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Research Article

Designing Persuasive Application to Promote Public Transportation Use

Thedy Yogasara, Vania Edra Christabel Naomi

Industrial Engineering Department, Universitas Katolik Parahyangan, Jl. Ciumbuleuit No.94, Hegarmanah, Bandung, 40141, Indonesia

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CORRESPONDENCE

Phone : +62 22 2032655
E-mail : thedy@unpar.ac.id

A B S T R A C T

The poor air quality of Jakarta, caused among others by fossil fuels combustion for transportation, harmfully affects the health of its people. Carbon emissions resulting from transportation activities can be reduced by getting people to use public transportation more frequently. This research aims at designing a persuasive application to encourage people to use public transportation more often. The steps of interaction design were employed. Firstly, user needs were identified using interviews, resulting in 48 interpreted needs which were then grouped into nine primary needs. Secondly, design workshop involving users and designers was conducted to produce three concept alternatives. In the next stage, the best concept was selected using concept scoring method, and was subsequently refined through SCAMPER method. A high-fidelity prototype was developed based on the final concept. Lastly, the evaluation process of the application prototype named ecoGlide consisted of two major parts, i.e. the evaluation on performance and persuasive qualities. The performance evaluation was conducted through Usability Testing using five criteria. The effectiveness and efficiency criteria consecutively score 91% and 71.43%, exceeding the minimum acceptable value of 70%. Furthermore, the satisfaction, usefulness, and learnability criteria respectively score 3.83, 3.88, and 3.88, which surpass the threshold value of 3.4. The persuasive quality was evaluated using qualitative method through a coding scheme. The result shows that the Emotion and Persuasion categories were most closely related to the application use. The most influential sub-category of the persuasion aspect is Reward Driven, which ranks 4th out of 14 sub-categories. Overall, the ecoGlide application was considered to have good usability and persuasive ability.

INTRODUCTION

Environmental problems have become a serious matter and must be immediately addressed by all countries in the world, including Indonesia. A facet of the environmental problems is the greenhouse effect, a term for trapped solar heat in the Earth's atmosphere. Some types of greenhouse gases, such as carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, and ozone trap the sun's heat and create temperature imbalances on the Earth's surface [1,2]. This situation leads to several damaging natural phenomena and social impacts.

Jakarta's air quality index (AQI) in 2019 reached 163 and ranked Jakarta as the 11th city with the highest AQI in the world [3]. According to AirNow [4], this number is in the red category, which means unhealthy, and is quite far from the range of AQI numbers that can be categorized as healthy or good. The deteriorating air quality, in addition to affecting environmental conditions, also harmfully affects the health of the people of Jakarta.

Humans play an important role in the production of greenhouse gases. The use of transportation facilities is one of the factors that considerably contributes to the air pollution and greenhouse effect. Jakarta is a metropolitan area of about 11 million people [5] who have a high level of mobility. This is inevitably followed by a rapid increase in the number of vehicles. According to the Transportation and Traffic Department of the Government of Jakarta (Dinas Perhubungan DKI Jakarta) [6], the number of cars and motorbikes in Jakarta continues to grow every year. The growth rate of the number of cars in average is 390 units/day or 142,452 units/year, while that of motorcycles is 1,216 units/day or 443,965 units/year.

To overcome this problem, one of the efforts made by the Government of Jakarta is providing a large selection of adequate public transportation. The Jakarta's Transportation and Traffic Department [7] reports that there are 22 types of public transportation provided by 26 transportation companies. They include TransJakarta bus rapid transit, Jakarta MRT, Jakarta LRT, KRL Commuterline, and privately-owned bus systems such as MetroMini, Kopaja, Mayasari Bakti, and PPD. In addition, angkot microbuses are a common public transportation of Jakarta.

Despite the diverse alternatives of public transportation available in Jakarta, their use is still considered very low. According to the Institute for Transportation and Development Policy as cited in

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Prabowo [8], only 25 percent of Jakarta residents used public transportation in 2019. This figure needs to be increased to contribute to reducing air pollution in Jakarta. To achieve this, one of the strategies that can be used is technological intervention. Technology can affect an individual's lifestyle and behavior because it is used in humans' daily life. A type of technological device that is regarded to be an integral part of the life of society nowadays is the smartphone.

Smartphone is currently an easy and inexpensive choice to fulfil one's needs for communication, information, entertainment, and personal assistance. The information obtained via smartphone is quite vast and diverse, and the applications functioning as personal assistant may be accessed very frequently, so that the smartphone can unwittingly affect the way its users live. This also applies in the context of public transportation use. There are several smartphone applications that can help users in using public transportation, including Trafi, Moovit, KRL Access, and Komutta. However, while they may assist public transportation users, their current design may not be persuasive. In other words, the existing applications may not motivate or encourage the users to use public transportation more often. If designed properly with persuasive ability, the smartphone applications can play an important role in making existing and new users to choose and use public transportation more frequently and habitually. This, in turn, can help in reducing the use of private vehicles and the production of greenhouse gases.

Reviews on previous research support the importance of persuasive technology in the context of public and green transportation use. Anagnostopoulou et al. [9] reviewed 44 papers from 2003 to early 2018 that combine the three domains of persuasive technology, sustainable mobility, and transport behavioral change. They concluded that persuasive technology is a promising approach to form desirable users' behavior toward the use of environmental-friendly transportation modes. However, large scale and longitudinal evaluations are required to obtain a firm judgment regarding the long-term impact of persuasive technology on the use of sustainable transportation [9]. Bothos et al. [10] developed an approach employing persuasive technology supported by a choice architecture concept to encourage urban traveler to select trips that cause low emissions when making transport decisions. Implemented in a form of smartphone application and tested by 24 participants over a period of eight weeks, the approach resulted in users' good acceptance, increased awareness of environmental impacts, and instances of behavioral change [10]. Moreover, Wunsch et al. [11] explored the implementation of persuasive technology using three strategies to encourage biking as a low-energy transportation mode. While the first strategy (frequent biking challenge) showed a considerable increase in bike use, the other two (virtual bike tutorial and bike buddy program) remained inconclusive whether they could increase users' intention to bike.

In other domains, Suhartono and Octavia [12] designed a persuasive mobile game to improve physical activities of elementary school students. Similarly, Tonadi and Damayanti [13] designed a persuasive and educative game application about environmental cleanliness for children. Furthermore, Mintz and Aagaard [14] explored the potential use of persuasive technology to effectively induce positive behavior and attitude change in educational settings. These studies strengthen the idea that persuasive design can promote the change toward the target behavior of users.

Based on the study background, this research has the following objectives: 1) identifying user needs of an application supporting the use of public transportation, 2) developing concept alternatives of a persuasive application to encourage users' behavior in using public transportation, 3) evaluating the prototype of persuasive application supporting the users' behavior in using public vehicles through trials on users.

METHOD

In designing a persuasive application that can shape users' behavior in using public transportation, aspects that must be designed are the display interface and persuasive content of the application. Therefore, interaction design method was employed in this study. According to Preece et al. [15], interaction design is the design of interactive products that support humans in communicating and interacting in their everyday life. Interaction design consists of four basic activities as design stages, namely establishing requirements, designing alternatives, prototyping, and evaluating [15]. In this research, the design stages were divided into five processes, i.e. identification of user needs, concept generation, concept selection and refinement, prototyping, and evaluation, as described in Figure 1.

At the stage of user needs identification, the need statements of prospective users were identified through two sessions of interview. The first interview session, involving 12 participants, was intended to explore users' experiences and general needs related to the use of public transportation; whereas the second one, involving eight participants, was used to obtain more

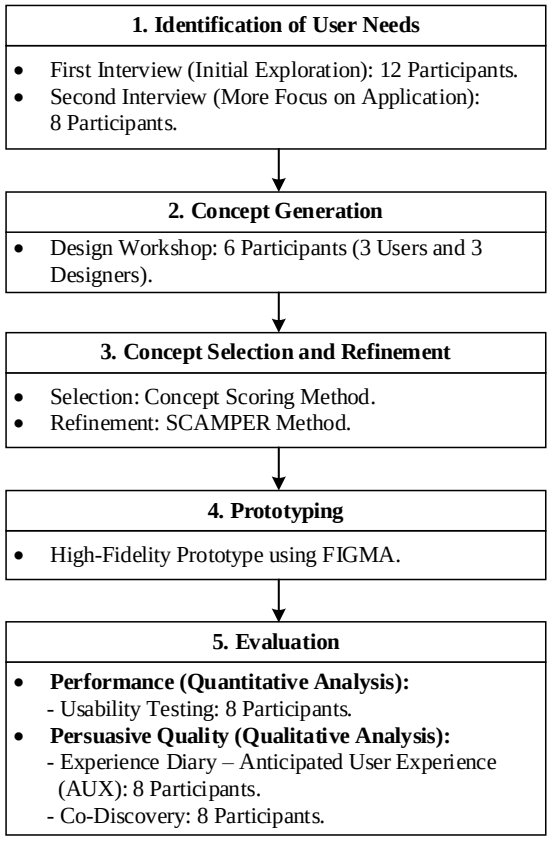


Figure 1. Design Stages Flowchart

focused information regarding users' needs related to public transportation application.

In this research, all participants were recruited using convenience sampling and they must fulfill several criteria. The selected respondents were male or female, were smartphone users who owned a private vehicle, were domiciled in Greater Jakarta (Jakarta, Bogor, Depok, Tangerang, and Bekasi), and were aged between 19-54 years. Greater Jakarta was determined as the location of study because of the more diverse public transportation available in this area compared to that in other areas. Furthermore, the age limit was set, since active users of smartphone are in the age range of 19-54 years, according to the Indonesian Internet Service Providers Association (Asosiasi Penyelenggara Jasa Internet Indonesia) [16].

The concept generation stage was the development of application concept alternatives using the design workshop process based on the previously identified need statements. Concept alternatives of the application interface were also designed by considering persuasive aspects with the aim of changing user behavior. Therefore, in creating the concept alternatives, the persuasive design strategies [17] and the persuasive technology tools [18] were employed. The strategies of persuasive design that were explored to encourage desired user behavior are as follows [17]:

1. Direct Appeal
   This method focuses on the associated risks if the users do not change their current behavior. These risks are displayed and cause more impact if the displayed risks are immediate and detrimental to the users.
2. Social Triggers and Support
   This method uses social life, which can be channeled through social media owned by the user to build motivation. The motivation built may remain in a short or long term, depending on the form of use of these social triggers. The social triggers can be a medium of self-actualization as a form of reward, or a medium of competition. Both types of media can be a motivation for users to use the application and change their behavior in accordance with the objectives.
3. Gamification
   Almost related to social triggers, gaming can be used to increase user's motivation in using the application. Gamification includes elements such as level-ups, competitions, and high scores. This method can be used so that users interact with other users and provoke their competitive feelings.
4. Reward
   Incentives or rewards are external triggers that can be used to change user's behavior according to specific purposes. These rewards can be in the form of virtual coins, money, discounts, bonuses, or other things that cause positive emotions of the user.
5. Data Visualization
   Analytic information, or precisely the use of interactive information representations to form and control an analytic reasoning process, can support effective decision making. Analytical information provided to the users can influence their response to change their current behavior.
6. Multimodal Design
   This is related to the use of application on several devices at the same time. This technique can be done by the ability of the application to be accessed from wearable devices such as smartphones, e-mail, websites, tablets, and other media. This method supports the convenience aspect for users to use the application to change their behavior.

The persuasive technology tools considered in this study were based on Fogg [18], which include:

1. Reduction: simplification of tasks or actions that must be performed by the users.
2. Tunneling: sequential activities that guide the users in carrying out new behaviors.
3. Tailoring: providing feedback to the users based on actions taken.
4. Suggestion: providing suggestions to the users at the right time and context.
5. Self-monitoring: providing the users with opportunity to track their own behavior changes to achieve predetermined output.
6. Surveillance: openly observing users with the aim of improving or changing their behavior according to the target.
7. Conditioning: providing consequences (reinforcement / punishment) to improve or change the users' behavior.

Concept alternatives that had been generated were assessed using the Concept Scoring method [19] to select the best one. Subsequently, the best concept was refined using the SCAMPER (Substitute, Combine, Adapt, Modify, Put on another use, Eliminate, and Reduce) method [20] into the final concept, which was then developed into a high-fidelity prototype representing the final product.

Having the prototype developed, it was necessary to test the product's success based on its performance and persuasive ability. The method used in evaluating the application's performance was Usability Testing, while the persuasive ability was evaluated using User Experience Diary and Co-discovery methods. According to Rubin and Chisnell [21], Usability Testing is used to find out how usable a product is. To be usable, a product or service needs to have six attributes, namely usefulness, efficiency, effectiveness, satisfaction, accessibility, and learnability [21]. In this study, all the attributes, except accessibility, were used as the testing criteria. The exception was due to the scope of this study, in which the users were assumed to not have any disabilities that hamper their ability to access the application.

User Experience Diary method was used to learn the success or potential of the application in changing the users' behavior according to the main goal. According to Lallemand [22], User Experience Diary is a qualitative technique used in researching Human-Computer Interaction to get data from things that have been done and from users' experiences. However, because of the COVID-19 pandemic that prevent the participants from having real experiences with the application when actually using public vehicles, task scenarios were employed to engender anticipated user experience [23,24]. Subsequently, to support the findings from the User Experience Diary, the Co-Discovery method [24,25] was used to explore more deeply the users' experiences through discussions between users in pairs. The users' anticipated experiences recorded in the diary and users' comments from the Co-Discovery session were qualitatively analyzed to assess the persuasive quality of the application.

The evaluation process involved eight participants. The justification regarding the sample number was based on findings

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from Dumash and Redish [26] and Dumash and Fox [27] that typical number of respondents for usability testing is five to ten, where five respondents can reveal 80% of usability problems. This is supported by Nielsen [28], pointing out that five participants for usability testing are enough, as they can discover about 85% of usability problems. In addition, a sample number of five provides near maximum benefit-cost ratio of the testing [28].

RESULT AND DISCUSSION

In this section, the results of the study are elaborated along with the discussion.

Identification of User Needs

The needs of users were required as a basis in designing the application. Two sessions of interview were carried out to gather this information. To explore the users' experiences and general needs when using public transportation, the first interview session was conducted with 12 respondents. In addition, the interview was also intended to learn the users' point of view of the environmental problems. The users' general needs based on the interview are recapitulated as follows: 1) comparative information of costs and travel duration of public vehicles and those of private vehicles usage; 2) information providers of public transportation routes that are clear and easy to understand; 3) information providers of the schedule, duration of travel, and the nearest location of desired public transportation modes; 4) more encouragement to use public transportation more often in order to contribute to reducing air pollution in Jakarta.

The second interview session was intended to more specifically identify users' needs related to public transportation application. The interview continued to the next user until there were no new needs added from the last three users [21]. The interview was conducted using several questions that were prepared previously (semi-structured) but did not rule out the possibility to add new questions to make the users flesh out their answers. Eight respondents (six females, two males, aged 19-54 years, live in Greater Jakarta, and own a private vehicle) were interviewed, resulting in 48 need statements that represent user needs. Figure 2 presents the number and addition of user needs. It is shown that respondents 6, 7, and 8 did not provide additional new information and therefore the interview was ended.

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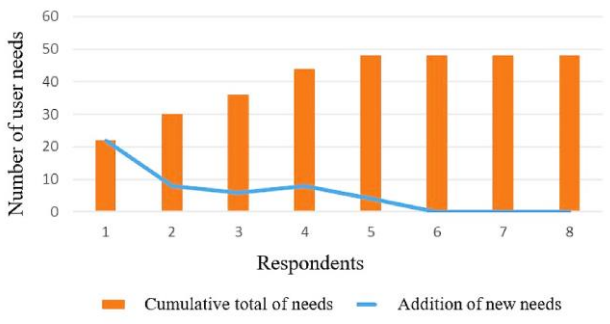


Figure 2. Number and Addition of User Needs

Table 1. Primary Needs and Their Level of Importance

No	Primary Needs	Rank	Weight
1	Application provides information related to duration and schedule	1	13.40%
2	Application provides information related to routes	2	13.06%
3	Application has a design and display that makes it easy to use	3	12.37%
4	Application provides information related to costs	3	12.37%
5	Application provides information related to position	4	11.34%
6	Application educates users	5	11.00%
7	Application provides information for user convenience	6	10.65%
8	Application is integrated with social media	7	7.90%
9	Application is pleasurable	7	7.90%
TOTAL			100%

needs added from the last three users [21]. The interview was conducted using several questions that were prepared previously (semi-structured) but did not rule out the possibility to add new questions to make the users flesh out their answers. Eight respondents (six females, two males, aged 19-54 years, live in Greater Jakarta, and own a private vehicle) were interviewed, resulting in 48 need statements that represent user needs. Figure 2 presents the number and addition of user needs. It is shown that respondents 6, 7, and 8 did not provide additional new information and therefore the interview was ended.

The 48 need statements were grouped based on their similarities into nine super groups. These super groups were also referred to as primary needs, while the need statements were called secondary needs or supporting needs. To determine the level of importance of each primary need, a process of questioning was done to respondents who had contributed in the second interview stage. Respondents were asked to give values from 1 (very unimportant) to 5 (very important) for each primary need. The scores received by each need from eight respondents were then totaled and converted into weight. The nine primary needs and their level of importance can be seen in Table 1.

Concept Generation

Design workshop was carried out to generate concept alternatives of the application. This design workshop involved six participants consisting of three designers and three users, guided by a facilitator (researcher). Each designer was paired with one user, and they were asked to collaborate to generate an application concept. Because of the COVID-19 pandemic, the workshop was conducted online via video calls using Zoom application. Video calls were made at different times for each pair of user and designer, and were divided into two sessions. The first session comprised the stages of briefing, designing concept alternatives, presenting the results, and closing. The design process was done using paper and pencil media, resulting in sketches of the application concept. The participants were provided with the list of primary needs, persona (a fictional character representing users), and usage scenario of the application being designed.

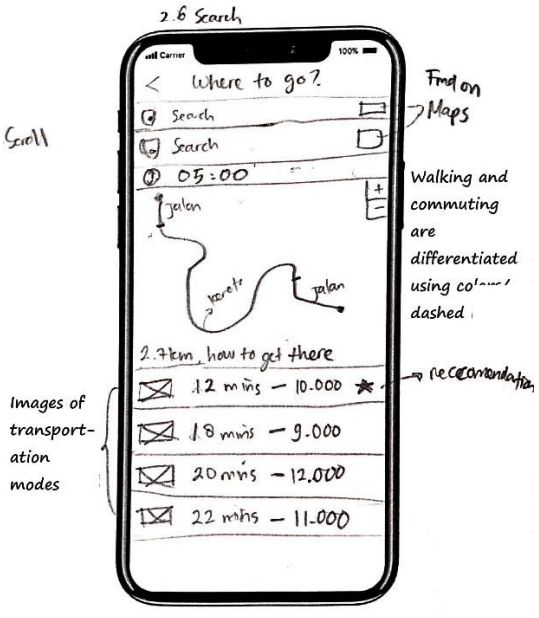


Figure 3. Sketch of Concept 1

After the three pairs of participants had each drafted an application concept and presented it to the facilitator, the second session of the workshop began. In this second session, the facilitator presented to each pair of participants the two designs created by the other groups. Afterward, the participants were asked to assess the two concept alternatives by giving a score for each assessment criterion. Activities carried out in the second session of the design workshop consisted of presentations, scoring of concept alternatives, and evaluations.

Selection and Refinement of Best Concept

Through the design workshop, three concept alternatives were produced. The first concept presented a gamification idea, whereas the second concept focused on providing information about public transportation and the environment to increase knowledge and awareness of the users. Lastly, the third concept was more emphasizing on fulfilling the primary needs using the design and appearance that were simple and easy to use. Figure 3 illustrates an example of the application concept sketches.

The selection of the best concept was conducted through an assessment process in which each pair of participants of the design workshop scored the concept alternatives created by other pairs. The concepts were assessed against the nine primary needs (Table 1) as the selection criteria. Each primary need received score ranging from 1 to 5, where 1 means the design does not fulfill the need at all and 5 means the design strongly fulfills the need. For a particular concept, the scores provided by all participant groups to each criterion were averaged. Following this, each of the averaged score was multiplied by the associated weight (Table 1) of the primary need. The total score of a concept was then obtained by summing up the weighted scores from the nine criteria. Example of the total score calculation is shown in Table 2.

The total scores of concept alternatives 1, 2, and 3 respectively are 4.34, 3.72, and 4.04. Based on these results, the first alternative was selected as the best concept, as it has the highest total score (highlighted in Table 2). In addition to the concept scoring, persuasive design strategies and persuasive technology tools that each concept encompassed were taken into consideration. Concept 1 as the selected one, covers the most

Table 2. Example of Total Score Calculation of the Concepts

Need No. (weight)	Concept 1 Score A	Concept 1 Score B	Concept 1 W score	Concept 2 Score A	Concept 2 Score B	Concept 2 W score	Concept 3 Score A	Concept 3 Score B	Concept 3 W score
1 (13.40%)	5	5	0.67	3	5	0.54	4	5	0.60
2 (13.06%)	5	5	0.65	4	5	0.59	5	5	0.65
....			....			....			....
9 (7.90%)	5	5	0.40	4	5	0.36	5	4	0.36
Total score			**4.34**			**3.72**			**4.04**

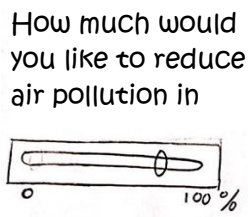
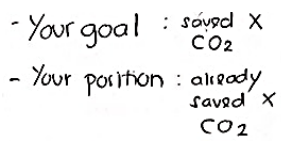
*The highlighted number indicates the highest score

Table 3. Assessment of Persuasive Aspects of the Concepts

Persuasive Design Strategies	**Concepts**		
	1	**2**	**3**
Direct Appeal			
Social Triggers and Support	v		v
Gamification	v	v	
Reward	v	v	v
Data Visualization	v		v
Multimodal Design			
TOTAL	**4**	**2**	**3**
Persuasive Technology Tools	**Concepts**		
	1	**2**	**3**
Reduction			v
Tunneling	v	v	v
Tailoring			
Suggestion	v		v
Self-monitoring	v	v	
Surveillance			
Conditioning			
TOTAL	**3**	**2**	**3**

*The highlighted number indicates the highest score

Table 4. Example of SCAMPER

No.	Picture	Description
Concept 2		
1.		The goal setting feature is adapted (A) from Concept 2. However, its placement is changed to the page after the user has finished registering an account.
2.		The goal and position feature is adapted (A) from Concept 2, in accordance with the goal setting feature that is adapted previously.

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aspects for both categories, as can be seen and highlighted in Table 3.

To refine the selected concept into the final one, a SCAMPER process [20] was carried out. At this stage, the process of substituting, combining, adapting, modifying, putting on another use, eliminating, and reducing was done by referring to the two other concepts, primary needs, persuasive design strategies, and persuasive technology tools. Table 4 exemplifies the SCAMPER process by adapting features from Concept 2 into Concept 1.

Prototyping

A high-fidelity prototype was developed based on the final concept sketched on paper. The prototype was built using the Figma software. The application prototype is called ecoGlide (Figure 4) and can be seen fully at the following link: https://www.figma.com/proto/l04h53mEYOVx1Zrshbx63T/ecoGlide-ori?node-id=386%3A192&scaling=scale-down

Evaluation

The evaluation of ecoGlide application was carried out with the aim of identifying the positive and negative points of the prototype. This evaluation was also used to measure the application's performance. The evaluation of this persuasive application consisted of two main parts, namely Usability Testing and the testing of persuasive quality using the User Experience Diary and Co-Discovery methods.

Usability Testing

Usability Testing was conducted to find the flaws in the prototype's user interface. The testing involved eight users and used five criteria, namely effectiveness, efficiency, satisfaction, usefulness, and learnability. The details of the Usability Testing are summarized in Table 5.

Effectiveness criterion measures the ease of application to be used to achieve users' goals in accordance with users' expectation. For this criterion, the participants were asked to perform the given tasks. The application being tested is considered effective if the participants can complete the tasks without any errors. Thus, effectiveness can be measured by dividing the number of successful participants by the total number of participants. Table 6 shows the calculation of the application's effectiveness.

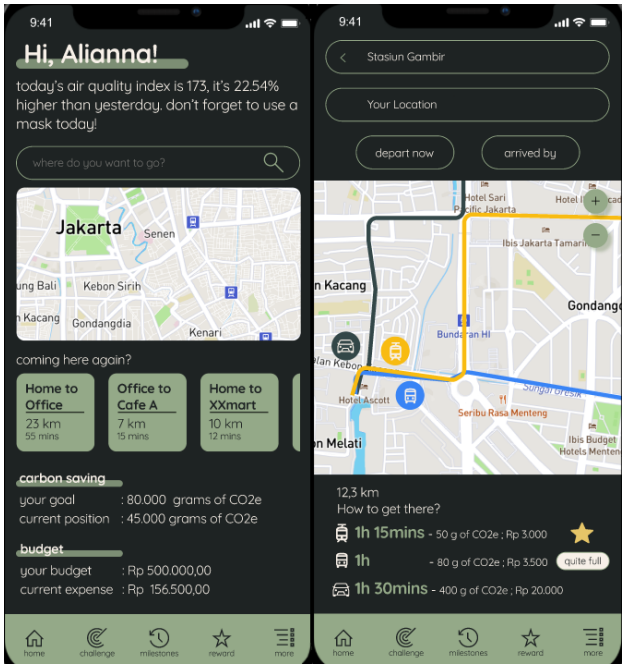


Figure 4. Example of ecoGlide Application Prototype

Based on Table 6, the application's overall effectiveness is 91%, way exceeding the minimum value of 70% to be considered acceptable [21]. Thus, the ecoGlide application meets the effectiveness criterion. However, two tasks in this test indicate only 50% of success rate. The cause of this problem would be investigated and rectified accordingly to improve the application.

Efficiency criterion measures how fast the application can be used to complete a task accurately. To test the application's

Table 5. Detailed Plan of Usability Testing

Goal	Identifying the flaws of the application interface design
	Rectifying the application interface design based on evaluation results
Participants	Eight participants
	Smartphone users
	Domiciled in Greater Jakarta
	Aged between 19-54 years
Method	The testing is conducted online and recorded so that it can be reviewed if needed
	The participants are asked to complete the given tasks using the application prototype
	After completing the tasks, participants are asked to fill out the SUS questionnaire
	Interview is conducted to get advice on the better design of the persuasive application
Environment	Testing is done online via video call using Zoom or Google Meet application
Tools	Smartphone and laptop
	ecoGlide application prototype
	SUS questionnaire
Tasks	Signing up
	Filling out the target of carbon saving
	Searching for and choosing the best route to a destination
	Completing the trip and checking the points earned
	Checking the current challenges
	Sending challenges to friends
	Creating the personal milestones data visualization
	Creating the comparative milestones data visualization
	Redeeming points for train vouchers
	Checking the achievements on the profile page
	Checking the points required to level up to the next level
	Reading the latest news
	Changing reminder settings
	Logging out

Table 6. Calculation of Application's Effectiveness

No	Tasks	Successful Participants	Effective-ness (%)
1st Scenario			
1	Signing up	8	100%
2	Filling out the target of carbon saving	8	100%
3	Searching for and choosing the best route to a destination	8	100%
4	Completing the trip and checking the points earned	8	100%
2nd Scenario			
1	Checking the current challenges	8	100%
2	Sending challenges to friends	7	88%
3	Redeeming points for train vouchers	8	100%
4	Checking the points required to level up to the next level	4	50%
3rd Scenario			
1	Creating the personal milestones data visualization	7	88%
2	Creating the comparative milestones data visualization	8	100%
3	Checking the achievements on the profile page	4	50%
4	Reading the latest news	8	100%
5	Changing reminder settings	8	100%
6	Logging out	8	100%
Overall Effectiveness			**91%**

*The highlighted number indicates the effectiveness score less than minimum acceptable value of 70%

efficiency, a maximum completion time (MCT) is required as a time limit against which the users' completion time will be measured. The application design is efficient if users can complete the given tasks without surpassing the associated MCT. The MCT of each task was obtained by measuring the time required by an expert (in this case was the researcher) to complete the task. This time measurement was replicated five times with a half day interval between replications to minimize the learning effect. Next, the results were averaged and then multiplied by an allowance factor of 1.5 that was determined based on Shumard adjustment method [29]. The participants did the tasks in accordance with the scenarios previously described while the completion times were recorded. The efficiency score was obtained by dividing the number of participants who could complete the task with completion time under or equal to MCT by the total number of participants. The calculation of the efficiency score can be seen in Table 7.

Table 7 shows that there are three tasks whose scores are under the minimum acceptable value of 70% [21]. The problem causes would be addressed to improve the application performance. However, the application's overall efficiency is 71.43% (i.e. above the minimum value of 70%), indicating that the ecoGlide prototype has met the efficiency criterion.

Table 7. Calculation of Application's Efficiency

No	Successful Participants	MCT (sec)	Efficiency (%)
1st Scenario			
1	6	62.76	75%
2	6	15.78	75%
3	7	22.67	87.5%
4	7	1529	87.5%
2nd Scenario			
1	8	6.98	100%
2	8	24.67	100%
3	6	15.93	75%
4	4	1063	50%
3rd Scenario			
1	0	23.30	0%
2	7	30.41	87.5%
3	0	7.75	0%
4	7	8.28	87.5%
5	6	23.41	75%
6	8	5.92	100%
Overall Efficiency			**71.43%**

*The highlighted number indicates the efficiency score less than minimum acceptable value of 70%

The satisfaction, usefulness, and learnability qualities of the application were measured using the System Usability Scale (SUS) Questionnaire [30]. Satisfaction refers to the users' feeling of being satisfied by the application's performance and ease of use. Usefulness is the measure of application's ability in helping the users to achieve their goals, indicated by the users' desire to reuse the application. Lastly, learnability refers to the ease of application to be learnt and used after a certain period of interacting with it.

The SUS questionnaire consists of 10 statements to which the participants were asked to give score ranging from 1 (strongly disagree) to 5 (strongly agree). The statements are as follows:

1. I think I would like to use this application frequently.
2. I find the application is unnecessarily complex.
3. I think the application is easy to use.
4. I think I would need support from a technical person to be able to use this application.
5. I find the various functions in this application are well integrated.
6. I think there are too many inconsistencies in this application.
7. I imagine that most people would learn to use this application very quickly.
8. I find the application is very cumbersome to use.
9. I feel very confident using this application.
10. I need to learn many things before being able to use this application.

Users' satisfaction is measured by statements number 2, 3, 5, 6, 8, and 9, whereas the application's usefulness is measured by statement number 1. The learnability of the application is addressed by statements number 4, 7, and 10. Because the even statements are negative remarks, their scores must be converted by subtracting 6 by the score received from the respondents. For example, if statement 2 receives a score of 5, this score is then

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Table 8. Results of SUS Questionnaire

Statement Number	Participants 1	2	3	4	5	6	7	8	Mean
1. Satisfaction									
2	3	4	2	4	2	4	4	2	3.125
3	4	5	4	2	4	5	5	3	4.000
5	4	4	2	2	5	4	4	5	3.750
6	5	5	2	3	4	4	4	4	3.875
8	4	5	4	2	4	2	5	3	3.625
9	5	5	5	4	4	5	4	5	4.625
Total Mean									**3.830**
2. Usefulness									
1	5	5	3	3	5	4	2	4	3.875
Total Mean									**3.880**
3. Learnability									
4	4	5	5	2	2	2	5	5	3.750
7	3	4	4	2	4	4	5	2	3.500
10	4	5	4	3	5	5	1	4	3.875
Total Mean									**3.880**

*The highlighted number indicates the SUS score less than minimum acceptable value of 3.4

converted into 6 – 5 = 1. Eight participants filled out the questionnaire and the results are recapitulated in Table 8.

The satisfaction, usefulness, and learnability qualities respectively score 3.83, 3.88, and 3.88, which are above the minimum acceptable value of 3.4 (maximum score of 5 multiplied by 68% [30]). This means the overall design of the application meets the criteria of satisfaction, usefulness, and learnability. However, statement 2 scores below 3.4 (highlighted in Table 8). According to the participants, there was too much information on the application's home page, which caused the feelings of confused and overwhelmed as they had to digest a lot of information at once. This problem would be fixed.

User Experience Diary

Anticipated user experience (AUX) is an evaluation system in which users imagine that they are in a situation of interacting directly with products that are fully functional [23,24]. This method was used because there were limitations in getting the data of real user experience (RUX) due to the COVID-19 pandemic, where participants were very limited in the use of public transportations. The data of AUX were collected using Experience Diary method. In this study, the experience diary was prepared in the form of Google Form, which was distributed to and filled out by the participants electronically.

The users were asked to use the ecoGlide application for three days with three different scenarios given each day. The evaluation procedure using the Experience Diary method is as follows:

1. Users were asked to read a specific scenario according to the day they evaluated the application.
2. Users were asked to imagine the situation in the scenario and to imagine that the situation actually happened to them.
3. Users were asked to identify the feelings and emotions they felt when the events in the scenario occurred to them.
4. Users were asked to use the ecoGlide application in accordance with the needs and feelings or emotions that arose due to events in the scenario.
5. Users were asked to fill out the experience diary in accordance with the things they did and the feelings or emotions that arose when using the ecoGlide application.

Co-Discovery

Having completed the Experience Diary stage, the users were brought together in pairs at the Co-Discovery stage. Co-Discovery was conducted to complete the process of AUX that users had during the Experience Diary session. At this stage, users were asked to verbally discuss their experiences in using the ecoGlide application with fellow users in pairs, facilitated by the researcher as the moderator. Topics of discussion include:

1. Experiences in using the application.
2. Feelings and emotions when using the application.
3. The desire to use the application in daily life.
4. The role of the application in motivating users to use public transportation more often.
5. Imagined or anticipated behavior of the users when using the application.

To process users' comments as qualitative data, the Grounded Theory [31] and Data Coding [32] methods were used to determine the causality relationships between categories in the data. To classify these data, a coding scheme consisting of five categories and 14 sub-categories was developed (**Table 9**).

Users' comments from the Experience Diary and Co-Discovery sessions were analyzed to be grouped in the categories according

Table 9. Coding Scheme

Categories	Sub-Categories	Code
User Interface	Liked Interface	LI
	Disliked Interface	DI
	Liked Feature	LF
	Disliked Feature	DF
Persuasion Aspect	Behavioral Change	BC
	Awareness	A
	Positive Desire to Use	PDU
	Negative Desire to Use	NDU
	Reward Driven	RD
User Experience	Positive User Experience	PUX
	Negative User Experience	NUX
Emotion	Positive Emotion	PE
	Negative Emotion	NE
Social Interaction		SI

Table 10. Example of Data Coding

No	User's Comments	Sub-Category
1	When I use public transportation for the first time, it would certainly make me feel anxious and unsure whether the selected route is correct. Therefore, it is important for me to sign up for this application with an easy and practical process. This application does not require many steps and many things to fill out to sign-up. So, it is easy and fast (does not add up my panic).	LI, NUX, PE, NE

*LI: Liked Interface, NUX: Negative User Experience, PE: Positive Emotion, NE: Negative Emotion

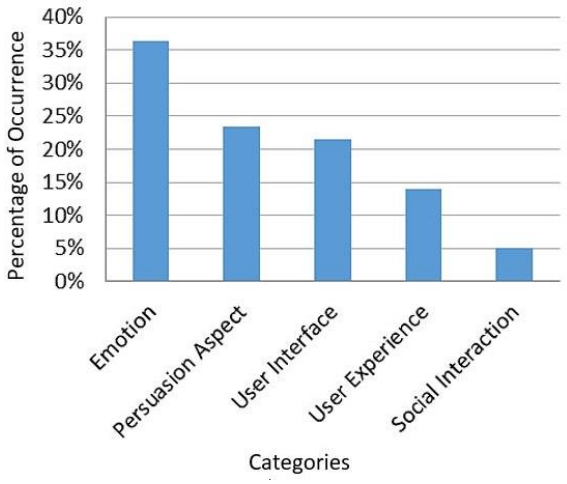
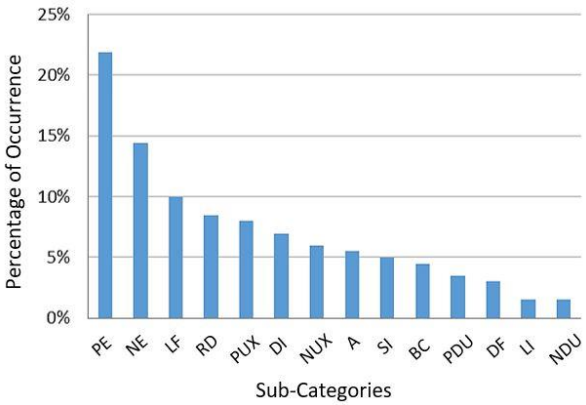


Figure 5. Percentage of Occurrence of Categories

to the coding scheme (i.e. data coding process). The data coding process was to match the users' expressions with the scope of each category and sub-category in the coding scheme. Each sentence can be associated with more than one category or sub-category. An example of the data coding is presented in Table 10.

There were 104 sentences which were classified into five categories in the coding scheme. The occurrences of each category were counted. The percentage of occurrence of each category is shown in Figure 5. Based on Figure 5, the category that dominates most in users' comments is Emotion with a percentage of 36.32%. The next dominant category is Persuasion Aspect with a score of 23.38%. This indicates that the emotion and persuasive aspects play an important role in shaping the experience and behavior of users in using the ecoGlide application related to the public transportation use.

Figure 6 presents the percentage of occurrence of sub-categories. Out of the fourteen sub-categories, the dominant sub-category is Positive Emotions (PE) with a percentage of occurrence of 21.89%. It can be inferred that the application influences and evokes positive emotions from the user during use. Furthermore, Reward Driven (RD), which is a part of Persuasion Aspect category, places the fourth as the most dominant sub-category



PE: Positive Emotion, NE: Negative Emotion, LF: Liked Feature, RD: Reward Driven, PUX: Positive User Experience, DI: Disliked Interface, NUX: Negative User Experience, A: Awareness, SI: Social Interaction, BC: Behavioral Change, PDU: Positive Desire to Use, DF: Disliked Feature, LI: Liked Interface, NDU: Negative Desire to Use

Figure 6. Percentage of Occurrence of Sub-Categories

(8.46%). This indicates that providing reward to the users is an essential persuasive strategy that can influence users' behavior. Therefore, the rewarding system in the ecoGlide application is expected to motivate the users to use public transportation more often.

Co-occurrence analysis was conducted to explore the relationships among sub-categories, especially between those belong to Persuasion Aspect category and the other sub-categories. For example, Reward Driven (RD) co-occurs the most with Positive Emotion (PE, 48.28%) and Behavioral Change (BC, 13.79%). The causality relationships that can be inferred: 1) reward received by the users engenders positive emotions during the use of the application, and 2) appealingness and worth of the reward influence the change of users' behavior.

The results of co-occurrence analysis show that in general all sub-categories of Persuasion Aspect (i.e. Behavioral Change, Awareness, Positive Desire to Use, Negative Desire to Use, and Reward Driven) are closely related to Positive Emotion (PE). This demonstrates that positive emotion is an important and influential factor of the persuasiveness of the application. The more features and appearances stimulate users' positive emotions during use, the more effective and persuasive the application influences the users. Therefore, in the design and development stage of an application, it is essential to consider the users' emotions that may arise when they are interacting with it.

The ecoGlide prototype was improved according to the evaluation results. The final prototype can be seen in the following link: https://www.figma.com/proto/EVgPUu8bw6qxsG5mWf1xnS/ecoGlide-revised?node-id=386%3A285&scaling=scale-down

CONCLUSION

This research designs ecoGlide, a persuasive application to encourage users to use public transportation more often as an effort to reduce environmental problems in Jakarta. Interaction design steps were employed, comprising user needs identification, concept generation, concept selection and refinement, prototyping, and evaluation.

Three concept alternatives of the application were produced through the design workshop based on nine identified primary needs. Using the Concept Scoring process, Concept 1, which has gamification characteristics, was selected and then refined through the SCAMPER method into a final concept. A high-fidelity prototype was developed based on this final concept.

Evaluation of the prototype consisted of performance and persuasiveness tests. The application's performance was evaluated using Usability Testing with five criteria. Respectively, the scores of the application's effectiveness and efficiency are 91% and 71.43%, which exceed the minimum acceptable value of 70%. In addition, the average scores of satisfaction, usefulness, and learnability criteria consecutively are 3.83, 3.88, and 3.88, which also surpass the minimum acceptable value of 3.4. The persuasive quality of the application was assessed using Experience Diary and Co-Discovery methods, resulting in qualitative data. The most dominant sub-category of the persuasion aspect is Reward Driven, meaning that the ability of application to persuade users' behavioral change is mainly influenced by rewarding system. Appealingness and worth of the

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reward provided by the application may encourage the users to use public transportation more often. Moreover, user's positive emotions during the use of application play an important factor in developing persuasiveness of the application.

There are some aspects that can be addressed to improve this research. First is to create a prototype that is compatible for multiple screen types of smartphones. There were several users using certain types of smartphones who had to scroll down to see the main menu located at the bottom of the page, because the screen size of their smartphone is smaller than the prototype page size. This may cause a bias when evaluating the application's usability. Second is to assess the real user experience instead of anticipated one in evaluating the persuasiveness of the application to produce more accurate results. Therefore, the application prototype should be made into a working prototype that can be actually used in a real situation.

REFERENCES

[1] V. Ramanathan and Y. Feng, "Air Pollution, Greenhouse Gases and Climate Change: Global and Regional Perspectives", Atmospheric Environment, vol. 43, no. 1, pp. 37-50, 2009. doi: 10.1088/1126-6708/2008/09/063.

[2] S. Montzka, E. Dlugokencky, and J. Butler, "Non-CO2 Greenhouse Gases and Climate Change", Nature, vol. 476, pp. 43–50, 2011. doi: 10.1038/nature10322.

[3] Air Visual, "Jakarta Air Quality Index (AQI) and PM2.5 Air Pollution is 163, Unhealthy," airvisual.com, 2019. [Online]. Available: https://www.airvisual.com/indonesia/jakarta [Accessed: Nov. 25, 2019].

[4] Airnow, "Air Quality Index (AQI) Basics," airnow.gov, 2019. [Online]. Available: https://www.airnow.gov/index.cfm?action=aqibasics.aqi [Accessed: Nov. 25, 2019].

[5] Portal Statistik Sektoral Provinsi DKI Jakarta, "Berapa Kepadatan Penduduk DKI Jakarta Saat Ini?", Unit Pengelola Statistik, 2020. [Online]. Available: http://statistik.jakarta.go.id/berapa-kepadatan-penduduk-dki-jakarta-saat-ini/ [Accessed: Oct. 10, 2020].

[6] Dinas Perhubungan DKI Jakarta, "Data Pertambahan Jumlah Kendaraan Bermotor DKI Jakarta," data.jakarta.go.id, 2018. [Online]. Available: http://data.jakarta.go.id/dataset/data-pertambahan-jumlah-kendaraan-bermotor-dki-jakarta [Accessed: Nov. 10, 2019].

[7] Dinas Perhubungan DKI Jakarta, "Data Armada Angkutan Umum," data.jakarta.go.id, 2019. [Online]. Available: http://data.jakarta.go.id/dataset/data-armada-angkutan-umum-kpi [Accessed: Nov. 10, 2019].

[8] H. Prabowo, "Kenapa Warga Jabodetabek Sulit Beralih ke Transportasi Umum?", tirto.id, Aug. 9, 2019. [Online]. Available: https://tirto.id/kenapa-warga-jabodetabek-sulit-beralih-ke-transportasi-umum-efYl [Accessed: Jan. 4, 2020].

[9] E. Anagnostopoulou, E. Bothos, B. Magoutas, J. Schrammel, and G. Mentzas, "Persuasive Technologies for Sustainable Mobility: State of the Art and Emerging Trends", Sustainability, vol. 10, no. 7, 2018. doi: 10.3390/su10072128.

[10] E. Bothos, S. Prost, J. Schrammel, K. Röderer, and G. Mentzas, "Watch Your Emissions: Persuasive Strategies and Choice Architecture for Sustainable Decisions in Urban Mobility", PsychNology Journal, vol. 12, no. 3, pp. 107 – 126, 2014.

[11] M. Wunsch, A. Stibe, A. Millonig, S. Seer, C. Dai, K. Schechtner, and R. C. C. Chin, "What Makes You Bike? Exploring Persuasive Strategies to Encourage Low-Energy Mobility", in PERSUASIVE 2015: Persuasive Technology, Lecture Notes in Computer Science, vol. 9072, T. MacTavish and S. Basapur, Eds. Cham: Springer, 2015. doi: 10.1007/978-3-319-20306-5_5.

[12] K. Y. Suhartono and J. R. Octavia, Perancangan Mobile Game yang Persuasif untuk Meningkatkan Aktivitas Fisik Anak Sekolah Dasar. Undergraduate Thesis. Bandung: Parahyangan Catholic University, 2017.

[13] F. Tonadi and K. A. Damayanti, Perancangan Aplikasi Game Edukatif dan Persuasif Dengan Tema Kebersihan Lingkungan untuk Anak-anak. Undergraduate Thesis. Bandung: Parahyangan Catholic University, 2017.

[14] J. Mintz and M. Aagaard, "The Application of Persuasive Technology to Educational Settings", Educational Technology Research and Development, vol. 60, pp. 483–499, 2012. doi: 10.1007/s11423-012-9232-y.

[15] J. Preece, Y. Rogers, and H. Sharp, Interaction Design: Beyond Human-Computer Interaction, 5th Ed. Chichester: John Wiley & Sons Ltd, 2019.

[16] Asosiasi Penyelenggara Jasa Internet Indonesia, "Penetrasi & Profil Perilaku Pengguna Internet Indonesia 2018", apjii.or.id, 2018. [Online]. Available: https://apjii.or.id/survei [Accessed: Jan. 3, 2020].

[17] B. J. Fogg, "The Six Most Powerful Persuasion Strategies", in PERSUASIVE 2006: Persuasive Technology, Lecture Notes in Computer Science, vol. 3962. W. A. IJsselsteijn, Y. A. W. de Kort, C. Midden, B. Eggen, E. van den Hoven, Eds. Berlin, Heidelberg: Springer, 2006.

[18] B. J. Fogg, Persuasive Technology: Using Computers to Change What We Think and Do. San Francisco: Morgan Kaufmann Publishers, 2003. doi: 10.1145/764008.763957.

[19] H. W. Stoll, Product Design Methods and Practices. New York: Marcel Dekker, Inc, 1999. doi: 10.1201/9781482276800.

[20] H. Harrington and F. Voehl, The Innovation Tools Handbook: Evolutionary and Improvement Tools That Every Innovator Must Know. Boca Raton, Florida: Taylor & Francis Group, LLC, 2016. https://doi.org/10.1201/b21448.

[21] J. Rubin and D. Chisnell, Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests, Second Edition. Indiana: Wiley Publishing, Inc, 2008.

[22] C. Lallemand, "Dear Diary: Using Diaries to Study UX," User Experience Magazine, vol. 11, no. 3, pp. 18-21, 2012. [Online]. Available: https://uxpamagazine.org/dear-diary-using-diaries-to-study-user-experience/ [Accessed: Nov. 10, 2019].

[23] T. Yogasara, Anticipated User Experience in The Early Stages of Product Development. PhD Dissertation. Queensland University of Technology, 2014. [Online]. Available: https://eprints.qut.edu.au/66240/ [Accessed May. 26, 2020].

[24] T. Yogasara, V. Popovic, B. Kraal, and M. Chamorro-Koc, "General Characteristics of Anticipated User Experience (AUX) with Interactive Products," Proceedings of IASDR2011, the 4th World Conference on Design

Research, 2011. [Online]. Available: https://eprints.qut.edu.au/47035/ [Accessed: May. 26, 2020].

[25] P. W. Jordan, Designing Pleasurable Products: An Introduction to the New Human Factors, London: Taylor & Francis, 2000. doi: 10.4324/9780203305683.

[26] J. S. Dumash and J. C. Redish, A Practical Guide to Usability Testing, Revised Ed., Exeter, UK: Intellect Books, 1999.

[27] J. S. Dumash and J. E. Fox, "Usability Testing", in The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications, 3rd Ed., J. A. Jacko, Ed. Boca Raton, FL: CRC Press, 2012.

[28] J. Nielsen, "Why You Only Need to Test with 5 Users?", Nielsen Norman Group, 2000 [Online]. Available: https://www.nngroup.com/articles/why-you-only-need-to-test-with-5-users/ [Accessed: Feb. 8, 2020].

[29] I. Z. Sutalaksana, R. Anggawisastra, and J. H. Tjakraatmadja, Teknik Perancangan Sistem Kerja, Bandung: Jurusan Teknik Industri ITB, 2006.

[30] J. Sauro, A Practical Guide to the System Usability Scale: Background, Benchmark & Best Practices. North Charleston SC: Createspace Independent Publishing Platform, 2011.

[31] J. Corbin and A. Strauss, Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. California: Sage Publications, Inc, 1998.

[32] G. Gibbs, Analyzing Qualitative Data. London: SAGE Publications Ltd., 2007. doi: 10.4135/9781849208574.

AUTHORS BIOGRAPHY

Thedy Yogasara
Thedy Yogasara is a senior lecturer in the Department of Industrial Engineering, Parahyangan Catholic University. He obtained a master's degree from the University of New South Wales in 2003, and received a doctorate from Queensland University of Technology in 2014. The author's research areas include ergonomics, human-computer interaction, usability engineering, and user experience.

Vania Edra Christabel Naomi
Vania Edra C. N. obtained her bachelor's degree in 2020 in Industrial Engineering of Parahyangan Catholic University, Indonesia. She was an exchange student in early 2020 in Seinan Gakuin University, Japan. She is interested in Product Design and Ergonomics. Her undergraduate thesis is related to User Experience and Persuasive Design.

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