, 1
1, 1, 1, 1, 1, 1, 1
```

Fig. 6. The node 1 boolean matrix before the attacker do the data tampering

```
> printMatriks();
1, 1, 1, 1, 1, 1, 1
1, 1, 1, 1, 1, 0, 0
0, 0, 0, 0, 0, 0, 0
```

Fig. 7. The malicious block boolean matrix comparison with compared with the canonical node 1 chain

After the attacker tampered the data with the malicious block in the node 1, the value from the matrix keeps the result same as before which resulting 1 inside all the matrix cells from the node 1 to the blockchain data in Fig. 7. After the change has been detected, the update was triggered by geth to adjust the local data from node 2 to node 1. Based on the boolean matrix result like in Fig. 6 after the attacker tampered the data, it means the integrity of the data is not compromised because the attacker blockchain data is ignored by the geth during the consensus process. If the last result of the matrix cells appears “0” in one of the cells like Fig. 7, the integrity of the data is not matched and the data integrity has been compromised.

V. CONCLUSION

Based on the problems discussed in this research, there are some conclusions which consist of:

- The blockchain usage in the system to store general election or Pemilu data can maintain the integrity of the data.
- Implementing biometric fingerprint during the authentication process, it can protect each participant vote rights.
- Implementing End to End Verifiable by using unique secret code to each participant, it can assure the chosen candidates are correct and matched to what the voters choose when the vote collection process is finished.

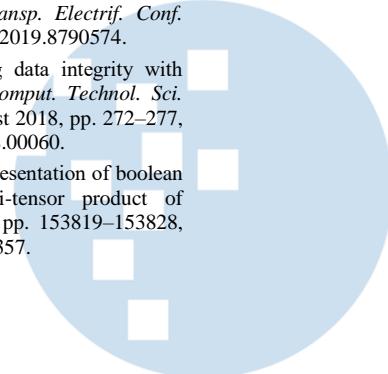
Although this proposed system is built in the form of a prototype, there are insights discovered during this research that can be useful for future research in this area which consist of:

- The scalability factor to make the recapitulation feature to another election field (TPS).
- Containerisation can be used to easily deploy the blockchain back-end with 1 package to each node.
- The candidate's photos need to be displayed in the legislative section.
- The chosen party and the details of the candidate need to be displayed on the verification page.
- The verification node needs to be shortened to make the voters do the verification check easier.
- The blockchain data write and retrieve operation need to be faster.
- Message box notification is not needed at every step during the voting process. Final summary of the actions are recommended instead.

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UMN

Sentiment Analysis about Indonesian Lawyers Club Television Program Using K-Nearest Neighbor, Naïve Bayes Classifier, and Decision Tree

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Abstract—Indonesia Lawyers Club (ILC) is a talk show on TVOne that discusses topics around public phenomena, legal issues, crime, and other similar topics. In 2018, ILC won the Panasonic Gobel Awards as the best news talk show program. But in 2019, ILC failed to win the award which was won by Mata Najwa which featured a talk show event that appeared on Trans7. As one of the television shows that has won awards, ILC has pros and cons for its shows from the public. This study applies a sentiment analysis approach to examine public opinion on Twitter about Mata Najwa and ILC in 2018 and 2019. This study applies K-Nearest Neighbor, Naïve Bayes Classifier, and Decision Tree classification algorithm to validate the result. The contribution of this study is to show that public opinion on Twitter can be examined to figure out community sentiment on a tv talk show as well as to confirm the Award winner of TV Talkshow.

Index Terms—datamining; decision tree; K-NN; Naïve Bayes classifier; sentiment analysis

I. INTRODUCTION

Sentiment analysis is a process for determining an opinion or response regarding a particular product or topic. Sentiment analysis can be useful for overcoming several problems, one of which is determining how people respond to a television broadcast [1].

One most popular TV talk shows in Indonesia is Indonesia Lawyers Club (ILC). ILC is a talk show on TVOne that features dialogues that discuss topics around public phenomena and legal or criminal issues [2]. According to Liputan6.com, ILC has been nominated several times to win an award from the Panasonic Gobel Awards. The last award that was won in 2018 was the 2018 Panasonic Gobel Awards in the News Talkshow Program category. However, in 2019, ILC only received a nomination at the Panasonic Gobel Awards because it lost to Mata Najwa, which featured Talkshow like ILC.

The Award winner is calculated from the rating. The value of the rating is especially important for the survival of a television show, but it does not show that the quality level of the shows. Viewers often provide their opinions on television shows through social media, one of which is Twitter [2]. The opinion is an expression of the belief that holds together among members of a group or public, about a controversial issue that concerns the public interest. Opinions are not always logical, formless, always ambivalent, contradictory, and easy to change [3]. Public opinion on ILC can be made from tweets taken from Twitter, this is because quite a lot of Twitter users also watch ILC.

This study applies a sentiment analysis approach to calculate public opinion on Twitter about ILC and Mata Najwa in 2018 and 2019. This study will compare the results of public opinions on ILC and Mata Najwa and will be validated by using three different algorithmic methods for classification, namely K-Nearest Neighbor, Naïve Bayes Classifier, and Decision Tree.

II. METHODOLOGY

A. Sentiment Analysis

Data Mining is an analysis of the process of seeking knowledge in a database. This knowledge can be interpreted as data patterns or relationships between valid data that have not been known before [4]. Sentiment analysis is usually done to seek public or customer opinion on a product or service that is owned by a company, organization, or entity [5]. Sentiment analysis can also be interpreted as learning an opinion, problem, feeling, or emotion from someone or the public in responding to something in the form of text or writing. In determining a sentiment, it is done by calculating some of the words contained in sentences, documents, or text [6]. Rapidminer is software that can be used to process data mining. The process that can

be carried out by RapidMiner in text mining is about text analysis, finding patterns from large datasets, and mixing them with various statistical methods, artificial intelligence, and databases.

In analyzing sentiments, several steps need to be taken to get the best results. The steps consist of data collection, data pre-processing, and sentiment classification. Fig. 1 shows the steps used in the analysis of sentiment analysis in this study.

B. Data Collecting

Data collection uses Python to retrieve data on Twitter from 2018 and 2019. Data collection for ILC uses the keywords "IndonesiaLawyersClub", "ILC", and "ILCtvone" while Mata Najwa uses the keywords "Mata Najwa". After getting the data, the next data is selected which is an opinion, and labeled manually by three volunteers as many as 30 tweets per month in 2018 and 2019, respectively. Rather than applying the single peer reviewer method, the benefit of applying the three peer-reviewing methods is to increase the accuracy of the manual review process [7]. An example of the labeling process result can be seen in Fig. 2.

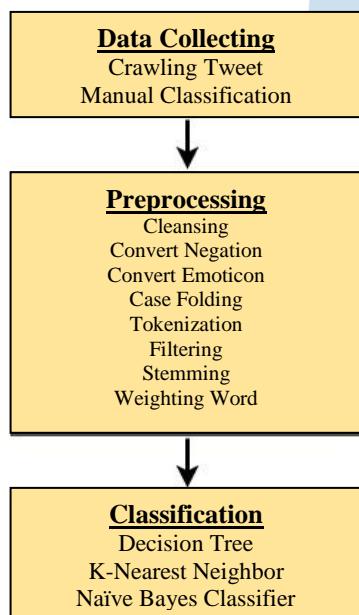


Fig. 1. Sentiment analysis flowchart

timestamp	text	sentimen
02/01/2018 194058484072448	Saya senyum sambil geleng2 Den, semoga di undang @ILCtvone kembali. https://twitter.com/dennysiregar7/status/948	
02/01/2018	Jangan ah mas.. Kasian di ILC cuma jadi badut.	negatif
04/01/2018	Pribumi anti fpi..... Allahuakbar	negatif
04/01/2018	Drama Sandal Jepit dan Kaos Oblong....	negatif
04/01/2018	Hoax membangun.....	negatif
04/01/2018	Bagusnya.... Keterlibatan Anggota TNI aktif maupun baru mengundurkan diri untk menjadi kepala daerah	positif
04/01/2018		positif

Fig. 2. Labeling

C. Preprocessing

After collecting and labeling the data, the next step is to pre-process the data. As can be seen in Figure 3, the preprocessing consists of several processes from Cleansing to Weighting word. The sub Operators of the Document Process Operator can be seen in Fig. 4.

- Cleansing is the step to remove duplicate data, URLs and symbols, numbers, and punctuation that are not needed from text such as exclamation marks, question marks, quotation marks, and so forth. For example: “Sebuah Program televisi ‘Kriminal’,tidak dicocokan untuk anak! www.kriminalberita.com” becomes “Sebuah Program televisi Kriminal tidak dicocokan untuk anak”.
- Case folding is a step to make a sentence into uppercase or lowercase letters. In this study, all letters are changed to be small to facilitate the next process”. For example: “Sebuah Program televisi Kriminal tidak dicocokan untuk anak” becomes “sebuah program televisi kriminal tidak dicocokan untuk anak”.

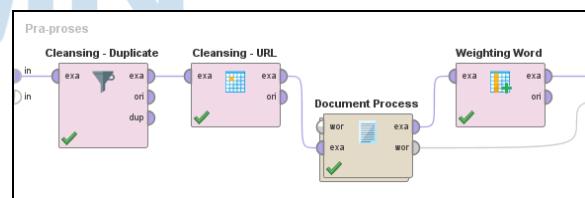


Fig. 3. Data preprocessing operators

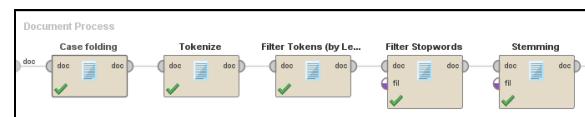


Fig. 4. Sub operators of the document process operator

- Tokenization is a step to break or cut a sentence or document into several parts or words called tokens. There are three types of tokens, namely unigram, bigram, and trigram [8]. In this research, the type of token used is

unigram, which is the breakdown of documents into one word. For example: "sebuah program televisi kriminal tidak dicocokan untuk anak" becomes "sebuah, program, televisi, kriminal, tidak, dicocokan, untuk, anak".

- Filtering is a step to eliminate words that often appear, but are not needed or do not have meaning. Words that appear in large numbers and are considered to have no meaning are called stopwords. For example: "sebuah, program, televisi, kriminal, tidak, dicocokan, untuk, anak" becomes "program, televisi, kriminal, tidak, dicocokan, anak".
- Stemming is a step to make all words that have an affix or suffix into basic words by the correct Indonesian rules. Stemming is done by removing each prefix and suffix in the word prefix or suffix. For example: "program, televisi, kriminal, tidak, dicocokan, anak" becomes "program, televisi, kriminal, tidak, cocok, anak".
- Weighting word is the final step from data preprocessing to calculate a score or a value on the frequency of the occurrence of words in a document or text. One method for weighting words is term frequency-inverse document frequency (TF-IDF). TF-IDF refers to a weighting method that unites two concepts, namely Term Frequency, and Document Frequency. The term frequency is a concept in which weighting is applied by finding the frequency or frequency of a term occurring in a document or text. Each document or text usually has a different length, so a word may appear more in a long document or text compared to a short document or text. So term frequency is usually divided by the length of the document or the number of words in the document. Document frequency is the number of documents or text in which a word appears. The lower the frequency of occurrence, the lower the value. In calculating the Frequency of the term, all words in it are usually considered important or significant. Therefore, it is very necessary to calculate TF-IDF, where scores can be obtained using an equation [9].

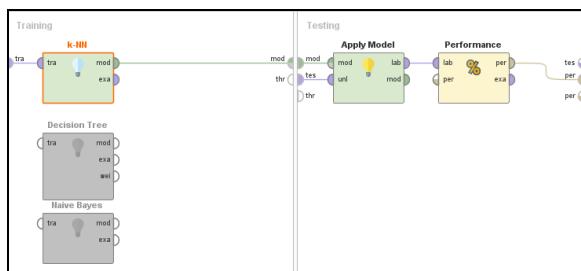


Fig. 5. Cross-validation operator

D. Classification

Sentiment classification is the step in which all pre-processed data will be further processed with a classification algorithm. This study using three classification algorithms, namely Decision Tree, K-Nearest Neighbor, and Naïve Bayes Classifier.

Fig. 5 shows a sentiment classification operator. In this sentiment classification operator, there are several sub-operators and sub-sub-operators. The sub operator there are 2 namely Cross-Validation and Apply Model (2). In Cross-Validation, there are 5 sub-sub-operators which are divided into 2 parts, training and testing. The part that includes training is the method or algorithm, namely K-NN, Decision Tree, and Naïve Bayes. The parts that include testing are Apply Model and Performance.

The use of K-NN in the illustration Fig. 6 where there are two classes, namely circles and triangles. But there is new data that is not yet known which class is marked with a red square shape. To find out the class of a square, we need the rule to determine the class [4]. In this example, $K = 3$. The value of $K = 3$ means that the class is classified according to the 3 closest members of its neighbor. Based on the value of $K = 3$, there are 2 classes of circles and 1 class of triangles. So the circle value is greater than the triangle and square data can be classified into circle classes.

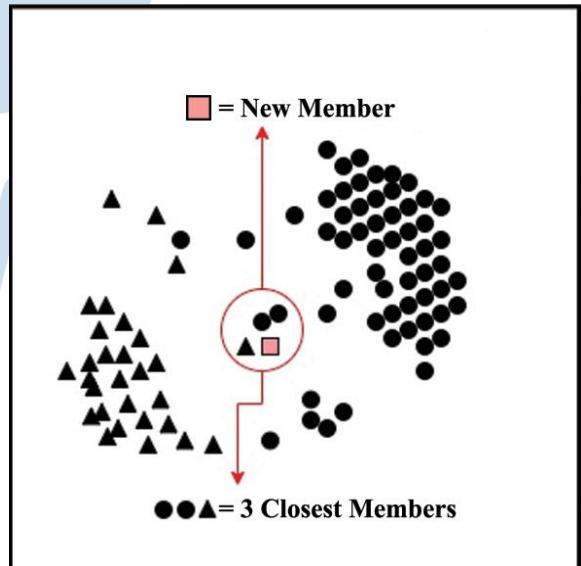


Fig. 6. K-Nearest Neighbor method [4]

As a method known for using conditional probabilities or opportunities, the Naïve Bayes Classifier is formulated as follows [4].

$$P(H|X) = \frac{P(X|H)P(H)}{P(X)} \quad (1)$$

Equation 1 is where X is the proof or data while H is the hypothesis. $P(H | X)$ is the probability that the hypothesis H is true for proof X . $P(X | H)$ is the probability for proof X is true for hypothesis H . $P(H)$ is the probability that the hypothesis H was true for each object the data does not care about the values of its attributes, while $P(X)$ is the previous probability for the data object X .

Decision Tree is a hierarchical model in which local areas are identified as a series of recursive separations by decision nodes in the test function. Decisions in the decision tree are most used by logical methods. In Fig. 7, the Decision Tree is a tree-shaped flowchart structure, in which each internal node (not a leaf node) tests an attribute, each branch represents the test result, and each leaf node (or terminal node) indicates the class label. While the node at the top of the decision tree is the root node.

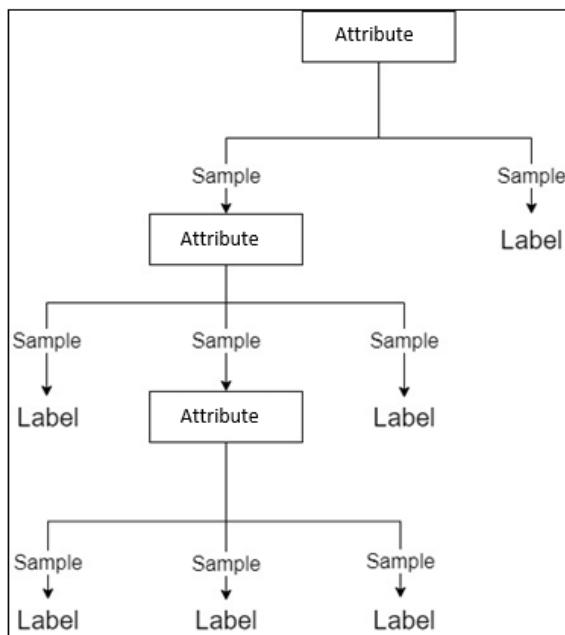


Fig. 7. Decision tree [4]

III. RESULTS

This section is an explanation of the results of the analysis process that has been done.

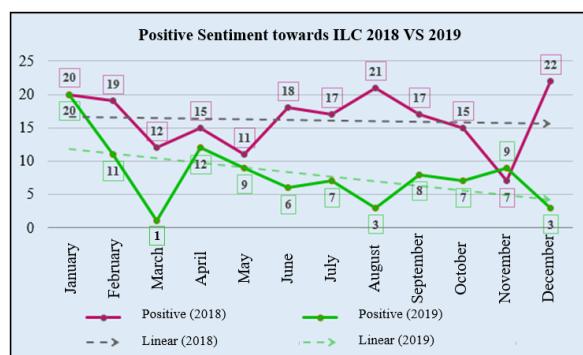


Fig. 8. Comparison of sentiments towards ILC in 2018 and 2019

A. Manual Analysis

A comparison of positive sentiment in ILC in 2018 and 2019 can be seen in Fig. 8. The trend shows a quite large difference between the number of positive sentiments in 2018 and 2019. It also shows that there was a decline in 2018, however, in 2019 there was even more decline, especially in March 2019 where the positive sentiment results fell to 1 in 30 tweets. As shown in Table I, the total positive sentiment of the ILC in 2018 was 194, while in 2019 it was 96. The total negative sentiment of ILC in 2018 was 166 while in 2019 it was 264. A decrease in the number of positive sentiments with a difference of 98 sentiments followed by an increase in negative sentiment with the same difference.

TABLE I. SENTIMENT TOWARDS ILC

Month	Positive		Negative	
	2018	2019	2018	2019
January	20	20	10	10
February	19	11	11	19
March	12	1	18	29
April	15	12	15	18
May	11	9	19	21
June	18	6	12	24
July	17	7	13	23
August	21	3	9	27
September	17	8	13	22
October	15	7	15	23
November	7	9	23	21
December	22	3	8	27
Total	194	96	166	264

A comparison of Mata Najwa's positive sentiment in 2018 and 2019 can be seen in Figure 9. The trend line shows a slight difference between the number of positive sentiments in 2018 and 2019. It also shows a slight increase in 2018, but it happened a decline although not very significant in 2019. As shown in Table II, the total positive sentiment of Mata Najwa in 2018 was 215 while in 2019 it was 227. The total negative sentiment of Mata Najwa in 2018 was 155 while in 2019 it was 133. An increase in the number of sentiments positive with a difference of 12 sentiments followed by a decrease in negative sentiment by the same difference.

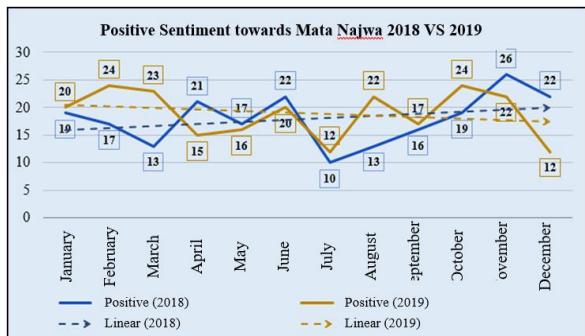


Fig. 9. Comparison of sentiments towards Mata Najwa in 2018 and 2019

Fig. 10. Comparison of positive sentiments towards ILC and Mata Najwa in 2018

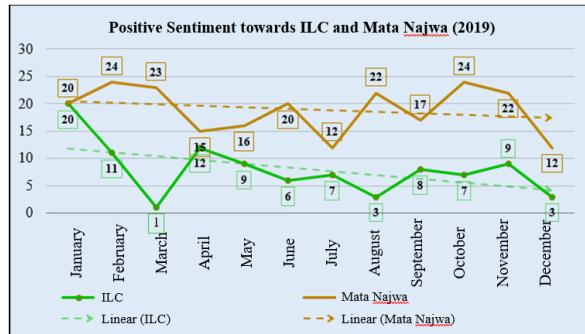
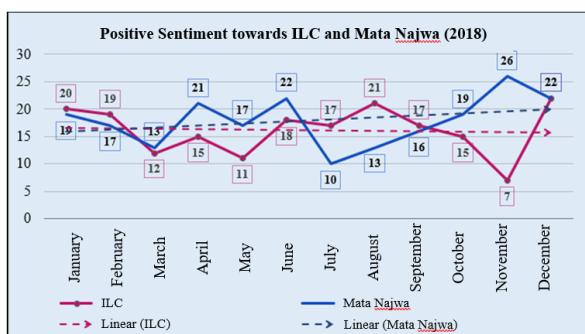


Fig. 11. Comparison of positive sentiments towards ILC and Mata Najwa in 2019

TABLE II. SENTIMENTS TOWARDS MATA NAJWA

Month	Positive		Negative	
	2018	2019	2018	2019
January	19	20	11	10
February	17	24	13	6
March	13	23	17	7
April	21	15	9	15
May	17	16	13	14
June	22	20	18	10
July	10	12	20	18
August	13	22	17	8
September	16	17	14	13
October	19	24	11	6
November	26	22	4	8
December	22	12	8	18
Total	215	227	155	133

Comparison between ILC and Mata Najwa in each year can be seen in Fig. 10 and Fig. 11. In 2018, the ILC trend line tends to decrease while Mata Najwa tends to go up. However, the difference is still not that big compared to 2019, where the trend line on the ILC is far below Mata Najwa and also tends to fall, while Mata Najwa is far above and tends to go up. In 2019, ILC suffered defeat and was defeated by Mata Najwa.



12/03/2019 wah tv one udah keliatan jd pengecut ini gegara sering disebut tv Pendukung no u negatif
12/03/2019 Kecewi juga, ILC tidak ada bung Rocky. Apa tidak diperbolehan tampil di ILC? negatif
12/03/2019 @ILCtv1 jika kau teruskan gayamu 2 minggu terakhir,maka kau akan di tinggalkan da negatif
12/03/2019 @ILCtv1 akan jadi sejarah utk mengenang sepak terjang datuk @karnilayis , sekara negatif
12/03/2019 tanda2 @ILCtv1 akan ditinggalkan penggemarnya... negatif
12/03/2019 sudahhh gak menarik lagi .. negatif
12/03/2019 ILC akhir akhir ini kurang greget. Why? negatif
18/03/2019 Lama gw juga muak ma ILC negatif
20/03/2019 Karin dah ga netral lagi, kalo saya sih sdh malas nonton.
20/03/2019 ILC, yg awalnya diisi oleh para lawyer handal, setidaknya olh org2 yg paham hukum, negatif
20/03/2019 Betul..@ILCtv1 hanya dijadikan tempat utk menghina dan menghujat org2 yg bers negatif
20/03/2019 Setuju .jgn nonton tv one negatif
21/03/2019 Setuju banget! Sudah gak ada nilai lawyer nya sama sekali! negatif
21/03/2019 Saat ini ILC lebih cocok jadi IPC (indonesian politician club).Dulu ilc banyak memb negatif
21/03/2019 Paling ogah nonton ILC sekarang.
21/03/2019 Dengerin bang karni ngos ngos aja udah males negatif
21/03/2019 menurut saya mungkin @ILCtv1 bisa dibubarkan saja deh... negatif
24/03/2019 ILC tanpa Rocky Gerung seperti sayur tanpa garam negatif

Fig. 12. Data set on March 2019

Topik ILC TVOne Selasa 19 Maret 2019 Dinilai Tak Adil, Warganet Minta Revisi dan Rindu Rocky Gerung

Fig. 13. News about citizens asking for revisions to the topic of ILC and the presence of Rocky Gerung [10]



Fig. 14. News about the reason Rocky Gerung is no longer present at ILC [11]

In March 2019, the positive sentiment towards ILC decreased to one sentiment. After further analysis, it turns out that in the March 2019 crawl text, there is a reason why sentiment has declined dramatically which can be seen in Fig. 12. It occurs since the disappointment with ILC because one of its sources, Rocky Gerung was not presented which is highlighted in yellow. Fig. 13 contains contra the community against the topic of the ILC discussion and asked to be revised, and also their longing for Rocky Gerung, while Fig. 14 contains the reason Rocky Gerung is no longer present in the ILC.

As a result of this manual analysis, public opinion on Twitter can be applied to explain the Panasonic Gobel Award Winner between ILC and Mata Najwa. In 2018, ILC outperforms Mata Najwa. This is matched with the public opinion result. ILC is above Mata Najwa before October 2018. Afterward, more positive opinions for Mata Najwa in 2019, and Mata Najwa comes as the winner this year.

B. Analysis Using Rapidminer

The analysis using RapidMiner is applied to validate the manual labeling results by predicting them using several algorithms. This analysis is performed by using algorithms and operators in RapidMiner. The main operators can be seen in Fig. 15. The analysis process is done by retrieving data from Twitter and then processed using a series of operators created in the RapidMiner application. The series starts from the Read Dataset Training which continues to the Preprocessing until Sentiment Classification.

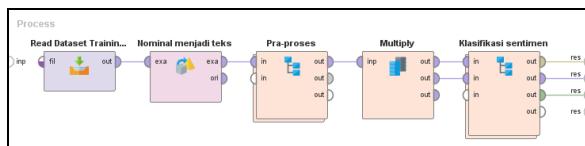


Fig. 15. Main operators

sentimen	prediction...	text	timestamp	adem	adil
positif	negatif	senyum geleng den semoga undang ilctvone	Jan 2, 2018	0	0
negatif	negatif	mas kasian ilc badut	Jan 2, 2018	0	0
negatif	negatif	pribumi anti fpi allahuakbar	Jan 4, 2018	0	0

Fig. 16. Prediction results

Fig. 16 shows the results of the RapidMiner process in which the classification carried out using the algorithm method produces predictions which if positive sentiment and positive prediction will become True Positive and vice versa for negative sentiment.

TABLE III. CONFUSION MATRIX ILC 2018

Methods	True Positive	False Positive	True Negative	False Negative
Decision Tree	186	8	22	144
Naïve Bayes	118	76	123	43
k-NN (k=7)	149	45	82	84

TABLE IV. CONFUSION MATRIX ILC 2019

Methods	True Positive	False Positive	True Negative	False Negative
Decision Tree	20	76	255	9
Naïve Bayes	58	38	195	69
k-NN (k=9)	25	71	252	12

Tables III and IV contain data in the form of the number of positive and negative sentiments of ILC in 2018 and 2019 using the three algorithms. Positive sentiments consist of true positives and false positives, while negative sentiments consist of true negatives and false negatives. The number of true positives in 2018 is more than in 2019.

Whilst, the comparison of Mata Najwa's positive sentiment in 2018 and 2019 can be seen in Table V and VI. By using the three algorithms, it can be stated that the number of True Positive in 2019 is more than in 2019.

TABLE V. CONFUSION MATRIX MATA NAJWA 2018

Methods	True Positive	False Positive	True Negative	False Negative
Decision Tree	196	5	27	132
Naïve Bayes	157	44	95	64
k-NN (k=13)	159	42	80	79

TABLE VI. CONFUSION MATRIX MATA NAJWA 2019

Methods	True Positive	False Positive	True Negative	False Negative
Decision Tree	222	5	12	121
Naïve Bayes	151	76	86	47
k-NN (k=3)	182	45	77	56

TABLE VII. ACCURACY OF ALGORITHMS METHODS

Methods	2018		2019	
	ILC	Mata Najwa	ILC	Mata Najwa
Naïve Bayes	66.94%	70.00%	76.39%	65.83%
k-NN	64.17%	66.39%	76.94%	71.94%
Decision Tree	57.78%	61.94%	70.28%	65.00%

As shown in Table VII, in 2018, Naïve Bayes was the best algorithm, while in 2019, K-NN was the best algorithm. This means that no algorithm is always at the top. All algorithms are used based on data content and the level of accuracy of certain data is always changing. In 2018, the performance of both Mata Najwa and ILC is fluctuated, as a result, K-NN finds more difficulties to find the nearest neighbor. In such a situation, the conditional probability capability of Naïve Bayes performs better. While in 2019, the public opinion of Mata Najwa is clearly above the ILC. So K-NN can easily separate them into the nearest neighbor. The best accuracy is found on the ILC in 2019 by using K-NN because its public positive opinion in 2018 is above in 2019. So that K-NN can separate them easier to the nearest neighbor.

IV. CONCLUSION

The public opinion on Twitter can be successfully applied to confirm the winner of the Panasonic Gobel Award. As a result of manual analysis, ILC wins in 2018. The number of the positive sentiment of ILC is slightly better than Mata Najwa. But ILC lost in 2019 because its number of positive sentiments is declined whilst Mata Najwa is obviously above ILC. In addition, from 2018 to 2019, the number of positive sentiment for ILC is dramatically decreased, whilst Mata Najwa fluctuated.

Three Algorithms are applied to validate manual labeling results with the highest accuracy is 76.94% by using K-NN. However, no one algorithm shows the best performance on all data. In 2018, Naïve Bayes was the best algorithm, while in 2019, K-NN was the best algorithm.

ACKNOWLEDGMENT

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Cyberbullying Sentiment Analysis with Word2Vec and One-Against-All Support Vector Machine

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Abstract—Depression and social anxiety are the two main negative impacts of cyberbullying. Unfortunately, a survey conducted by UNICEF on 3rd September 2019 showed that 1 in 3 young people in 30 countries had been victims of cyberbullying. Sentiment analysis research will be conducted to detect a comment that contains cyberbullying. Dataset of cyberbullying is obtained from the Kaggle website, named, Toxic Comment Classification Challenge. The pre-processing process consists of 4 stages, namely comment generalization (convert text into lowercase and remove punctuation), tokenization, stop words removal, and lemmatization. Word Embedding will be used to conduct sentiment analysis by implementing Word2Vec. After that, One-Against-All (OAA) method with the Support Vector Machine (SVM) model will be used to make predictions in the form of multi labelling. The SVM model will go through a hyperparameter tuning process using Randomized Search CV. Then, evaluation will be carried out using Micro Averaged F1 Score to assess the prediction accuracy and Hamming Loss to assess the numbers of pairs of sample and label that are incorrectly classified. Implementation result of Word2Vec and OAA SVM model provide the best result for the data undergoing the process of pre-processing using comment generalization, tokenization, stop words removal, and lemmatization which is stored into 100 features in Word2Vec model. Micro Averaged F1 and Hamming Loss percentage that is produced by the tuned model is 83,40% and 15,13% respectively.

Index Terms—One-Against-All; multi labelling; sentiment analysis; Toxic Comment Classification Challenge; Word2Vec; word embedding

I. INTRODUCTION

Cyberbullying refers to bullying that uses electronic technology such as smartphones and the internet. A victim of cyberbullying may increase the risk of low self-esteem [1]. Low self-esteem can cause anxiety and depression [2]. These impacts are supported by the statistics provided by Broadband Search regarding mental health that comes from cyberbullying that depression and social anxiety are in the top 2 ranks [3]. Unfortunately, 1 out of 3 young people in 30 countries has been a victim

of cyberbullying [4].

To prevent cyberbullying from happening, detection will be needed. This detection can be achieved by NLP technique which focuses on the interactions between computers and human (natural) languages to do text processing [5]. One of them is sentiment analysis with its ultimate task is to do emotion identification [6]. Sentiment analysis will be used by implementing the Word Embedding approach. This approach will represent words into a vector space and will be achieved by using Word2Vec with Continuous Bag-of-Words (CBoW) model architecture. This model will take words as input and generate vectors as outputs. By using Word2Vec, semantic relationships between words in a sentence can also be found [7]. Thus, Word2Vec has a great role in performing sentiment analysis.

Detection of cyberbullying will be done by using sentiment analysis from Word2Vec and implementing Multi-label Classification. There will be six classes that will be used, namely toxic, severe toxic, obscene, threat, insult, and identity hate. Support Vector Machine (SVM) model will be used to do classification as it is performed better in text processing [8]. Then, One-Against-All (OAA) strategy will be used to be able to implement Multi-label Classification on the SVM.

II. LITERATURE REVIEW

A. Pre-processing

Pre-processing is an important step to transform text into a better form with the intention of preparing text for the next step. Pre-processing steps includes [9]:

- Converting all letters to lower case
- Removing stop words
- Removing punctuations
- Converting text into its root forms (lemmatization)

- Splitting the text into smaller pieces (tokenization)

B. Word Embedding

Word embeddings are type of word representation in a form of a vector. This approach is widely used in the case of Information Retrieval (IR) and Natural Language Processing (NLP) because of its ability to capture semantic and syntactic information from a word, so that words containing similar meanings can be measured [10].

C. Word2Vec

Word2Vec is one of the models used to implement Word Embedding. This model gets input from a collection of texts and generates a vector of the words. This vector can be used to find the proximity of each word in the vector space [11]. Thus, this model can check all the representation that has been learned and displays the closest word [12], as shown in Table I.

TABLE I. WORD COSINE DISTANCE

Word	Distance
spain	0.678515
belgium	0.665923
netherlands	0.652428
italy	0.633130
switzerland	0.622323
luxembourg	0.610033
portugal	0.577154
russia	0.571507
germany	0.563291
catalonia	0.534176

D. Continuous Bag-of-Words(CBoW)

CBoW is Word2Vec model architectures to create word embedding. The function of this model architecture is to predict a word based on the surrounding words [13]. The network model of CBoW is shown in Fig. 1.

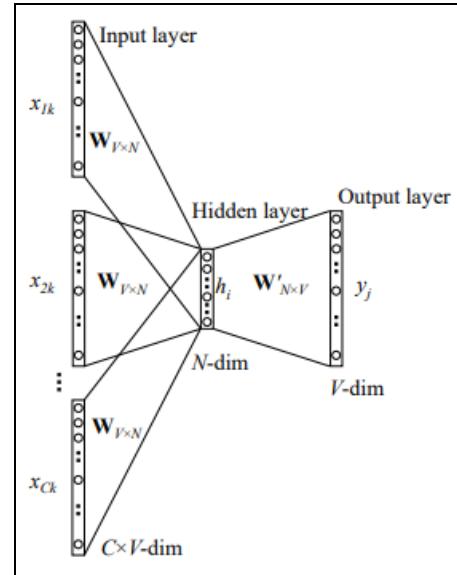


Fig. 1. CBoW model architecture

E. Support Vector Machine (SVM)

Support vector machine (SVM) was introduced by Vapnik. The objective of this algorithm is to classify data points by using hyperplane or separator function between classes [14]. There are four hyperparameters used in this algorithm, such as:

- Kernel

This parameter will affect the type of hyperplane that will be used to separate the data. The Linear kernel will use a linear hyperplane (straight lines as in 2-dimensional space). The Radial Basis Function (RBF) and Polynomial kernels will use a non-linear hyperplane. An illustration of the kernel can be seen in Fig. 2 [15].

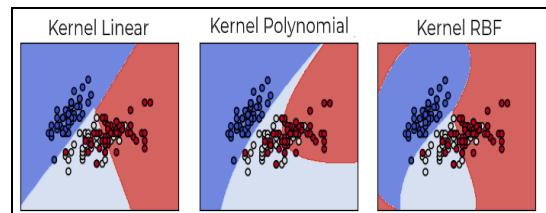


Fig. 2. Illustrations of Linear Kernel (left), Polynomial Kernel (center), RBF Kernel (right)

- Regularization Parameter

This parameter affects the margin maximization value. The smaller the value, the larger the margin that can be formed. On the other hand, the larger the value, the smaller the margin that will be formed [15].

- Degree

Degree is a parameter that will affect the flexibility of the hyperplane that is formed. The larger the value, the more flexible the boundary will be [16], as shown in Fig. 3.

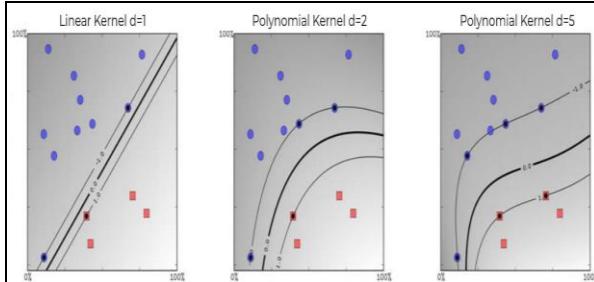


Fig. 3. Illustrations of the differences of degree values

- Gamma

Gamma determines how big and how far the influence of the training data sample is. If the value is small, then the result is far apart. The result of using different gamma values is shown in Fig. 4 [15].

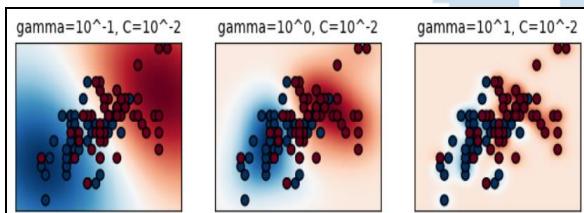


Fig. 4. Illustrations of the differences of gamma values

F. One-Against-All (OAA)

One-Against-All is a strategy to train samples to each available class. By doing this, a sample can obtain a binary value for each class and it can be known whether a class is part of the sample or not. OAA has higher accuracy value than One-Against-One and is more suitable for relatively small number of labels [17].

G. Micro Averaged F1 Score

Micro Average F1 Score (Micro-f1) is a method to get the average of F1 score values. The Micro-f1 will be calculated as follows [18]:

$$F1_{micro} = \frac{2 \cdot Precision_{micro} \cdot Recall_{micro}}{Precision_{micro} + Recall_{micro}} \quad (1)$$

The $Precision_{micro}$ is the precision value calculated using micro averaged approach formulated as follows:

$$Precision_{micro} = \frac{\sum_{k \in C} TP_k}{\sum_{k \neq c} TP_k + FP_k} \quad (2)$$

And The $Recall_{micro}$ is the recall value calculated using micro averaged approach formulated as follows:

$$Recall_{micro} = \frac{\sum_{k \in C} TP_k}{\sum_{k \neq c} TP_k + FN_k} \quad (3)$$

The value of C is the total class that is available. The value of TP_k is the number of true positives in class k. The value of FP_k is the number of false positives in class k. The value of FN_k is the number of false negatives in class k.

H. Hamming Loss

Hamming Loss is a metric specifically designed for multi-class (also called multi label) learning [19]. This metric is used to calculate how many misclassified pairs of sample and label. The range of values generated by the Hamming Loss metric is between 0 to 1 or 0 to 100 in percentage.

Smaller value of this metric means better the classification model that has been created. The calculation is carried out using the following equation [20].

$$Hamming\ Loss(h, D) = \frac{1}{|D|} \sum_{i=1}^{|D|} \frac{|y_i \Delta z_i|}{|L|} \quad (4)$$

III. METHOD

A. Dataset

The dataset that will be used is the Toxic Comment Classification Challenge, available on the Kaggle Page [21]. This dataset is collected from Wikipedia page and has a focus to learn the negative behavior of online chatting. There are around 150.000 records for training data that is provided by this dataset. The dataset is divided into 6 classes, namely toxic, severe toxic, obscene, threat, insult, and identity hate. Fig. 5 shows the first two data in the dataset.

	id	comment_text	toxic	severe_toxic	obscene	threat	insult	identity_hate	none
0	0000997932d77bf	Explanation in Why the edits made under my user...	0	0	0	0	0	0	1
1	0001030d9cb60f	D'aww! He matches this background colour I'm s...	0	0	0	0	0	0	1

Fig. 5. The first two data in the dataset

B. System Overview

The dataset file is in CSV format and will be retrieved in the first process. After retrieving dataset, it will go through pre-processing step. This step includes:

- Generalization, which is the process of converting text into lowercase and removes punctuation.
- Tokenization, which is the process to break a

text into the smallest form without losing its meaning.

- Stopwords Removal, which is the process to omit very common words to give more accurate result, such as ‘the’, ‘a’, ‘an’, ‘in’, etc.
- Lemmatization, which is the process to change word into its root forms, for example, words ‘liked’, ‘liking’, ‘and ‘likes’ will be change to ‘like’.

After pre-processing, the dataset is trained to the Word2Vec model. We use CBoW model architecture since this model architecture is faster and considered as the best approach for the use of words that are not unique.

After the process is done, we generalize the data distribution to avoid overfitting. After that, the generalized data will be prepared to be used by SVM. When the data is prepared, it will first pass through Hyperparameter Tuning and the best parameters from this process are used to predict. Finally, the prediction results will be evaluated using Micro Averaged F1 Score and Hamming Loss. Fig. 6 shows the system main flowchart.

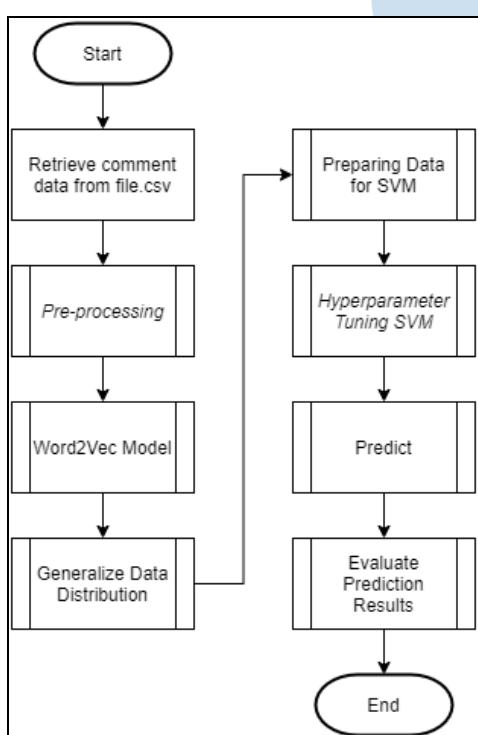


Fig. 6. Main flowchart

IV. RESULTS AND DISCUSSION

The experiment is performed with Google Colaboratory and Python version 3. We conducted 4 types of pre-processing as follows.

- Words with stop words

- Words without stop words
- Lemmatized words with stop words
- Lemmatized words without stop words

After pre-processing, each type is trained to the Word2Vec model twice, the first one is using 50 features and the second one is using 100 features. Eight types of Word2Vec models that will be generated are as follows.

- Words with stop words + 50 features
- Words with stop words + 100 features
- Words without stop words + 50 features
- Words without stop words + 100 features
- Lemmatized words with stopwords + 50 features
- Lemmatized words with stopwords + 100 features
- Lemmatized words without stopwords + 50 Features
- Lemmatized words without stopwords + 100 Features

We divided the data so that 70% of the data is for learning and 30% of the data is for testing. Before the training begin, we generalized the data distribution to avoid overfitting. The training data that have been prepared will be used to tune the OAA SVM model. The tuning process will look for the best combination of 3 types of parameters. The three types of parameters are as follows.

- Regularization [0.001, 0.01, 0.1, 1, 10, 100, 1000]
- Kernel ['linear', 'rbf', poly']
- Degree [3,4,5]

After the tuning process, it is found that the best parameter configuration as follows.

- Regularization = 1
- Kernel = RBF
- Degree = 3

Table II shows precision, recall, micro average, micro f1, and Hamming Loss of the model with stop words and 50 features. From 650 testing data, the micro-f1 percentage is 80,77% and Hamming Loss percentage is 17,85%.

TABLE II. PERFORMANCE OF MODEL WITH STOP WORDS + 50 FEATURES

Category	Precision	Recall
Identity Hate	0.74	0.78

Insult	0.75	0.86
Obscene	0.84	0.84
Severe Toxic	0.62	0.79
Threat	0.62	0.81
Toxic	0.95	0.90
Micro Average	0.78	0.84
Micro f1	0.8077	
Hamming Loss	0.1785	

Table III shows precision, recall, micro average, micro f1, and Hamming Loss of the model with stop words and 100 features. From 650 testing data, the micro-f1 percentage is 81,29% and Hamming Loss percentage is 17,05%.

TABLE III. PERFORMANCE OF MODEL WITH STOP WORDS + 100 FEATURES

Category	Precision	Recall
Identity Hate	0.80	0.78
Insult	0.74	0.86
Obscene	0.84	0.81
Severe Toxic	0.64	0.76
Threat	0.66	0.81
Toxic	0.95	0.90
Micro Average	0.80	0.83
Micro f1	0.8129	
Hamming Loss	0.1705	

Table IV shows precision, recall, micro average, micro f1, and Hamming Loss of the model without stop words and 50 features. From 650 testing data, the micro-f1 percentage is 82,23% and Hamming Loss percentage is 16,23%.

TABLE IV. PERFORMANCE OF MODEL WITHOUT STOP WORDS + 50 FEATURES

Category	Precision	Recall
Identity Hate	0.81	0.81
Insult	0.75	0.83
Obscene	0.87	0.86
Severe Toxic	0.66	0.80
Threat	0.64	0.81
Toxic	0.95	0.88
Micro Average	0.80	0.84
Micro f1	0.8223	
Hamming Loss	0.1623	

Table V shows precision, recall, micro average, micro f1, and Hamming Loss of the model without stop words and 100 features. From 650 testing data, the micro-f1 percentage is 82,90% and Hamming Loss percentage is 15,51%.

TABLE V. PERFORMANCE OF MODEL WITHOUT STOP WORDS + 100 WORD2VEC FEATURES

Category	Precision	Recall
Identity Hate	0.81	0.81
Insult	0.75	0.82
Obscene	0.88	0.86
Severe Toxic	0.68	0.80
Threat	0.68	0.82
Toxic	0.95	0.89
Micro Average	0.82	0.84
Micro f1	0.8290	
Hamming Loss	0.1551	

Table VI shows precision, recall, micro average, micro f1, and Hamming Loss of the model with lemmatized words, stop words and 50 features. From 650 testing data, the micro-f1 percentage is 80,73% and Hamming Loss percentage is 17,74%.

TABLE VI. PERFORMANCE OF MODEL WITH LEMMATIZED WORDS + STOP WORDS + 50 FEATURES

Category	Precision	Recall
Identity Hate	0.76	0.76
Insult	0.73	0.85
Obscene	0.82	0.82
Severe Toxic	0.64	0.80
Threat	0.65	0.82
Toxic	0.95	0.89
Micro Average	0.78	0.83
Micro f1	0.8073	
Hamming Loss	0.1774	

Table VII shows precision, recall, micro average, micro f1, and Hamming Loss of the model with lemmatized words, stop words and 100 features. From 650 testing data, the micro-f1 percentage is 81,92% and Hamming Loss percentage is 16,45%.

TABLE VII. PERFORMANCE OF MODEL WITH LEMMATIZED WORDS + STOP WORDS + 100 FEATURES

Category	Precision	Recall
Identity Hate	0.79	0.79
Insult	0.76	0.86
Obscene	0.84	0.82
Severe Toxic	0.65	0.77
Threat	0.69	0.80
Toxic	0.95	0.90
Micro Average	0.80	0.84
Micro f1	0.8192	
Hamming Loss	0.1645	

Table VIII shows precision, recall, micro average, micro f1, and Hamming Loss of the model with lemmatized words, without stop words and 50

features. From 650 testing data, the micro-f1 percentage is 82,29% and Hamming Loss percentage is 16,28%.

TABLE VIII. PERFORMANCE OF MODEL WITH LEMMATIZED WORDS WITHOUT STOP WORDS + 50 FEATURES

Category	Precision	Recall
Identity Hate	0.79	0.79
Insult	0.75	0.84
Obscene	0.86	0.87
Severe Toxic	0.66	0.82
Threat	0.65	0.82
Toxic	0.95	0.89
Micro Average	0.80	0.85
Micro f1	0.8229	
Hamming Loss	0.1628	

Table IX shows precision, recall, micro average, micro f1, and Hamming Loss of the model with lemmatized words, without stop words and 100 features. From 650 testing data, the micro-f1 percentage is 83,40% and Hamming Loss percentage is 15,13%.

TABLE IX. PERFORMANCE OF MODEL WITH LEMMATIZED WORDS WITHOUT STOP WORDS + 100 FEATURES

Category	Precision	Recall
Identity Hate	0.81	0.83
Insult	0.76	0.82
Obscene	0.88	0.86
Severe Toxic	0.68	0.82
Threat	0.67	0.81
Toxic	0.96	0.90
Micro Average	0.82	0.85
Micro f1	0.8340	
Hamming Loss	0.1513	

Table X shows the overall performance for each classifier model. Micro-f1 metric requires high value to be considered as a good model and Hamming Loss metric requires low values to be considered as a good model. Table X also shows that the model which goes through lemmatization, without stop words, and with 100 features is the best model in this experiment. The Micro-f1 percentage is 83,40% and Hamming Loss percentage is 15,13%.

TABLE X. OVERALL PERFORMANCE FOR EACH MODEL

Model	Micro-f1	Hamming Loss
With Stopwords + 50 features	80.77%	17.85%
With Stopwords + 100 features	81.29%	17.05%
Without Stopwords + 50 features	82.23%	16.23%
Without Stopwords + 100 features	82.90%	15.51%

Lemmatize + With Stopwords + 50 features	80.73%	17.74%
Lemmatize + With Stopwords + 100 features	81.92%	16.45%
Lemmatize + Without Stopwords + 50 features	82.29%	16.28%
Lemmatize + Without Stopwords + 100 features	83.40%	15.13%

After getting the values of Micro-f1 and Hamming Loss from each model, we chose the best model for the prediction using OAA SVM. Fig. 7 shows predicting process to evaluate whether the comments “Your brain is now working, you are so idiot!” contain cyberbullying or not.

```
comment = "Your brain is not working, you are so idiot!"
predict(comment)
```

Fig. 7. Predicting process

Fig. 8 shows the result of the pre-processing stage for generalization. In this process, there was a word conversion into lowercase and punctuation removal.

```
Preprocessing Phase 1 - Generalize Sentence:
your brain is not fucking working you are so idiot
```

Fig. 8. Generalization results

The result of the pre-processing stage for stop words removal is shown in Fig. 9. Common words are removed in this process, such as “your”, “is”, “not”, “you”, “are”, and “so”.

```
Preprocessing Phase 2 - Stopwords Removal:
['brain', 'fucking', 'working', 'idiot']
```

Fig. 9. Stop Words Removal Results

Fig. 10 shows the result of the pre-processing stage for lemmatization. Words are changed into its root forms.

```
Preprocessing Phase 3 - Lemmatize:
['brain', 'fuck', 'work', 'idiot']
```

Fig. 10. Lemmatization results

After the pre-processing stage, data preparation is performed to be used by the SVM model as shown in Fig. 11. This preparation will average all words from the context, making it exactly has 100 features.

```
Preparing Vector:
[[ 0.02240257 -0.00429264 -0.02547644 -0.02865745  0.01357894  0.02596491
-0.02817285  0.07908064  0.09677246  0.0656467  0.0135063 -0.11998299
0.01815119 -0.03160822  0.0610728 -0.06916609  0.03945785 -0.0081053
0.07160521 -0.01934485  0.01515664  0.08639322  0.03117311  0.00424128
-0.12907142  0.03300603 -0.10104456  0.00902278  0.14088548 -0.01158431
0.03288348  0.01598303 -0.06828469  0.1146581 -0.05428487  0.02119448
0.03820391  0.02697186 -0.02877118 -0.03967395 -0.0922182  0.01495544
0.02936358  0.07023284  0.0025290 -0.02271912 -0.00355084 -0.00507396
0.06212217  0.0324675 -0.03788377  0.01868856  0.01139327 -0.00877795
-0.03900629 -0.0017574 -0.05821458  0.06357033 -0.03845195  0.03959218
-0.01189519  0.00401462 -0.03818751  0.04595883  0.00798893 -0.10733551
-0.07774414 -0.05510152 -0.06148012 -0.018995 -0.03778869 -0.06097493
0.05133448  0.06269939 -0.00704147 -0.00250102 -0.049388 -0.07832998
0.03169693 -0.03824546  0.02795014  0.04778979  0.22009029  0.0208241
0.06807572 -0.07214178  0.03511916  0.10855071 -0.13714732 -0.11155756
0.0318217 -0.09968748  0.00482078  0.05594885  0.03894299 -0.05364824
0.03679092  0.08053967 -0.01489202 -0.02382686]]
```

Fig. 11. Averaged vectors

Fig. 12 shows the result of the prediction probability values. This probability can be used if there is a need to create own threshold.

```
identity_hate: 0.11511408831741254
insult: 0.7074889659516207
obscene: 0.5496630405056658
severe_toxic: 0.3032125286486208
threat: 0.19702725030463242
toxic: 0.8981090775753815
```

Fig. 12. Prediction probability values

Fig. 13 shows the result of prediction in text value. From this result, it can be concluded that the sentence “Your brain is not working, you are so idiot!” contains cyberbullying in the form of insult, obscene, and toxic.

```
identity_hate: No
insult: Yes
obscene: Yes
severe_toxic: No
threat: No
toxic: Yes
```

Fig. 13. Prediction result in text

V. CONCLUSION AND FUTURE WORK

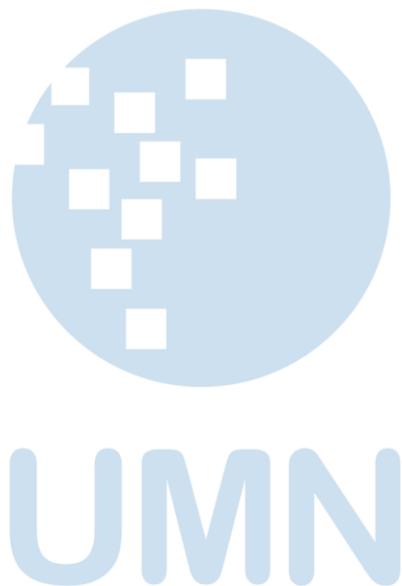
Based on the research that has been conducted, it can be concluded that the Word2Vec and OAA SVM methods can be implemented to carry out cyberbullying sentiment analysis. The most optimal model based on hyperparameter tuning is by using pre-processed words (lemmatized and without stop words) and 100 features in the Word2Vec model. Then, using Regularization value by 1, RBF Kernel, and Degree value by 3 in the OAA SVM model. Micro Averaged F1 and Hamming Loss percentage that is product by this tuned model is 83,40% and 15,13% respectively.

Since the prediction model that is used is still classifying labels independently, there is no relation between one label with another. The final result still in the form of a model. Therefore, a classifier model that can also determine the relationship between labels like Classifier Chains might be a consideration for future research.

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Java Programming Language Learning Application Based on Octalysis Gamification Framework

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Abstract—Java programming language is rated as the second most active language in the world based on GitHub active repository statistic. Meanwhile, many university students are found lack interest to learn Java. Many researches have shown the positive impact of gamification in many areas of life, include education and learning. The purpose of this study is to design and build an application to learn java programming language with gamification in mind. We use Octalysis Gamification Framework to design the usage of game mechanics in the application. The application was tested on second year students to learn Java for the first half semester and evaluated using the Unified Theory of Acceptance and Use of Technology (UTAUT) Model and get the result of 74.27% agree that the application is well accepted by the students.

Index Terms—gamification; java programming language; octalysis gamification framework

I. INTRODUCTION

Java programming language is a high-level object-oriented programming language that allows its developers to write a write once, run anywhere (WORA) code [1]. Based on data from GitHut.info, Java programming language ranks second after JavaScript as the most active programming language on the GitHub repository (Fig. 1). Java programming language is also widely used at higher education to learn object-oriented programming concept [2][3]. While Java is one of the most widely used programming language and is included in the higher education curriculum, from a student's point of view, there are several difficulties in learning, one of which is the lack of interest in learning Java [4].

Gamification has been used as a way to change people's behavior in various fields, such as health [5], social [6], economy [7] and education [8][9]. Many studies have been conducted and found that gamification can be used as a way to increase student motivation, engagement and achievement [9]. In other study, it was also found that the use of gamification, especially in learning programming language can increase effectiveness and enhance student

understanding [10]. The main objective of gamification is not making computer games, but rather implementing game elements, such as challenges and feed back in the learning process [11]. The Application of gamification can be done directly by the instructor in the class [12] or through an application (desktop, web or mobile) [13].



Fig. 1. Active repository by programming language on GitHub
Source: GitHug.info [accessed: 19 June 2020]

Octalysis Framework is a gamification design approach introduced by Yu-Kai Chou [14], which has often been adopted to design gamified systems [15], including gamification of learning systems [16][17][18]. The aim of this study is to design and develop a mobile application to motivate, engage and help students learn Java programming language in an interesting way with gamification designed with Octalysis Gamification Framework. To evaluate the resulting application, we use UTAUT model which has proven to be a practical reference for designing mobile learning systems [19].

II. GAMIFICATION DESIGN

Octalysis is a gamification design framework introduced by Yu-kai Chou, on his way to discover how gamification can improve life in various aspects. Chou found that the most successful games had core drives that triggered them to make decisions and carry out activities [14]. These core drives are called octalysis framework. Octalysis comes from the octagon from which represents 8 main human core drives which drives their motivation to act desired behavior (Fig. 2). We will design the gamification of our application based on this 8 core drives.

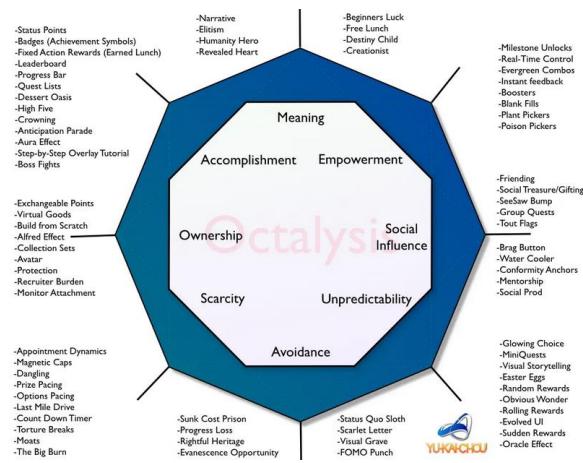


Fig. 2. Octalysis gamification framework

A. Core Drive 1: Epic Meaning & Calling

This core drive is about selfless acts which drive people to do something bigger than themselves because they feel they are chosen, even though there is no reward guarantee. In the stages of learning Java programming language, we provide a narrative to the user about a programmer who is struggling to solve a pandemic problem, where he has to solve a various kinds of code questions to get a vaccine. This implies that by learning Java, user can make a good contribution to the world.

B. Core Drive 2: Development & Accomplishment

Points, Badges, and Leaderboard (PBLs) activities mostly use this core drive. It triggers internal drive of people to always make development which lead to a commitment to gain more skills in order to accomplish goals. Challenge is the main point, without challenge, any reward got by someone will be meaningless. Development and accomplishment core drive is implemented using Status Points, Leaderboard and Quest. Points are obtained after completing several questions from each level, these points will be displayed on the Leaderboard screen which displays the users' rank based on points. Points also can be used as exchangeable points to be exchanged for virtual goods. Quest's screen will display quest list that the user can complete to get the prizes that has been determined. This quest list is divided into two, namely daily quest that can be repeated everyday and quest that can only be completed once. By completing the mission in this quest list, user can get prizes in the form of points, and/or virtual goods.

C. Core Drive 3: Empowerment of Creativity & Feedback

This core drive focuses on creative activity which repeatedly done by someone to find out other combination in something followed by feedback given from others to improve his result. Milestone unlocks are used to trigger the core drive of empowerment of

creativity and feedback. Milestone unlock is a stage that opens after the user complete certain levels. This new stage has a more complicated difficulty level than the previous stage.

D. Core Drive 4: Ownership & Possession

This core drive comes up when people feel that they own something to control and triggered the eagerness to improve it. Gamification elements used in core drive ownership & possession are virtual goods and avatar. Virtual goods are goods or items in the form of virtual technology gears that can be purchased from the shop screen. Any virtual goods acquired by the user will be displayed in the user avatar to increase the user pride.

E. Core Drive 5: Social Influence & Relatedness

This core drive cover all social elements that motivate people, including mentorship, acceptance by society, feedback from peers, companionship, competition and envy. Core drive social influence and relatedness is implemented through friending and social treasure. Friending is a friendship system that is implemented in the application where user can establish friendship with other users. Social treasure allows connected users to help each other by giving points or help with the code problems.

F. Core Drive 6: Scarcity & Impatience

Most people want something that is rare, exclusive or not immediately attainable. This is the idea behind scarcity & impatience core drive. Implementation of core drive scarcity and impatience is done using Magnetic Caps, Prize Pacing and Countdown Timer. Magnetic Caps is used to limit the use of hints for each given question. Prize Pacing is prizes that are obtained after completing each level with an amount that is adjusted to the user's current level. The count down timer is set each the user answer a question, and the remaining time available determines the amount of bonus that the user can get.

G. Core Drive 7: Unpredictability & Curiosity

This drive comes up when people don't know what will happen next. When something going out of their regular pattern, they tend to pays attention to the unexpected. Core drive unpredictability and curiosity applies the Random Rewards gamification element, where the user will get random rewards on daily login.

H. Core Drive 8: Loss & Avoidance

This core drive is about motivation to avoid something negative from happening. This could be to avoid losing previous work. Core drive loss and avoidance applies the gamification element of Progress Loss. It is used by reducing the user's progress if the user does not use the application for learning for a certain period of time.

III. RESULTS AND DISCUSSION

The Java programming language learning application was built using ReactNative and uses Firebase to store user data. The final result of the application is an Android mobile application. To use the application, user must register or login first. Fig. 3 shows the home screen after the user has logged into the application. At the top of the home screen, there is information on the points and hints count owned by the user. At the top left, there is a menu for Quest, Profile and Notification. At the bottom, there are Shop, Avatar, Home, Friends and Leaderboard tabs.



Fig. 3. Home screen

The user starts learning by entering the gameplay, the user will get a question in the form of incomplete source code. Users will be asked to enter the answer in the available blank fields. Users can also ask for hints or instructions regarding the answer by tapping the user character on the bottom left (Fig. 4). When the user has finished answering questions, a modal window

will appear showing the result and the prize that will be given to the user. The yellow star at the top of the modal window shows how many questions have been answered correctly. Finish time is the time used to solve questions, the score is the final result and the item and points obtained. Each question will be reviewed again by comparing the answer inputted by the user with the correct answer from the source code.

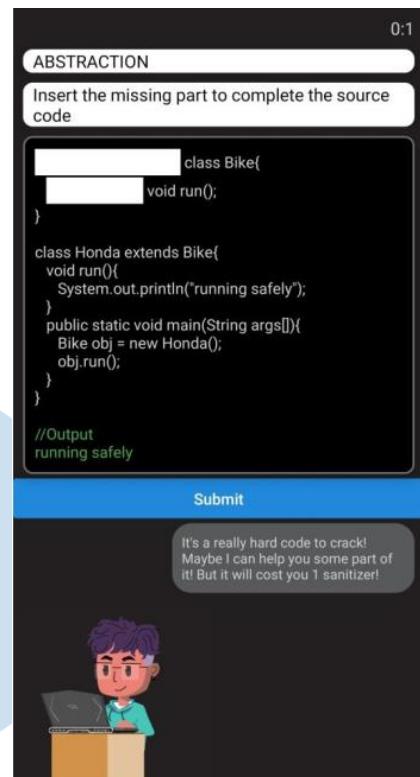


Fig. 4. Gameplay screen

When the user selects the Quest menu, a modal window will be displayed with two quest options, Daily Quest and Quest. When the user successfully completes a quest, he will get a reward according to the mission completed. Fig. 5 is a profile screen that displays user data, such as points, hints count, number of avatars, friends, and completed levels.

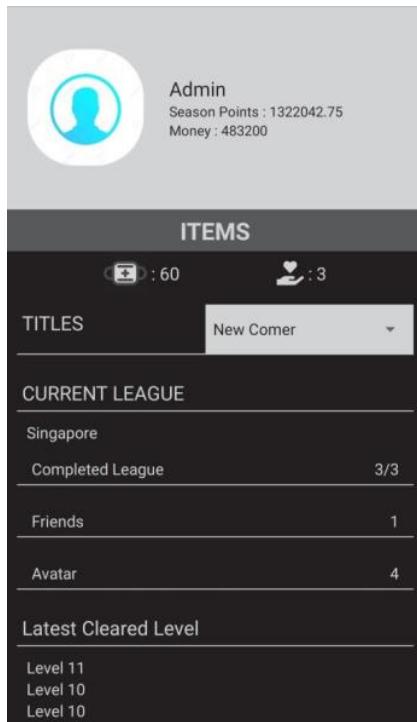


Fig. 5. Profile screen

Shop screen displays a list of virtual goods that a user can acquire by exchanging their points, while the Avatar Screen displays the avatar and virtual goods the user already has. Friends screen displays list of friends the user has along with summary information about them, such as points and levels. The Leaderboard displays the order of users based on points who are actively using the application to learn Java for the past 30 days.

IV. TESTING AND EVALUATIONS

The application was tested using questionnaire following the Unified Theory of Acceptance and Use of Technology (UTAUT) model. UTAUT model is an integrated model introduced by Venkatesh et al based on social cognitive theory with a combination of eight leading research models regarding the acceptance of information technology [20]. This study uses a simplified version of the UTAUT model that uses indicators of Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, and Behavioral Intentions (Fig. 6).

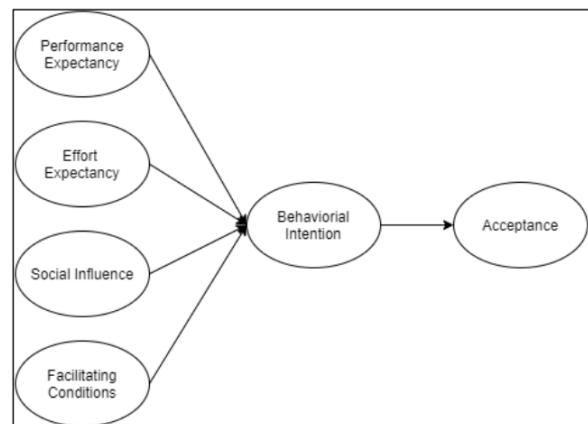


Fig. 6. Simplified UTAUT model

The questionnaire was given to 40 2nd year students who were taking object-oriented programming course after using gamified Java learning application for half a semester. Table I shows the results of the Likert scale calculation for the questionnaire responses collected based on factors from the UTAUT model. The result shows that the gamified application for learning Java programming is successful and well accepted by the respondents.

TABLE I. LIKERT SCALE RESULT FROM UTAUT MODEL

UTAUT Factor	Result	Percentage and Interpretation
Performance Expectancy	0.7675	76.75% (Agree)
Effort Expectancy	0.776	77.6% (Agree)
Social Influence	0.66	66% (Agree)
Facilitating Conditions	0.76	76% (Agree)
Behavioral Intentions	0.75	75% (Agree)

The results of the user acceptance test were successful, but if we look closely, it can be seen that Social Influence got the lowest score on the Likert scale. We conducted interviews with the respondents to analyze the result further and found that this application is not yet well known. So, the use of gamification may increase motivation and interest to learn Java, but the application itself is not widely known, which is not the main goal of this study.

V. CONCLUSION AND FUTURE WORKS

In this study, we have design and develop a gamified Java learning application to improve students' interest and motivation in learning Java programming language. The framework that was used is Octalysis Gamification Framework by Yu-kai Chou. We carried out a user acceptance test following the UTAUT model with an average Likert scale calculation result of 74.27%, which means that the Java learning application with gamification was well accepted by users. For future study, we are planning to experiment and analyze each core drive in the

Octalysis Framework to find out which drive give the most impact on the students' behavior in learning programming language.

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Web-based Inventory Application Development for PT. Palugada Indonesia

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Abstract—PT. Palugada Indonesia still records their transactions and inventory of goods in traditional ways, which could result in some errors caused primarily by human interventions. The aim of this research is to assist PT. Palugada Indonesia to control their inventory through an information system. Specifically, a web-based application that can process product data, supplier data, customer data, user data and transaction data was purposefully developed in this study. In addition, the developed application has notification and sales forecast features. These features are expected to further assist PT. Palugada Indonesia to control their inventory optimally. Moreover, the application also has some other useful features, for instance in displaying more informative data, by bringing up sales forecasts and notifications. The developed application was modeled using UML diagram 2.0 and developed using HTML, PHP, and MySQL database.

Index Terms—inventory; PT. Palugada Indonesia; sales forecast; web-based application

I. INTRODUCTION

A. Background and Purpose

In the era of globalization, Information Technology (IT) has become an essential factor that companies use to make decision and distribute information between stakeholders. One of many applications of IT is web-based Information System for inventory management. Information System is a group of components that work together to collect, manage, calculate, store and distribute information to support decision making, coordination, control, problem analysis and visualization in an organization [1]. General understanding of inventory is goods or materials that are owned by a business for a purpose certain, such as resale or repair [2]. Meanwhile, the website can be interpreted as a facility channel that contains a page set that is display data information [1].

The web-based inventory information system can facilitate companies in processing data on incoming goods, outgoing goods and provide the information for availability of goods, as the system can be accessed directly anytime and anywhere. This is different with the conventional inventory system that processes data manually. Manually processed data can result in data

errors and inaccuracies due to human mistakes. Other than that the length of the information sharing process can lead to some calculation errors. PT. Palugada Indonesia which is engaged in redox water distribution, annually handles deals for up to four tons of pure redox water which is the largest number of transactions in the islands of Java and Sumatra. However, they still record their transactions and inventory of goods in conventional ways, which could result to some problems mentioned before. Some major identified problems are the followings:

- The process of recording incoming goods, goods that are exit and the availability of goods were done manually; hence it took longer time to record and count.
- Manual calculations lead to difficulties in searching information on the availability of goods accurately.
- Lack of company awareness when availability of goods is running low, resulting in serious problems in controlling the availability of goods.
- Manual recording of data makes it difficult for companies to get hold of information quickly and accurately.

Hence, the purpose of this current study is therefore to solve the aforementioned problems by developing a web-based inventory application for PT. Palugada Indonesia, which has the following main functions:

- Calculate incoming goods, outgoing goods and available goods in easier, more detailed and accurate manners.
- Assist companies to maintain the availability of goods with the notification feature.
- Quickly obtain information of transaction and inventory to be used in decision making.

The functions included in the developed web-based inventory application aforementioned are significant and important for PT. Palugada Indonesia to overcome its problems. However, it is important to

note that the developed application has some limitations, they are:

- The developed application is only limited to processing data, the entry and exit of goods and the availability of goods. In addition, it can be used as a means to display existing data through the website.
- The notification feature is limited only to assist the provision of goods.
- The application is particularly designed and intended for the operational field of inventory, operational managers and directors at PT. Palugada Indonesia.

B. Literature Review

Inventory can be defined as goods that are used to facilitate production or meet consumer demand [3]. Other experts conceptualize inventory as company-owned goods that are stored with the aim of being sold for a certain period, goods that are still in the production stage, or raw materials to be used for a production process [4]. Inventory is an investment decision, so care is needed in controlling the availability of goods [5]. So, errors in controlling the availability of goods can harm the company. Inventory has a main function in ensuring the smoothness of the mechanism for fulfilling consumer demand so that the managed system achieves optimal results [6].

The System Development Life Cycle (SDLC) is a process for understanding how information systems can support business needs through designing a system [7]. SDLC is a gradual improvement process so that each stage can improve and elaborate on the work that has been done previously. SDLC consists of four basic stages, namely planning (planning), analysis (analysis), design (design) and implementation (implementation).

Rapid Application Development (RAD) has been developed since the early 1990s. RAD-based methodologies make several adjustments to the stages of the System Development Life Cycle (SDLC) aimed at providing faster results to users, making it easier for users to understand and analyze the system [7]. The RAD methodology is divided into three methods, namely phased development, prototyping, and throwaway prototyping. The method used in this current study is the prototyping method. The main purpose of this method is to develop the model to be a final working system. Unlike SDLC traditional method, the prototyping method has a faster development phase and a lower cost [7].

Unified Modeling Language (UML) is the result of standardized diagram making that has been accepted by the Object Management Group (OMG). It aims to provide a general term for object-oriented development [7]. UML was created by having four

main functions [8], namely: Visualizing, specifying, constructing, and documenting.

Relational Database Management System (RDBMS) is a system that uses the relational data model to manage data sets. Meanwhile, the Database Management System (DBMS) itself is a set of interrelated data, including programs and procedures for accessing and managing data [9]. Database is a collection of data that is stored and used by certain application systems. Databases are useful for combining and controlling data centrally so that it can reduce the repetitive same data (data redundancy), which can make data use easier. Meanwhile, Structured Query Language (SQL) is the language used to access databases and includes two main components, namely Data Definition Language (DDL).

Sales Forecasting is the process of forecasting future business sales [10]. The sales forecast period can be in per month, per quarter, per half year to yearly. With the idea of future sales, this will make it easier for businesses to manage the availability of goods, cash flow and future growth plans. The purpose of forecasting sales is to provide information that can be used in making business decisions [10]. There are a variety of sales forecasting methods, such as executive jury opinions, labor force opinions, marketing results testing, consumer purchase plans, market factor analysis, expert opinion, econometric model building, statistical methods and past sales (historic method). The past sales method (historical method) or the past sales method is the method that will be used for this study.

Related Works. Table I summarizes the relevant prior studies pertaining to the development of inventory application. As seen in table 1 below, it can be concluded that the majority of prior studies merely focus on the main functions of inventory system. There are two important functions that were missing from the extant literature, such as notification features and sales forecasting. These two features were included in our developed application, and therefore, becoming the main contribution or novelty of this current study.

TABLE I. RELATED WORKS SUMMARY

Ref.	Remarks		
	Title	Type	Summary
[11]	Web-based inventory application using PHP and MySQL programming language (case study of pekanbaru hang tuah stikes)	Journal	The development of inventory application for data analysis and reporting.
[12]	Web-based inventory application at PT. Telkomsel NS	Journal	The development of application to automatically generate serial

Ref.	Remarks		
	Title	Type	Summary
	Tasikmalaya		number, and for reporting
[13]	Analysis and implementation of inventory items application web-based using Codeigniter framework	Journal	The development of web-based inventory system to assist the company in managing inventory related data
[14]	Analysis and design of web-based ship spare-parts inventory information system: Case study Asia Group Pangkalpinang	Journal	Designing web-based inventory system to improve the spare-parts inventory data management
[15]	Design of goods inventory application at PT. Kartika Graha Indonesia – using Java Netbeans	Journal	The development of inventory application for better inventory management and goods control
[16]	The implementation of inventory-based information system (Case study of CV. Sinar Abadi Cemerlang)	Journal	Designing inventory system which has several functions, such as data and transaction reporting

II. METHOD

In conducting this study, there are two stages of method that was used, namely: First stage is about Data Collection Methods, which consist of literature review, field study, observation, interview, and survey. The second stage is the system development, which used RAD, specifically Prototype development method [7], which included several phases, namely:

- **Requirement gatherings.** In this step, the users' requirements were carefully captured (through field study, observation, interview, and survey). All of the required functions were recorded and modeled using three UML diagrams, they are: use case diagram, class diagram, and table relationships diagram.
- **Prototyping development.** The prototype of the application was circumspectly developed, following the users' requirements.
- **Prototyping evaluation.** The developed prototype was then evaluated by the users (in this case the staff and manager). Afterwards, based on their inputs, the prototype was further improved.
- **System coding.** The coding (programming) process of the application was performed.
- **System testing.** In this step, the black box testing method was incorporated to test the developed application.

- **System evaluation.** The system was carefully evaluated both by the developers (researcher) and by the users (staff, managers, admin, and also the owner of PT. Palugada Indonesia). A final interview with the users was carried out to ensure that the application was developed according to the users' requirements.
- **System implementation.** The system was implemented using local host.

III. RESULTS AND ANALYSIS

A. Use Case Diagram

Use Case diagrams (as seen in Fig. 1) describe the functions that can be performed in the system. The users are divided into several actors as follows:

- **Staff** are actors who describe all employees of PT. Palugada Indonesia that has been registered in the system. Staff are actors who have the lowest access rights in the system.
- **Managers** are actors who have higher access rights and also have staff features and can access validation features, notifications, dashboards, product settings and supplier settings.
- **Admin** is an actor who can also use all the features used by the manager and added features of customer settings and user settings at PT. Palugada Indonesia.

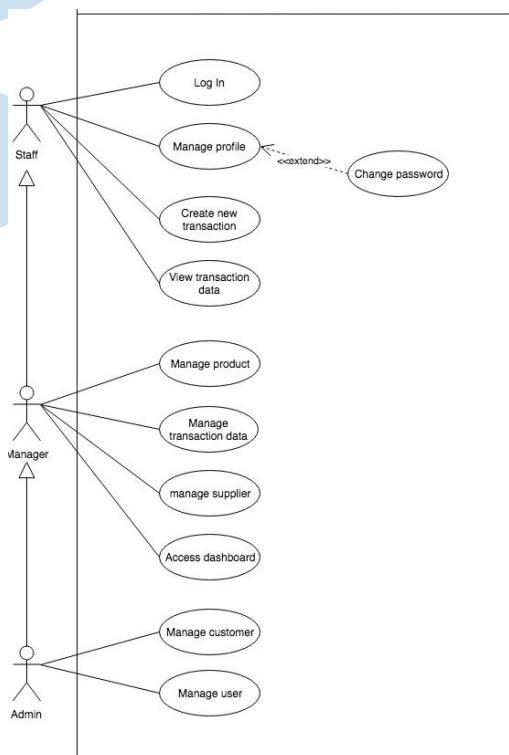


Fig. 1. Use Case diagram inventory application
PT. Palugada Indonesia

B. Class Diagram and Table Relationship Diagram

Structural modeling aims to describe the structure of the proposed system. The structural modelings used are class diagrams and table relationship diagrams. Both diagrams can be seen in the appendix 1 and appendix 2.

C. Business Process

Inventory application of PT. Palugada Indonesia has several business-process related features including:

- Notification feature applies to items that have a playing category on the system. A notification will be raised when inventory reaches 25% and less than 25%. The product's color will also change to red on notifications and on the dashboard.
- Customer points, customers who make a purchase will get 1 (one) point for each purchase with a total price of 10,000 and multiples apply. Points can be exchanged for products with promotion status on the system. 1.000 points can be exchanged for 1 (one) promo product. The amount of point exchange that can be done in one transaction is 10.000 points.

D. User Interface Design

Inventory application of PT. Palugada Indonesia has three different access levels, and each of them has a different interface design according to the functions that have been provided. Inventory information system of PT. Palugada Indonesia can only be used if the user logs in first. The log in page consists of the username and password fields which will be filled in by the user. After filling in the two fields the user presses the log in button to enter the system. If the username and password are not registered in the database, the system will generate an error message. The log-in page interface can be seen in Fig. 2 below.



Fig. 2. Login page

Dashboard page (as shown in Fig. 3) can only be accessed by the access manager and admin levels. This page shows the name, a brief description of the product and product supplies. Products with an

inventory that has reached 25% or less than 25% will turn red.

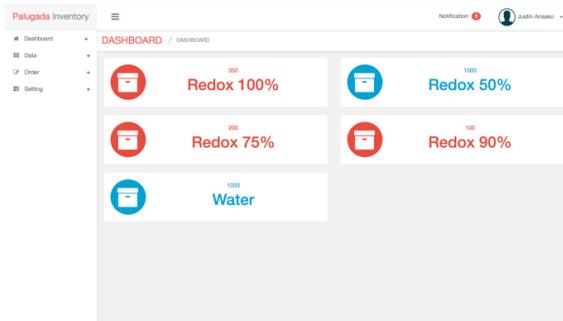


Fig. 3. Dashboard page

Products can be selected to view sales charts and forecasting for sales of these products (as seen in Fig. 4). Meanwhile, Fig. 5 shows notification features that can be used by the access manager and admin levels. Notifications are only for products in the main category which can be set on the product settings page. The notification badge will appear when the inventory reaches 25% or less than 25%, and will disappear when the product has been added again.



Fig. 4. Dashboard product page

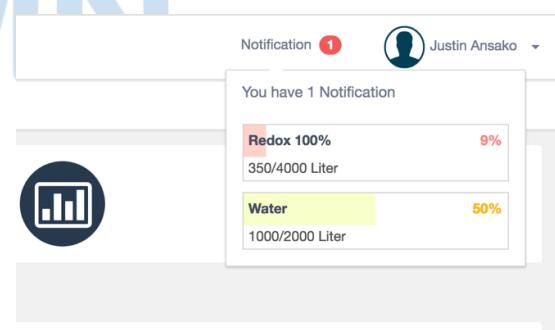


Fig. 5. Notification feature

Fig. 6 shows the stock out data page. This page displays a table of stock outs and the number of transactions for the day. In this table, there are customer names, delivery types, date of exit, employees who enter data, information, invoice button, validation button (only owned by the access manager and admin levels), and a delete button.

Palugada Inventory		DATA / STOCK OUT	
Dashboard	Data	Order	Setting
TODAY TRANSACTION 0			
Data Stock Out			
All Year All Month Look			
10 # records page			
# Customer Delivery Date Employee Action			
31 Ursula Delivery 18 Jul 2017 Susanto Salim Valid			
3 Seemantti Pick Up 03 Aug 2017 Justin Ansaku Valid			
4 Risma Watt Pick Up 17 Aug 2017 Justin Ansaku Valid			
5 Teddy Pick Up 11 Oct 2017 Justin Ansaku Valid			
6 Seemantti Pick Up 22 Nov 2017 Justin Ansaku Valid			
7 Bima Heyyed Pick Up 03 Jan 2018 Justin Ansaku Valid			

Fig. 6. Stockout data page

Pressing the invoice button will display the invoice page (as shown in Fig. 7). Meanwhile, Fig. 8 shows the invoice of a transaction, the system shows a preview of the page to be printed.

Palugada Inventory		DATA / INVOICE	
Dashboard	Data	Order	Setting
Customer			
Name: Seemantti Delivery: Pick Up Date: 2018-03-16			
Invoice			
# Product Quantity Product Price Packing Quantity Total Price			
1 Redox 100% 20 420,000 Jengen 10 Liter 2 8,400,000			
Total: 8,400,000			

Fig. 7. Invoice data page

Palugada Inventory		STOCK OUT / PRINT	
Dashboard	Data	Order	Setting
STOCK OUT			
PT. Palugada Indonesia Jl. Koesih Raya 7e-f, Pekanbaru, Riau 28116 (+62) 365-385-3333			
INVOICE NO : 33 CUSTOMER NAME : Seemantti DELIVERY TYPE : Pick Up INVOICE DATE : 2018-03-16			
# Product Quantity Product Price Packing Quantity Total Price			
1 Redox 100% 20 420,000 Jengen 10 Liter 2 8,400,000			
Total: 8,400,000			
Payment Methods			

Fig. 8. Printing preview page

IV. DISCUSSION

A. Testing

Testing the inventory application of PT. Palugada Indonesia was carried out using the black box testing method which aimed to test the smoothness of the functions that exist in the system. Black box testing tested whether the output generated by the system was as expected. In this study, all functions in the application were tested in accordance to the black box testing method, in which the users (testers) would test the function, and ensure whether all tested functions works as expected (Passed) or not (Failed). In general, the testing was conducted successfully. Some samples

(in form of the testing tables) from the test results are provided in the appendix 3.

B. Conclusions

A web-based inventory application for PT. Palugada Indonesia has successfully been developed. The application can assist the process of recording and viewing transaction data, inventory, customers, users and suppliers. This application can also help the managers of PT. Palugada Indonesia to get notifications when the availability of goods is low. This system can fulfill the needs of the companies, such as:

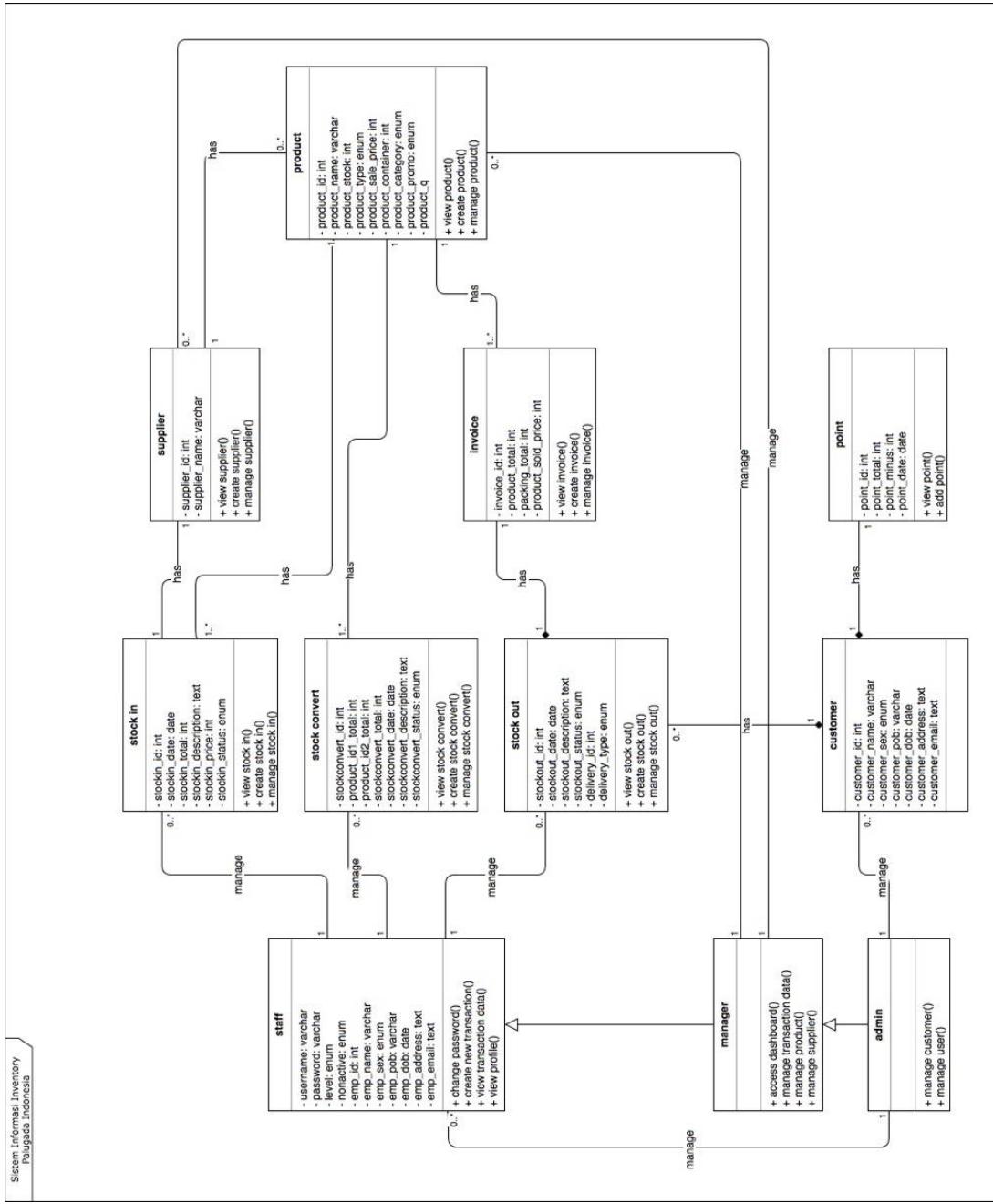
- PT. Palugada Indonesia has a digital means to record and view every transaction that occurs.
- PT. Palugada Indonesia has a means to store and display customer data, supplier data, and user data.
- There is a means to display the condition of inventory in an informative manner at PT. Palugada Indonesia.
- Synchronized data so that all employees have the same data, thereby minimizing data errors or information that an employee has.
- The notification feature in the system makes it easy for PT. Palugada Indonesia when the inventory was running low.
- With the sales forecast feature, thus helping companies to estimate the availability of goods.
- A feature to validate transaction data helps PT. Palugada Indonesia, when a transaction is already valid, it cannot be changed again.
- All of the features above can be used by the decision maker to decide what to stock in the future.

C. Suggestions

Some useful suggestions that can be proposed to develop a web-based inventory information system at PT. Palugada Indonesia are the followings:

- Added accounting features, so that companies can immediately get financial reports.
- Adding e-commerce features, so that customers can directly make purchases online via the web.
- Adding a tracking feature on delivery of goods, as well as detailing the details of delivery of goods.

APPENDIX



Appendix 1. Class diagram inventory application PT. Palugada Indonesia



Appendix 2. Table relationship diagram application PT. Palugada Indonesia

Test Number: 12			
Test Subject: Employee (Bagus Priyatno)			
Function: Enter order stock out			
Input Data	Event	Condition	Expected Result
	Choose sidebar order stock out		The system displays a stock out form
Enter data according to the fields	Pressing The Next button	All fields are filled correctly	Data storage system entered, the system displays the form of adding items
Enter data according to the fields	Pressing The Next button	There are fields that are not filled in correctly	The system shows error message

Test Number: 27			
Test Subject: Manager (Astri)			
Function: See dashboard page			
Input Data	Event	Condition	Expected Result
	Choosing sidebar dashboard		The system displays dashboard page

Appendix 3. Test case example

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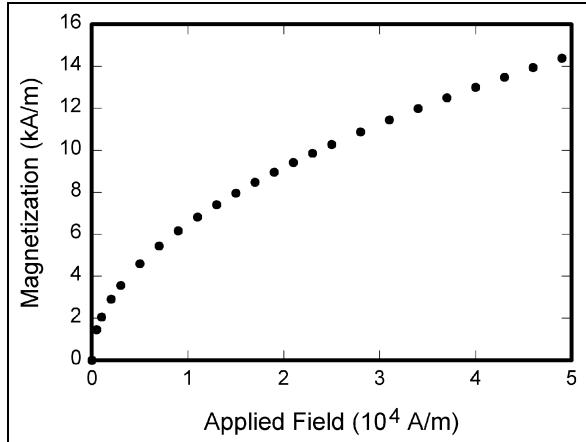


Fig. 1. Example of a figure caption

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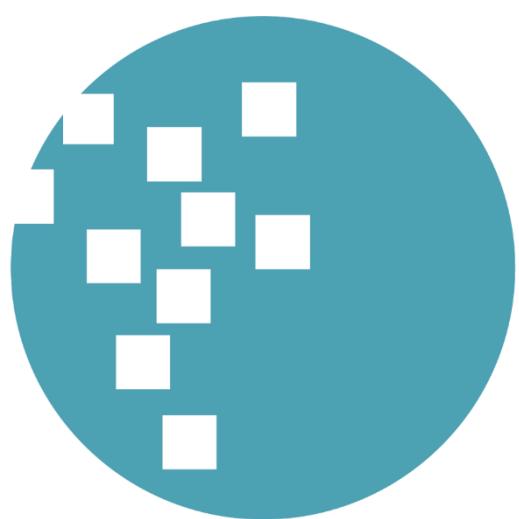
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