

The Design of Sustainable Lifestyle Application User Interface Using Design Thinking Approach

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Abstract

Human awareness of environmental control is getting bigger due to the increasingly urgent world situation. However, the lack of knowledge of sustainability behavior and consistent commitment results in not fully living a sustainable lifestyle. Furthermore, recent studies have shown that smart device is only a tool, and does it not always support and build sustainable behavior; especially, if the system or tool does not interact much with the user. The aim of this study is that to design a mobile-based sustainable lifestyle gamification application which can motivate and build sustainable behavior. This study used a design thinking framework for practical and creative solutions by emphasizing a user-side approach. Finally, the user interface design with gamification features is considered to be able to improve a unique, fun and motivating user experience since it prioritizes user involvement by providing challenges and prizes as well as making users aware of the great impact of sustainable behavior. Therefore, from the two final designs, which are usability and performance tests, show that applications with light mode and dark mode designs have satisfactory scores; besides, they are recommended. However, the value in the light mode design concept is higher than the dark mode design.

Keywords

Sustainable Lifestyle, Gamification, Design Thinking, User Interface, User Experience.

1. Introduction

The Covid-19 pandemic has severely disrupted community priorities and individual lifestyles with major implications for sustainable development (Echegaray 2021). It is in line with research which had conducted by (Bayer et al. 2021) which stated that climate change is considered to have a role in the global pandemic. Furthermore, research which had conducted by Dr. Simon Evans from Carbon Brief shows that Indonesia is in the fourth rank of emitters in the world. Moreover, in the Indonesia.go.id report, Indonesia is in the third rank of the largest plastic waste producer in the world; besides, Indonesia is predicted to experience a water crisis since it is at the lowest level of water availability in Southeast Asia. According to The Limits to Growth (1972) and Beyond the Limits (1992) Humanity's future is determined not by an emergency, such as, war, but it is determined by many separate crises, but they are related to and came from ongoing failure. In addition, sustainable lifestyle is an effort which underlies sustainable living behavior, not only personal health and lifestyle but also lifestyle related to the process of preserving nature. In recent years, sustainable thinking has gradually been recognized and accepted by society, but in daily life, there is a gap between the value of pursuing a sustainable lifestyle and people's behavioral habits.

Globalization era has an influence on behavior and lifestyle in aspects of life (Micklethwait 2003). Games and mobile based application give opportunities to improve sustainable behavior (Douglas and Mrauer 2020). According to Statista.com, Indonesia is in the fourth rank of smartphone users in the world and the number of smartphone users is expected to reach 239 million by 2026. Gamification is an informal general term which is used to describe the use of game elements in non-gaming systems in order to improve user experience (UX) and user engagement (Sebastian et al. 2011). Moreover, gamification can produce habits by increasing the rewards and emotional responses of individuals involved in the experience to produce desired behavioral changes. In addition, according to (Robson et al. 2015) gamification has broad application prospects in sustainable development.

There are several studies related to gamification, one of which is researchers (Mulcahy et al. 2020) which used gamification applications to encourage sustainable household energy consumption. Researchers (Ponce et al. 2020) used gamification to enable customers to save energy by engaging and motivating through dynamic interfaces. Furthermore, researchers (Ilhan et al 2020) used gamification to motivate users to control their bedtime routine. Meanwhile, researchers (AlSkaif et al. 2018) emphasized the fact that smart metering systems do not always encourage residential customers to use energy more sustainably. Therefore, we should more focus on customer engagement than technology. Researchers (Zang 2020) proposed gamification as a digital user experience (UX) solution with a more sustainable choice in changing water consumption behavior. According to (Gifford 2011) games and applications can reduce the barrier of ignorance for individuals about what behavior to adopt. Games can be useful in overcoming social influences, habit formation, and the tangible components of behavior change (White et al. 2019). Therefore, gamification is considered capable of educating and forming good habits with the aim of a sustainable lifestyle. In order to support user-center design, gamification will be combined with design thinking methods.

Design Thinking is an iterative process in which someone tries to understand the user, challenge assumptions, and redefine the problem to identify alternative strategies and solutions which may not be immediately apparent to the initial level of understanding (Soegaard and Dam 2018). The design thinking method which was originally applied in architecture, engineering and business, has resulted in new and creative problem solving so that it creates a lot of potential for use in sustainable development (Mara 2020). Furthermore, the design thinking process is divided into five steps that are Empathize, Define, Ideate, Prototype, and Testing. There are several studies related to design thinking, one of which is researchers (Kagan et al. 2020) which analyzed the potential and limitations of Design Thinking in clock sustainability and contribute to sustainability solutions. Furthermore, the researcher (Alexandrakis 2021) explained the stages of urban design thinking which contribute to the potential for sustainable living. Meanwhile, researchers (Rui 2021) explore the relationship between gamification and design thinking approaches in order to innovate in the context of early stages of the innovation process (ESoIP). This study explores the relationship between how the limitations of design thinking can be overcome by the gamification approach in making product or service innovations. Based on the literature review, there is no mobile-based sustainable lifestyle application in Indonesia which provides awareness and encourages a sustainable lifestyle by using design thinking and gamification to the design stage of service product innovation in Indonesia.

1.1 Objectives

This study aims to design a sustainable lifestyle gamification application user interface by using a design thinking approach combined with a user experience (UX) design method in order to educate society about the importance of a sustainable lifestyle; besides, provide fun experiences to encourage sustainable behavior. The result of the study is the design of the Prototype User Interface application which will be used by generations Y and Z, designed according to the wishes of users who can build awareness in forming and improving sustainable behavior. Thus, it becomes a long-term habit which is expected to be recommended for use on smartphones.

2. Literature Review

2.1 Sustainable Lifestyle

Sustainable Lifestyle is a group of habits and behavior patterns which are embedded in society, and it is facilitated by institutions, norms, and infrastructure that frame individual choices in order to minimize the use of natural resources, generate waste, as well as supporting justice and prosperity (Timmer et al. 2018). This sustainability behavior is in line with the objectives of the Sustainable Development Goals (SDGs), which is a global action plan which is agreed by world leaders, including Indonesia in order to eradicate poverty, reduce inequality and protect the environment. Environmentally and economically sustainable can be achieved if only we support sustainable lifestyles (Cohen 2017). The United Nations environment program concluded sustainable lifestyles as “rethinking the way we live, how we buy and what we consume, not just rethinking but how we organize our daily lives, changing the way we socialize, exchange, share, educate and identity building” (Timmer et al. 2018). With climate change, natural resource depletion, and increasing waste, humans need to focus on actions which drastically change the ecological footprint of lifestyles. In this case consumption patterns dominate the modern economy while consumer culture shapes the understanding of progress. Changing the way, we live is important to achieve global sustainability. Ecologically sustainable living ensures ecological stability, provides hope for future generations and helps individuals capitalize on shared values, such as, belonging, security, happiness, intergenerational care and good health.

2.2. Human Computer Interaction

Human Computer Interaction is a multidisciplinary field which focuses on the design of computer technology; especially, the interaction between humans and computers. Although initially related to computers, HCI has grown to cover almost all forms of information technology design (Interaction Design Foundation 2020). Furthermore, HCI is an important instrument for popularizing the idea that interactions between computers and users should resemble human-to-human dialogue and be open. HCI is rooted in three main fields that are: Industrial Engineering, Human Factors, and Cognitive Psychology (Samento 2005). The development of HCI has contributed to the fields of industrial psychologists, instructional and graphic designers, human factors and practitioners as well as ergonomics researchers, anthropologists, sociologists, economists, lawyers, privacy advocates, and ethicists (Shneiderman et al. 2013). The purpose of HCI in general is that to produce a system which is safe, effective and works well functionally. In the field of HCI, researcher examines how humans work with machines, ensure they can operate machines by designing interfaces that can optimize processes, which include a user interface and usability elements to ensure effectiveness, and produce better communication between humans and machines. This study will produce an interface which considers the user's feelings. Mobile-based applications are believed to be the most appropriate instrument to achieve the goal of supporting the achievement of a sustainable lifestyle since smartphones nowadays have become one of the daily necessities.

2.3 User Interface (UI)

In the world of design, the user interface has become one of the important issues which have become the center of attention (Hsiao et al. 2017). According to the Interaction Design Foundation (2018), User Interface is the process of creating computerized software or device interfaces with a focus on style and appearance. The user interface will operate and control the machine so that it can complete tasks effectively and receive feedback which helps in decision making (Lindberg 2019). Furthermore, the user interface design should aim to make it easy and pleasing to the user. Therefore, it is important to put the user in the design of the user interface. Empathy with users will be a determining factor in a good user interface design, further making users as comfortable as possible when interacting with a product by reducing the cognitive load of the user interface and design consistency. User-centered design is an interaction design method which involves designing software from the user's perspective so that it is more likely to meet needs and provide a more intuitive experience (Wray et al. 2019). A good understanding of the user is required to establish a "fit" between the product, user experience and perception (Redstrom 2006).

2.4 User Experience (UX)

User Experience is the process of manipulating user behavior through the usability, usefulness, and desire provided in interaction with a product (Eyal and Hoover 2014). The term User Experience was first used in 1990 by Donald Arthur Norman, academic in cognitive science, design and usability engineering and former vice president of Apple Inc. Furthermore, user-centered design is a technological and functional product which is able to provide a pleasant experience, easy to use so that it has high user involvement as measured by the length of time spent using the product. One of the factors behind the creation of UX is that the terms HCI and usability are still too narrow. UX covers all aspects of one's experience with a system, including industrial design, graphics, user interfaces, physical interactions, and manuals. User Experience is a form of interaction between humans and computers which includes websites, smartphone applications and desktop applications. Understanding UX is often interpreted as the achievement of a product or service which is considered successful or failed by users. In addition, there are 5 basic elements of UX that are strategy, scope, structure, skeleton and surface (Garrett 2011). The user experience is dynamic since it changes from time to time as the times change. With a good user experience, users can feel satisfaction so that it has a very good impact on the system with quality content and easy access. Many projects have attempted to help someone achieve behavior change. However, changing people's attitudes or behavior is actually not easy. Thus, it is important to understand and handle user responses in order to get a positive user experience value.

2.5 Gamification

Gamification is an informal general term which is used to describe the use of game elements in non-game systems in order to enhance user experience and user engagement (Deterding et al. 2006) can produce habits by increasing the rewards and emotional responses of the individuals involved to produce the desired behavioral changes. Moreover, gamification has broad application prospects in sustainable development (Robson et al. 2015). Game design elements are the basic building blocks of gamification applications (Werbach and Hunter 2015). The building blocks of this game are used to engage users, solve problems, and encourage certain behaviors. Some of the typical game design elements which are often used are points, badges, leaderboards, performance graphs, meaningful stories, and challenges (Sailer et al. 2014). One of the biggest roles of gamification is that to create user engagement. According

to (Lnders et al. 2015), gamification can use intrinsic and extrinsic motivation to change user behavior. Gaining gamified elements like badges exists as extrinsic motivation. At the social level, these elements satisfy the need for psychological relevance. In its application, gamification needs to find a meeting point between user goals and business goals. Users are expected to feel satisfied when they see progress as measured visually by gamification.

2.6 Design Thinking

Design Thinking is a structured solution approach method which is oriented towards user needs to solve problems (Schallmo et al. 2018). Design Thinking is an iterative process in which someone tries to understand users, challenge assumptions, and redefine the problem to identify alternative strategies and solutions which may not be immediately apparent to the initial level of understanding (Soegaard 2018). Design Thinking is a way of thinking which leads to transformation, evolution and innovation, to new forms of life and new ways of managing business (Tschimmel 2012). Furthermore, Brown's team concluded that design thinking is essentially a problem-solving approach which combines a holistic user-centered perspective with rational and analytical research with the aim of creating innovative solutions. Based on the Interaction Design Foundation (2018), design thinking consisted of 5 steps that were Empathy, Define, Ideate, Prototype, and Test. This step can be seen in Figure 1.

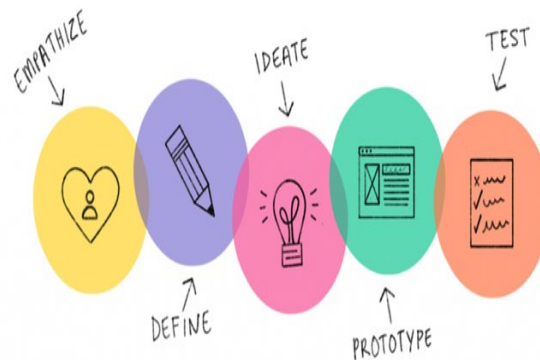


Figure 1. Design Thinking Phase

The first step of design thinking, namely empathize, is the stage where observations are made on user behavior. It will produce information regards to the user experience in using the system. The second is define, which is the stage where the information is obtained from the previous stage is summed up in the user's needs. In the ideate step, we look for some ideas which match the user's known needs based on information from the previous stage. Then the prototype step is the stage where the idea is used as a solution. The last, in the testing step, the prototype of the solution which has been built will be tested to users and get feedback.

2.7 Performance Metrics

Performance metrics are a suitable method for evaluating the usability of the product to be evaluated (Albert and Tullis 2013). It is the key for the designer to give a ready decision in launching the product. The category of performance metrics in Usability Testing is divided into five basic types that are:

1. Completion rate: Completion rate or called as task success is one of the performance metrics to measure how effectively the user can complete the given task.
2. Time on Task: Time on Task is a performance metric commonly which is used to measure how much time it takes to complete a task.
3. Errors: The Errors metric describes errors made while performing a task. This metric aims to identify confusing parts of the user interface.
4. Efficiency: The efficiency metric is used to measure the amount of effort a user puts into completing a task; for example, the number of clicks on the application page.
5. Learnability: Learnability metrics are metrics which measure whether performance increases or decreases over time.

2.8. PSSUQ Survey

Post-Study System Usability Questionnaire (PSSUQ) is a questionnaire designed to assess the user's perceived satisfaction with the system or application (Sauro and Lewis 2012). PSSUQ has undergone two updates and has entered the 3rd version. In the 3rd version of the PSSUQ survey there are a total of 16 questions. The magnitude of the resulting value uses a Likert scale of 1 to 7, where a smaller value is interpreted as a better degree of satisfaction. From these 16 questions, 4 types of values or scores will be obtained that are Sauro and Lewis 2012). (1) System Quality (SysQual): Average of questions 1 to 6. (2) Information Quality (InfoQual): Average of questions 7 to 12. (3) Interface Quality (IntQual): Average of responses to question 13 to 15. (4) Overall: Average score from questions 1 to 16. (All items).

3. Methods

This research was conducted using the design thinking method with five phases, namely empathy, define, ideate, prototype, and test. And each stage uses methods and tools that are considered in accordance with the research objectives. An explanation of the stages and methods used can be seen in Figure 2.

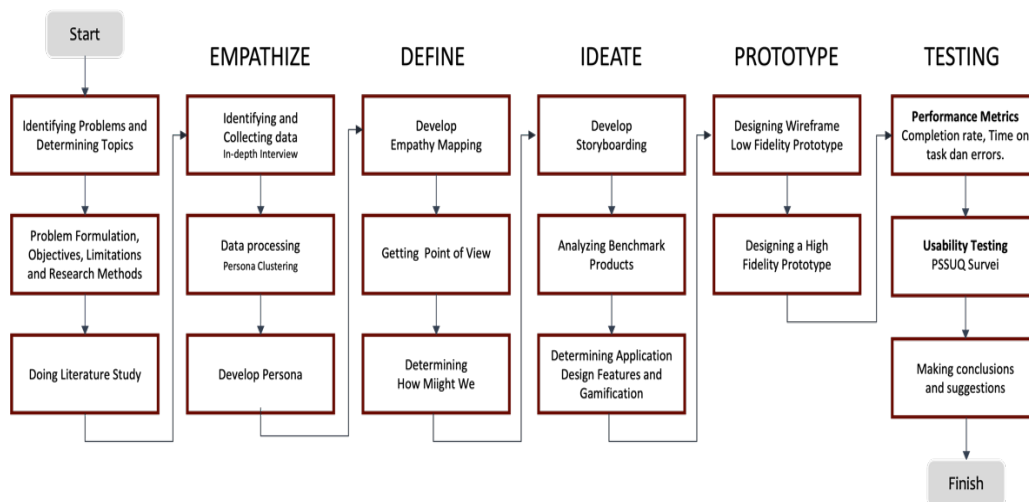


Figure 2. Research Flow

4. Collection Data

The collection process began with secondary data collection regards to the current situation to determine the level of young people's concern for environmental issues and interest in sustainable lifestyles. The data were taken from surveys of study groups and discussions of Indonesian public opinion. This institution conducted a survey of 1,200 respondents aged 14-40 years on October 14-21, 2021. The survey was conducted by telephone interview with a response rate of 13.97%.



Figure 3. Secondary Data Survey Result

In the Figure 3, it shows that only 22.6% of the respondents from this group are not interested in environmental issues. In detail, there are 78.2% of respondents from Generation Z (14-24 years) who are interested in environmental issues.

From generation Y (25-40 years), 76.5% of respondents are interested in environmental issues. Based on the survey results, it can be concluded that Generation Y and Generation Z have a high level of concern for environmental issues, and they are interested in adopting a more sustainable lifestyle. Therefore, the respondents are generations Y and Z.

Furthermore, the design thinking stage was conducted. The first was empathize, using in-depth interview by involving 16 respondents with 8 people each for generations X and Z. Then, using persona clustering, 3 user personas were formed. Moreover, in the second stage that was defining, compiling empathy mapping, point of view and how might we from the 3 user personas. In the third stage of ideate, 3 users who described the persona were visualized with a storyboard. The storyboard tells the content used to empathize with the user's thinking taking into account the technological background and factors from the user's perspective in the early stages of the design. In addition, product benchmarking was conducted that was comparing similar products as a reference for designing application designs, looking at features, designs, aesthetics, technology and even motivation to conduct sustainable lifestyle activities when using applications. Then, in the fourth stage of the prototype, 2 types of user interface designs were designed that were designs with light mode and dark mode. In the last stage of testing, the test involved 15 respondents, 5 each for persona 1,2 and 3. The initial stage of testing was usability testing by measuring performance metrics with 8 types of tasks given to see accuracy, time and errors in completing each task. In addition, usability testing was conducted for the level of user satisfaction using the PSSUQ questionnaire. The questionnaire was filled out objectively on each user's experience when using the application.

5. Result and Discussion

5.1 Empathize Stage

The initial stage was in-depth interviews with 16 respondents. Respondents are generations X and Y with 8 respondents each. In order to get a representative for each generation, generation Z is seen based on age and status while generation Y is based on 7 millennial behaviors according to the Indonesia millennial report 2020. The demographics of the respondents are as follows in Figure 4. Then, using persona clustering from 16 respondents, 3 user personas were formed. Personas 1,2 and 3 can see in Figure 5. Persona 1- The Student Elisa, Persona 2 – The Adult Alex and Persona 3 – The Young Adult Venny.

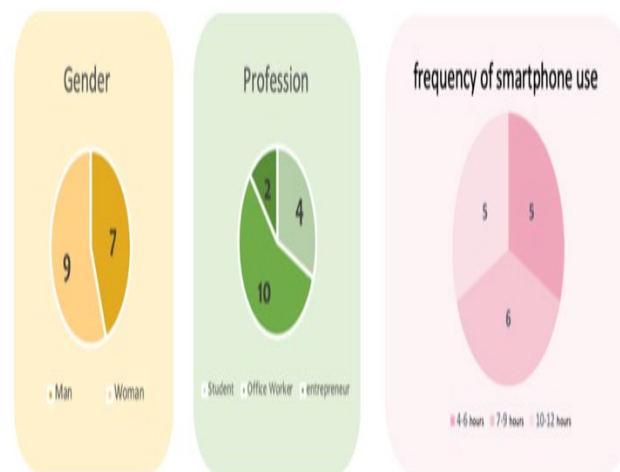




Figure 5. Persona

5.1 Define Stage

After defining and getting the number of personas, the next stage was the define stage. At this stage, the researcher used the empathy mapping method in order to help define the user's wants, needs and constraints of each persona. The categories contained in the empathy mapping relate to what the persona feels, thinks, says, and does so that points can be determined for pains and gains. In accordance with the number of persona clustering, three empathy mappings were designed based on all the opinions of each persona in Figure 6. Furthermore, the How might we and Point of View methods were used based on in-depth interviews and empathy mapping. It shows that the insights and needs of the three personas are the same that is having a reliable application to motivate and encourage sustainability behavior by providing a unique and enjoyable experience. Empathy Map for personae 1,2 and 3 can seen in Figure 6.

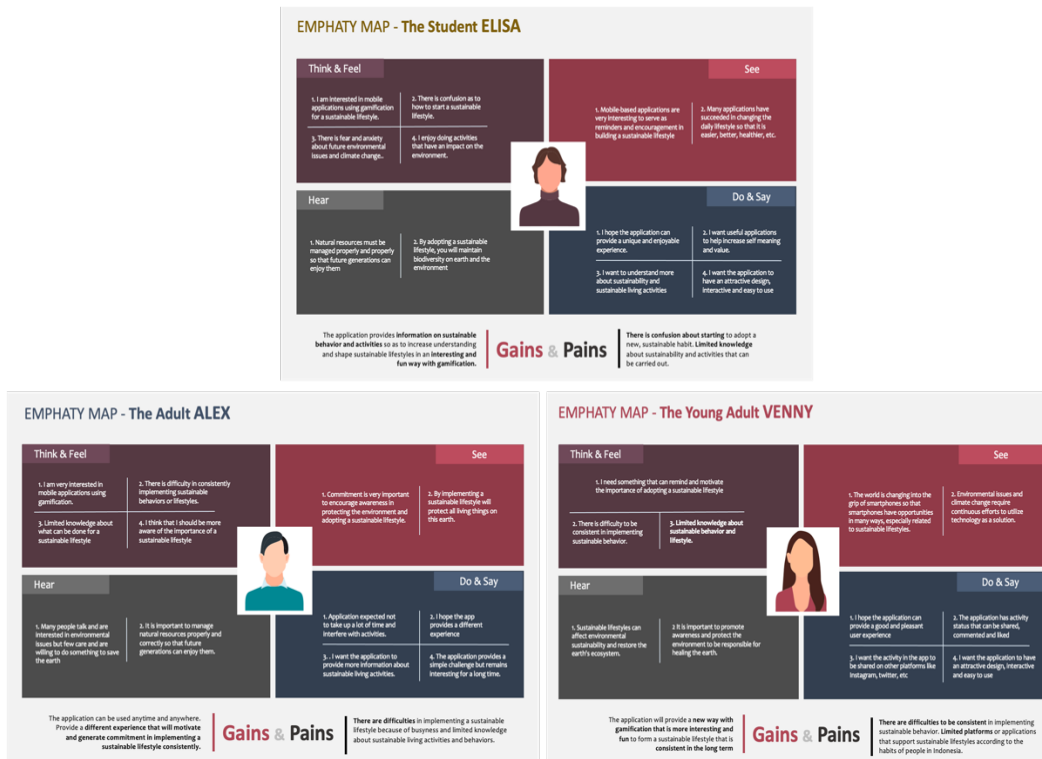


Figure 6. Empathy Mapping

5.2 Ideate Stage

Ideate stage used storyboarding and benchmark methods to determine references in designing the user interface design for sustainable lifestyle applications. Storyboard can see in Figure 7.

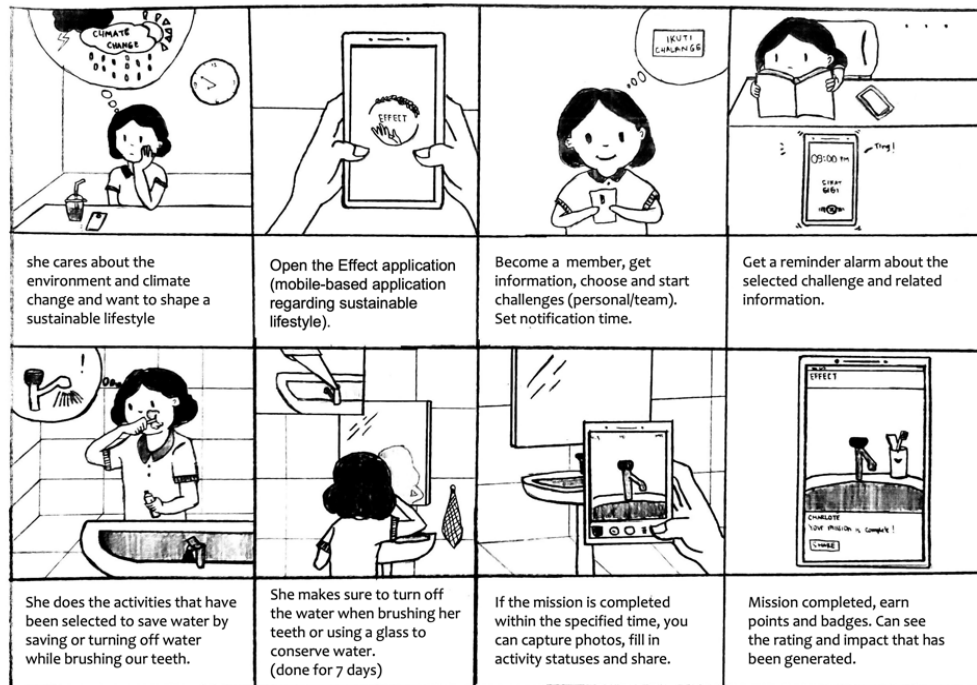


Figure 7. Storyboarding

Furthermore, product benchmarking was conducted by comparing similar products to assess products and find out their weaknesses and strengths. It can be seen in Table 1.

Table 1. Benchmark Comparison

Product	User Interface Design	Gamification Element	Limitations
Ant Forest App	<ul style="list-style-type: none"> - The main functional areas use cartoon elements with bright colors - Functional structure is not logical - Information medium 	<ul style="list-style-type: none"> Points, Badges Leaderboards Teammates Performance graph 	<ul style="list-style-type: none"> - Few low carbon behavior options available - Average intervention rate, users can't cheat
JouleBug App	<ul style="list-style-type: none"> - Simple and realistic. - interface structure is neat, very logical, detailed classification - Provides a large amount of information 	<ul style="list-style-type: none"> Points Badges Performance graphs 	<ul style="list-style-type: none"> - Too many choices so that it distracts the user's focus, and the user is confused to start - Low intervention rate prevents cheating
Stay focused – Forest App	<ul style="list-style-type: none"> - Animated interface - using a combination of gray - Logical arrangement of functional areas 	<ul style="list-style-type: none"> Points, Badges Leaderboards Teammates Performance 	<ul style="list-style-type: none"> - Low user motivation to change habits

EMISI	<ul style="list-style-type: none"> - Sempel - Clear design - Informasi banyak 	N/A	<ul style="list-style-type: none"> - Applications are less attractive - Low user motivation for sustainable behavior
Wattson Power Display	<ul style="list-style-type: none"> - Simple - direct light color interaction 	N/A	<ul style="list-style-type: none"> - Requires physical installation fee - cannot display certain electricity consumption data - Low level of motivation
Emoji from Schneider Electric	<ul style="list-style-type: none"> - Childish interface - Easy to understand 	Avatars	<ul style="list-style-type: none"> - Not attractive to adults - Low intervention rate

From the table mapped the process of each benchmark product to determine the application process to be designed and the application and gamification features to be used. Application features and gamification can see in Figure 8.

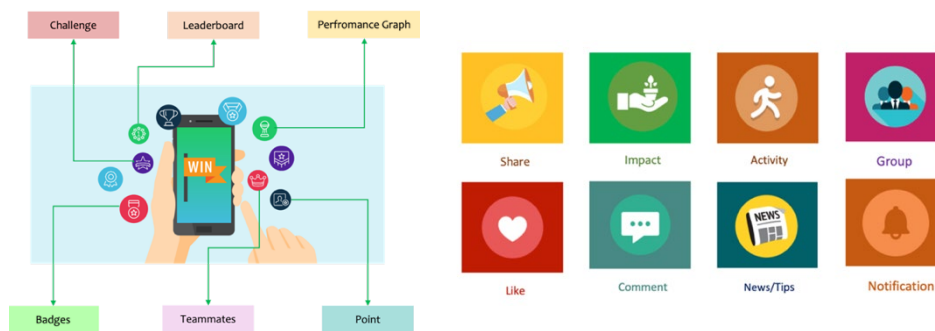


Figure 8. Gamification and Application Features

5.3 Prototype Stage

After determining the appropriate design elements, then it was implemented in the form of a prototype. The prototype was designed by using Adobe XD application. In Figure 9, the application user interface was designed into 2 designs concept that were light and dark mode. According to Nielsen, designers must give users choices, one of which is choosing between light mode and dark mode. Dark mode and light mode have a direct effect on work efficiency, visual performance, health and eye focus, one of which is on mobile applications (Kim et al. 2019).

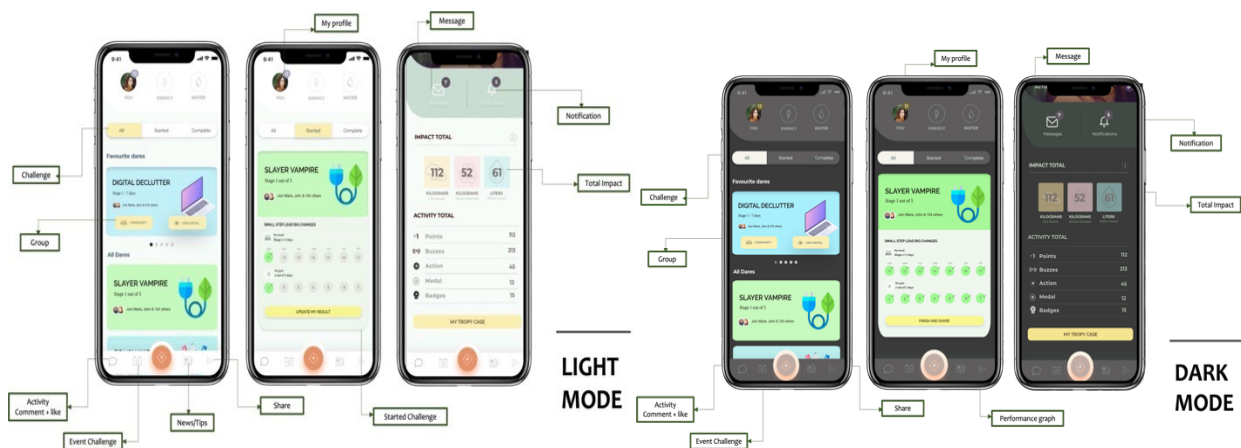


Figure 9. Light Mode and Dark Mode Prototype Design

5.4 Testing Stage

The last stage was prototype testing. Respondents at this stage amounted to 15 people, 5 people each for each persona 1, 2 and 3. Tests were conducted on two application design concepts that were light mode and dark mode with eight scenarios, including creating an account, choose the challenge of sustainable lifestyle activities, completing challenges and sharing activities, participating in challenge events, reading news and tips, setting reminder times, reading and writing comments and likes, and the last seeing rankings and total impact. The test indicators are effectiveness, efficiency, number of errors, and satisfaction. This study used usability testing performance metrics in order to assess the level of effectiveness and efficiency; besides used a PSSUQ survey in order to assess the level of user satisfaction with the application.

Performance metrics

(a) Completion Rate

Based on Figure 10, it can be concluded that all respondents from all personas can complete all tasks well on two design concepts that are light mode and dark mode. Moreover, from the results, it shows that all respondents 100% completed the task to the end and succeeded in fulfilling the tasks given for the second user interface design.

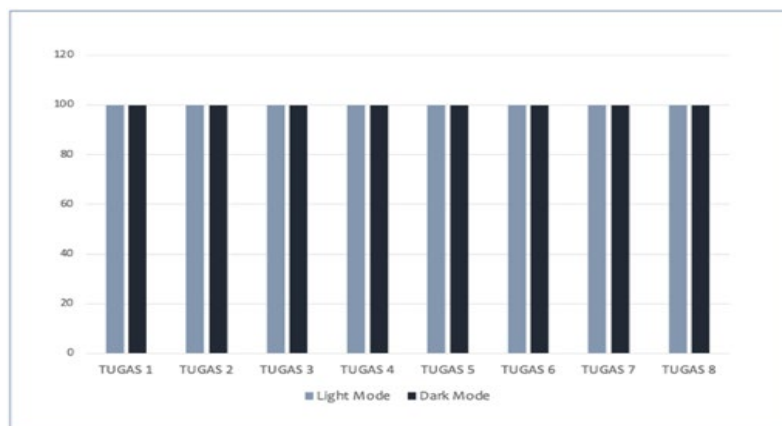


Figure 10. Completion Rate Comparison for Tasks 1-8 Personas 1-3

(b) Time on Task

This stage is data retrieval in completing task scenarios in seconds. It is conducted to measure the time it takes the respondent to complete the task scenario. In addition, from the graph, it shows that for the three user personas the results of light mode are faster in time to task compared to dark mode.(Figure 11)

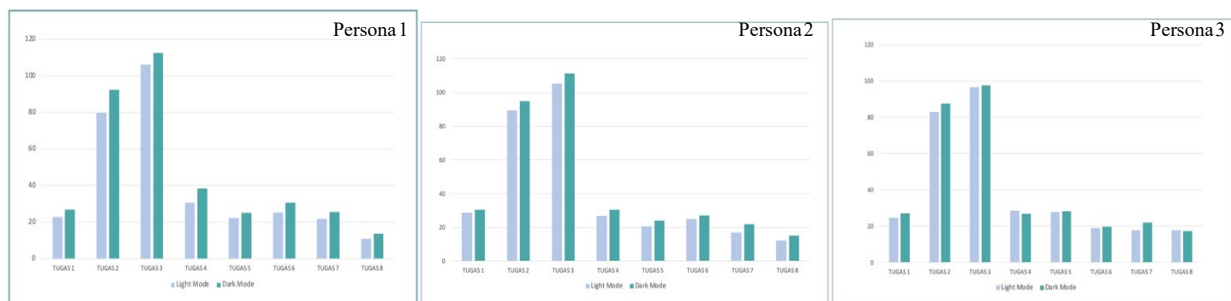


Figure 11. Time On Task Comparison of Tasks 1-8 for Personas 1,2 and 3

(c) Errors

The next stage is that test for errors. All respondents in both design concepts are the same as time on task. (Figures 11 & 12) However, task 2 experiences a few errors in persona 1 and 2. Many respondents feel confused in the task of choosing a challenge so that it took a lot of time to complete the task and errors occurred.

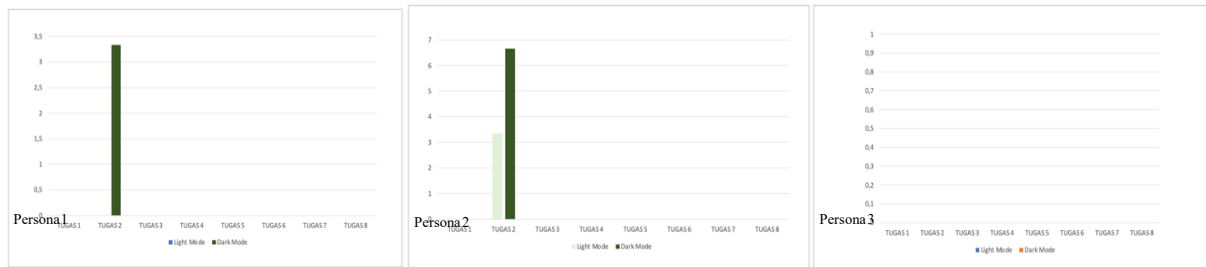


Figure 12. Comparison Errors of Tasks 1-8 for Personas 1,2 and 3

PSSUQ Survey

Based on the PSSUQ survey in Figure 13, it can be concluded that the average results of the system use, information quality, interface quality, and overall satisfaction scores are lower than the PSSUQ Norms values so that from the respondents' satisfaction scores, both designs fall into the satisfactory category, and it can be recommended. However, the satisfaction value of light mode is slightly higher than dark mode.

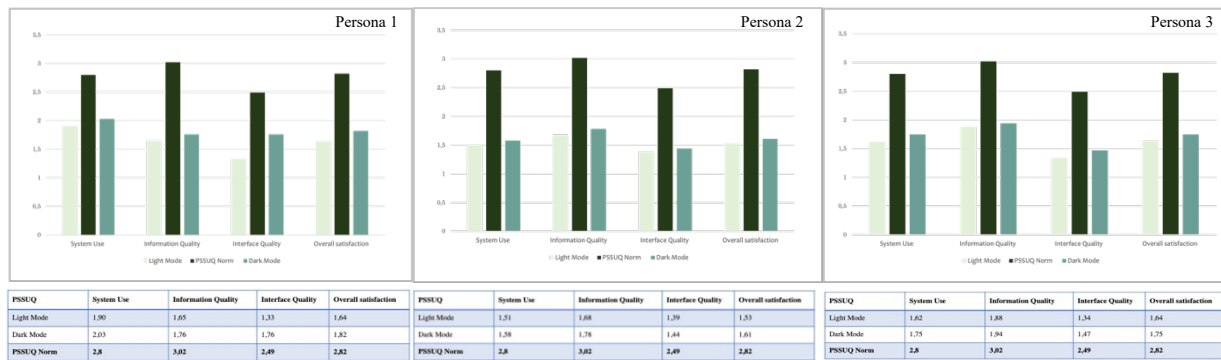


Figure 13. PSSUQ Survey Comparison for Personas 1,2 and 3

The results of usability testing analysis using performance metrics and the PSSUQ Survey to design the most suitable sustainable lifestyle gamification application interface are as follows.

1. Persona 1 – The student Elisa: Completes all tasks successfully but some errors occur in task 2. In time on task, it shows that Persona 1 completes tasks faster in light mode. In the PSSUQ test, the light mode value is also higher
2. Persona 2 – The Adult Alex: During the testing period, Persona 2 completes all tasks well but there are some errors in task 2. In PSSUQ's rating the light mode design is higher.
3. Persona 3 – The Young Adult Venny : Completes all tasks successfully and without errors. Persona 3 also completes tasks faster in the light mode design. In the PSSUQ test, the light mode value is higher.

6. Conclusion and Future Research

Human awareness of environmental control is getting bigger, but the lack of knowledge of sustainability behavior and consistent commitment has resulted in not fully living a sustainable lifestyle. Recent studies have shown that smart device is only a tool, and it does not always support sustainable behavior; especially, if the system does not interact much with the user. Through a design thinking approach, a sustainable lifestyle gamification application user interface design has been conducted based on user needs to improve sustainability behavior. The gamification features, challenges, points, badges, leaderboard, teammates and activity application feature, comments and likes, shares, notifications, news/tips, community and total impact are considered to support the application in order to provide a pleasant experience in motivating and increasing sustainable behavior so that it becomes a lifestyle. It can be concluded that the result of the user interface design of the two types of design modes that are light mode and dark mode is categorized as satisfied category and it can be recommended. However, over all the light mode gets a higher score than the dark model. This application provides education that there are many activities which can be conducted to keep the earth without harm, but it actually has benefit. In addition, when more people adopt a sustainable lifestyle,

there will be more impact. This study can be developed in the further research to address the limitation. For example, the design results and prototype solutions should be evaluated on a scale according to user needs in order to increase the value of user experience (UX) and further research can explore gamification by providing more varied options by following the times and technology.

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