DETERMINATION OF PRODUCT FEATURES USING KANO AND SENTIMENT ANALYSIS METHOD
CASE STUDY: REVERSE VENDING MACHINE

THESIS

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AUTHENTICITY STATEMENT

For the sake of Allah SWT, I admit this work is the result of my own work except for the excerpts and summaries from which I have explained the source. If in the future it turns out that my confession is proven to be untrue and violates the legal regulations in the paper and intellectual property rights, then I am willing to get a diploma that I have received to be withdrawn by the Islamic University of Indonesia.

Yogyakarta, February, 2021

(Putri Amalia)

THESIS APPROVAL OF SUPERVISOR

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DEDICATION PAGE

This undergraduate thesis is dedicated to my mother, Indah Sriwahyuni, S.S., my father, Guntoro, S.T., my brother, Unggul Laksana Bagaskara, who always gives me prays and supports during my study, and all of my friends, seniors, and juniors in International Program Industrial Engineering.

MOTTO

"Cogito, ergo sum" – René Descartes

PREFACE

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The author realizes that there are still shortcomings as well as weaknesses in this report, so the suggestions and critics are fully expected. The author hopes this report would bring advantages for everyone who reads this.

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ABSTRACT

The Sustainable Development Goals are having much impacts to the world, as they aim to make the better world. A circular economy was introduced to reduce waste by reproducing it to become new product. One of the wastes is plastics waste, especially PET waste which is relatively easy to recycle than the other type of wastes. Hence, a reverse vending machine is developed to collect plastic bottles from customers. A customer-centered machine design is needed to make the product is attractive and bring customers' satisfaction when being used. Therefore, this paper is aimed to reveal the customers' preferences on features that will be implied in the reverse vending machine product. There were two surveys carried out in this research, the first is to identify the customers' preferences, then the data are processed by using Word Cloud. The result of Word Cloud extracted 7 features, then Kano and open-ended question survey is generated to map the rank of features' importance and the sentiment of people regarding the proposed product. Finally, the technical requirements of feature implementations are proposed to be implemented in the reverse vending machine. The result from this research is must-be features that become the core reason why the targeted customers will use the product.

Keywords: Reverse Vending Machine, Kano, Sentiment Analysis, Word Cloud

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

1.1 Background

Sustainable Development Goals (SDGs) is the list of objectives to make the world better and should be implemented by every country around the globe. One critical thing in supporting SDGs is to improve the waste management (Fadeeva & Van Berkel, 2021; UNEP, 2016). Vanapalli et al., (2021) also stated that such policies and regulations should be arranged to reduce plastics pollutions and uphold the sustainable living concept. Since the concept of linear economy which consists of make, use, and dispose is not sustainable because it always takes new resources from nature, a circular economy concept is introduced to make the world become greener. Circular economy currently implemented in solving many problems on waste management scope such as plastic waste from packaging.

Plastic bottles are popular in the world of packaging. Many manufacturers make their products with plastic bottle packaging such as mineral water, sparkling water, tea, and other ready-to-drink beverages. Due to its beneficial properties, the number of products that use plastic bottles as the packaging are increasing (Jang et al., 2020; Khan et al., 2020). This convinced by Geyer et al., (2017) stated that plastics containers are the 36% topmost of appliance in the global plastic production. Its consumption rate also increases in line with the population growth of the country, so does the plastic waste that incurred during the consumption process (Lestari & Trihadiningrum, 2019; Van Eygen et al., 2018).

Since plastic is classified as non-degradable product, plastic waste is one of solid wastes that should be treated properly (Cruz Sanchez et al., 2020; Lokahita et al., 2019). The thriving plastic waste problem has been noticed by many international organizations and forums. In a report by World Economic Forum 2016, more plastics than fish in the ocean has been forecasted (Getor et al., 2020). In Indonesia, plastics waste problem become an important issue nowadays since it harms the environment as in landfill and ocean (Lestari & Trihadiningrum, 2019). It also worsens the climate change problem (Robaina et al., 2020). Many ocean pollutants in the world come from China, India, and Indonesia (Fadeeva & Van Berkel, 2021; Schmidt et al., 2017). As the second leading among the countries whose contributed largest amount of marine pollution, Indonesia still has an insufficient system of solid waste management proved by the reality that many dumpsites already superabounded (Lokahita et al., 2019; Tibbetts, 2015). A good management of solid waste should be designed by considering all the technical aspects in fields to be achieved (Zurbrügg et al., 2012). The human behaviour should be integrated as well to develop the solid waste management (Khan et al., 2020).

Circular economy aims to minimize the natural resources taken and maximize the products' life, as well as reduce the waste incurred from the products' consumption (Getor et al., 2020; Kristoffersen et al., 2020). In economic approach, circular economy is a system where the products, materials, and resources are preserved well as long as possible (Robaina et al., 2020). The concern of circular economy has been increasing in the past years resulting a trend in both economics and politics around the globe (Getor et al., 2020; Schöggl et al., 2020). It can strengthen the relationship between manufacturers, governments, and society to conduct circular economy and achieve sustainable goals together (Lonca et al., 2020). The current research and practices found out that some innovations such as product redesign and remanufacturing could maximize the material cost savings (Tseng et al., 2020).

The circular economy for plastics waste aims to reduce the number of plastics in the nature by perpetuating the life cycle of the materials by making the material flow of plastics follow along a close-loop system (Ellen MacArthur Foundation, 2017; Getor et al., 2020). The example of circular economy implementation could be seen in Europe where they have

plan to make all plastics packaging are fully recyclable in the next 10 years (Cruz Sanchez et al., 2020).

In order to support circular economy and accelerate the recycle chain especially for plastic bottles, a tool can be designed to gather the plastic bottle waste and to prevent the mix of plastic bottle waste with another waste. The tool can be in the form of self-operated machine which adopts vending machine system. As the machine has main goal to collect the plastic bottle waste, it can be named reverse vending machine. Furthermore, from this early stage of waste segregation, it will make the recycle chain faster and could boost circular economy.

During the development of the reverse vending machine, features determination which incorporates the voice of customers should be done. Some past studies related to the product development have been performed by Martí Bigorra et al. (2019), Violante and Vezzetti (2017), and Wu et al. (2020). Martí Bigorra et al. (2019) researched about making aspect-based Kano by crawling the opinion data from determined websites and determine the feature categories in Kano using aspect-based sentiment analysis. There are two examples presented, and the result is the proposed methodology, which can categorize the aspects into three Kano categories which are must be, one dimensional, and attractive. However, the limitation of this research is, this research used the data from online review websites. The more specific data sources such as survey is needed to explore the potential researches. Another study has been brought by Violante & Vezzetti (2017) about the framework for products attribute analysis using Kano. This research utilized customer requirements for its input. A new assessment framework for product and service quality attributes has been successfully developed. However, the limitation of this research does not incorporate the customers' self-stated requirements importance. The study from Wu et al. (2020) also provided same limitation, in which the study only obtained the Kano quantitative analysis and processed to the functional analysis with QFD. There was no qualitative study and reviews to ensure the result of the study.

According to the explanations, this research will be focused on the product features determination of the reverse vending machine as a solution to tackle plastics waste problem. The method that will be used is the integration of Kano and sentiment analysis. A list of features that already classified by Kano is the result expected from this study.

1.2 Problem Formulation

According to the research background, the formulated problem is what are the features of the reverse vending machine that needed and wanted by the targeted customers.

1.3 Research Objectives

According to the problem formulation, this research has an objective to acquire the customers' desires on the features that will be equipped in the reverse vending machine.

1.4 Research Limitation

The limitations of this research are set as follows:

1. This research particularly analyses the voice of customers about the reverse vending machine.
2. This research particularly analyses the targeted features in four aspects which are appearance, time, accessibility, and feedback.
3. This research only gains the customers' data from Indonesia.

1.5 Research Benefits

By doing this research, it is expected to provide benefits to some parties involved in this research. Expected benefits include as follows:

1. Upsurging the knowledge of the researcher about the voice of customers regarding to the features of the reverse vending machine and giving suggestion for the development of the machine.
2. Familiar with the practice of processing the voice of customers into technical features using KANO and sentiment analysis approach.

CHAPTER II

LITERATURE REVIEW

This chapter will explain the basic theory used in the research about the determination of product features, to be later discussed in the inductive and deductive study. Inductive study will explain the previous research related to this research. While, deductive study will explain about the theory that covers the concept of Kano method and sentiment analysis.

2.1 Related Studies

Many studies have incorporated Kano as the method to integrate the voice of customers to the product design and development. Liao et al. (2015) conducted research on mobile phone. A study on Kano requirement model has been conducted to recognize the combination of synchronized multi-product design. As a part of family-based product, mobile phone has several features that can be combined and selected based on its need and demand. A Kano requirement model equipped to achieve the goal. The result of the research is a significant aggregate between features in the synchronized multi-product design, such as a mobile phone. Another similar research by Ma et al. (2019), who conducted research for an automobile manufacturer. A Kano model used to differentiate the features in the future vehicles. Based on the research, the manufacturer can classify each feature into 5 quality categories based on Kano two-dimensional model of quality, such as attractive, one

dimensional, must-be, indifferent, and reverse. The manufacturer then can manage the possibility of dissatisfaction from the customers according to the Kano model. Some improvements proposed to the manufacturer in order to increase the customers satisfactions.

The Kano method can be combined by several methods to increase the product development, one of the is Wang and Wang (2014) that conducted research about smart camera. Since the demand of smart camera is increasing, the product development based on customer preferences was done. By combining fuzzy AHP and fuzzy Kano to extract the preferences and know the customer perceptions about the attributes, the researchers also used ZOIP (zero-one integer programming) to maximize overall customer utility and determine the optimal product. The ZOIP also used to consider the price of smart camera. To breakdown the materials and requirements from targeted customers, Wu et al. (2020) conducted research about the product design of a baby stroller. The researchers combined three main methods: Kano, QFD, and FAST methodologies. The research started from mining the potential requirements that may occurred by the users then conduct quantitative analysis of the user requirements by Kano and QFD. Then, the FAST function analysis technique was to determine some factors that may affect the users' decision and also experiences regarding the product. The method in this research could also applied in other class of vehicles.

Features importance assessment also has been conducted by Tama et al. (2015) and Madzík et al. (2019). Using Kansei engineering and Kano model, Tama et al. (2015) wanted to know some factors that may affecting the customers' satisfaction of ceramic souvenir. The researcher divided the factors into two, which are appearance and performance. The research was conducted from categorizing the customer perception in Kansei words and process it to become attributes in the Kano model. The finding in this research is the top prioritization in product design should be appearance. Madzík et al., (2019) conducted research about educational services in an educational institution. A Kano model equipped to know the requirements that are needed by the respondents in the high school. The study concludes that the most stable requirements are practice orientation and quality resources, meanwhile the least stable one is for the staff quality in the educational institution.

Besides using Kano as quantitative assessment in integrating voice of customer to the product design and development, sentiment analysis also can be used to know the tendency of targeted customers to a certain product or feature. Mirtalaie et al., (2018) conducted research about camera product. The input of the research is the reviews from customers related to the product. As the goal is to analyze the reviews that spread in a website, the researchers extracted the customers' review with sentiment analysis. After the sentiment analysis is done, each review is tagged as pros or cons according the polarity strength of the reviews. The result of this study is the analysis of pros cons reviews about camera product. Mirtalaie & Hussain, (2020) also conducted research about camera product. This research employs SA-TF method (sentiment aggregation framework for targeted features). This method is used to address the exact feature in each review, rather than just tag it as pros and cons. SA-TF method in this research can map the features that are discussed and consider the features dependencies to determine the data polarity.

Another method to do product design and development is by incorporating QFD method. Guo et al., (2017) conducted research regarding shafting installation process. The researchers used QFD and FMEA to do research in knowing the importance of elements in the shafting installation process. The QFD used to find the importance of process based on the customers' requirements. Then, FMEA used to get the comprehensive importance of the elements in the installation process. Based on the research, FMEA made the result more actual if equipped after QFD. Another research about machine has also been done by Fan et al., (2017) where the research has machine-made sand as the research object. The researchers combined QFD and axiomatic design in order to optimize the parameters, considering the interdependence, until draw the correlation between the function reaction demand with the design parameters. According to the study, the axiomatic design can be reached and feasible.

The significant factors that may influence the customers' satisfaction can be done in several methods. Apparao and Birru, (2017) conducted research using QFD-Taguchi hybrid approach. By identifying the parameters in high pressure die casting such as pressure, temperature, and velocity, the contribution of each parameter can be identified. With the QFD-Taguchi hybrid approach, the result of the study discovers that injection pressure is the

most significant factors in the die casting process. Another research that also consider about the profit done by He et al., (2017), with the research about home elevator to optimize satisfaction and also profit. Kano and QFD equipped in this research. IF-Kano model is used to do the categorization of customers' requirements. Then, the output processed in QFD with nonlinear programming model. The result of this research is the surplus maximization which formed by the cost from the enterprise and cost to make the satisfaction of the product.

The result of a research should have benefit to be implementation, such as helping decision making process, or selecting the best sample or proposal from many. Wang et al., (2017) conducted research about a self-service restaurant. This research was done to propose new service by integrating TRIZ and QFD. In this research, TRIZ approach is used to solve the current problem situation in the restaurant and QFD is employed to deploy the elements to be improved based on the TRIZ output. After conducting the research, a new service is proposed which can enhance the production of meal flexibility and improve the managerial in the restaurant. The selection of proposed product has been researched by Moghimi et al., (2017), who conducted research in housing design and incorporating nine architects. A combination of MEC and QFD is used to facilitate the housing design. Based on the responses gained from the user, the researchers did focus group discussion to establish House of Quality (HOQ). Then, the outputs are mapped into four main emphasis. The result of this study is the design that fulfil the user's expectation and environment congruence. Another use of QFD is on a study conducted by Liu, (2011), who integrated fuzzy QFD and fuzzy MCDM approaches for the aluminum product development. The usage of fuzzy QFD and fuzzy MCDM could help the product developer to identify and select the best prototype of the product. Besides implementing the methods to product, QFD can be implemented in determining maintenance activities. Bolar et al., (2017) conducted research in the maintenance activities of infrastructure. The researcher used hidden Markov model (HMM) and Quality Function Deployment. This research mainly discussed about the framework that can be implemented to rank the user expectations using QFD. The HMM used probability to measure the interest of user expectation as the hidden parameters. The focus areas in this research are based on sustainability parameters such as economic, social, technological,

safety, and environmental. This research successfully proposed the method to be implemented in the maintenance activities for infrastructures.

Designing a product involves several processes to combine the technical requirements and customers' needs. One of the studies which conduct customer-oriented design is Alp & Öz, (2020). In the research, a conjoint analysis done to know the attributes needed by the customer about laptop product. The conjoint analysis can measure the preferences of customers related to the product or services. The result of this research reveals that the most preferred feature in laptop by the customer is the computer processor, then followed by RAM. Like the previous study, Wang et al. (2018) conducted research in electronics but focused on mobile phone. This research implemented deep learning to link the customer's needs. The researchers used deep learning because the input of this research is a big number of data that contains online product reviews. The data then mapped into three problem classifications. A satisfactory result achieved in conducting this study. Anh et al., (2019) also conducted research about camera and laptop from specific brands to get the perspective of user about the product. The customers' perspective gained from online shopping platform. The improvement framework conducted in this study is to review the identification then do the sentiment classification. The proposed system in this study can improve the product quality and it is useful for the product designers.

Several other studies that use Kano are research by Lukman and Wulandari (2018) and Harianto (2012). Lukman and Wulandari (2018) used the integration of Kano and QFD to make product which desired by the customers. The researchers gained the voice of customers and found out the attributes of desired chocolate products. The Kano is designated to classify the products' attributes and QFD used to rank the attributes based on its priority. The result showed that there were 11 attributes that can be improved such as adding filling nuts, better packaging, and check raw material composition. Meanwhile, Harianto (2012) conducted research to analyse a fast-food restaurant company website. By the aims to analyse the functional features, the researcher wanted to know what are the important aspects in the corporate website based on the customers' points of view. A Kano model was developed to

process the data from questionnaire, resulting 7 features that grouped by each classifications of Kano model.

A study about the impact of product attributes on customer satisfaction has been conducted by Yuren Wang et al. in 2018. By using sentiment analysis and regression model, the researchers conducted a study about washing machine. After gaining the online reviews, the reviews then processed using selected methods to know on which attributes of product that mostly impacted the customers. As the result, drainage mode, loading type, frequency conversion, type, and capacity are the attributes that most affects the customer satisfaction on a washing machine. A study on other electronics has been done by Jiang et al. (2019). The researchers used opinion mining and DENFIS (dynamic evolving neural-fuzzy inference system) to do dynamic modelling for product design based on customer preferences. The use of opinion mining is to analyse the online reviews and execute sentiment analysis of the reviews based on several periods of time. The result of opinion mining and sentiment analysis as the input to be modelled by DENFIS approach. DENFIS equipped to do dynamic modelling of the preferences of customers based on mined time series data.

The importance of concerning on customers point of view is described in several research. Liu et al. (2018) conducted research to develop method in perceiving key requirements of customers in the low-carbon product design. A fuzzy grey relational analysis and genetic algorithm that used in this research has been proven to consider the heterogeneity of customers and to determine the evaluation language. The weakness of this method is the exclusion of the behaviour factors from psychological aspects. Meanwhile, Zhao et al., (2020) conducted research on customized product configuration on car design. The research involved a car design manufacturing, in which the customer requirements are used to be mapped using Kano model. The researchers wanted to integrate the customer requirements into engineering characteristics. The Kano model resulted quantitative outcome then formulated as multi-objective functions in a mixed non-linear programming to determine the solution of product configuration.

Dou et al., (2016) has also conducted a research in customer-oriented product design. The object of this study was a tablet PC. The researchers used IGA (iterative genetic algorithm) to make the design of existing product evolved in the customized process and achieve the optimal design. This proposed approach can effectively identify the customers' preferences towards the product. improve the customization efficiency, and reduce the operational fatigue.

The study of sentiment analysis for product design and development is still limited. There are several researches aims to know how people perceived a particular product, issue, or services. A research using sentiment analysis has been executed by Mundra et al. (2019). The researchers used binarization to transform the data which from IMDB dataset and twitter. The study is addressed to predict a movie's success by comparing several methods such as LDA, CART, KKN, and Random Forest. The result is random forest, which encouraged the best model for the dataset gained with the maximum accuracy as 93.71%. Another sentiment analysis research conducted by Gunawan et al., (2018). The research object was online product review. By using Naïve Bayes method, the accuracy result of sentiment classification compared to the supervised classification was lower. More improvement needed to do the classification of online review data.

Sentiment analysis is mainly employed to evaluate public opinion, which done by Shekhawat (2019). The research aimed to know which method that has higher accuracy in doing sentiment classification of public opinion regarding to BREXIT. The data obtained for the research were derived from Twitter. There were two methods being utilized, Naïve Bayes classification and TextBlob library. From the research, it was indicated that Naïve Bayes performed better than TextBlob library, with the slight difference around 12,55% of accuracy. An analysis about public sentiment also done by Krishna et al. (2013) by gaining data from YouTube video comments. The researchers used Naïve Bayes method that has been trained in IMDB database. With the number of comments data that reached 3 million comments, the result showed that the trends in user's sentiments were correlated enough in the real-world events and associated by the respective keywords.

Table 2.1 Literature Review

No.	Author	Year	Feature Determination				Word Processing	
			Kano	Conjugation Analysis	Fuzzy Logic	QFD	Sentiment Analysis	Word Cloud
1.	Liao, et al.	2015	√	√				
2.	Ma, et al.	2019	√					
3.	C. H. Wang & Wang	2014	√		√			
4.	Wu, et al.	2020	√			√		
5.	Tama, et al.	2015	√					
6.	Madzik, et al.	2019	√					
7.	Mirtalaie, et al.	2018					√	
8.	Mirtalaie & Hussain	2020					√	
9.	Guo, et al.	2017				√		
10.	Fan, et al.	2017				√		
11.	Apparao & Birru.	2017				√		
12.	He, et al.	2017	√			√		
13.	Y. H. Wang, et al.	2017				√		
14.	Moghimi, et al.	2017				√		
15.	Liu.	2011			√	√		
16.	Bolar, et al.	2017				√		
17.	Alp & Öz.	2020		√				
18.	Y. Wang, et al.	2018					√	
19.	Anh, et al.	2019					√	
20.	Lukman & Wulandari	2018	√			√		
21.	Harianto.	2012	√					
22.	Yuren Wang, et al.	2018					√	
23.	Jiang, et al.	2019			√			
24.	A. Liu, et al.	2018			√			
25.	Zhao, et al.	2020	√					
26.	Dou, et al.	2016			√			
27.	Mundra, et al.	2019					√	
28.	Gunawan, et al.	2018					√	
29.	Shekhawat.	2019					√	
30.	Krishna, et al.	2019					√	
31.	Author	2021	√				√	√

Based on the previous research about product design, especially in the incorporation of customers' reviews towards the design or the product development, one of the common methods is Kano. Kano model is developed to do quantitative analysis based on the voice of customers. The input is originated from Kano questionnaire then being processed to generate the classification of the features to be translated into five dimensions: attractive, must-be, indifferent, one-dimensional, and reverse. Most of the researchers use Kano as quantitative analysis then followed by another quantitative method such as QFD.

However, this method only gains the data from respondents in scale, such as Likert scale, it turns out to be its weakness. The qualitative studies which collect and transform customers' voice or opinion in the scope of product development mostly conducted by sentiment analysis. Nevertheless, many research only ended up in identifying the positive and negative sentiments without further actions. This research is going to reveal how are the customers' voice about reverse vending machine features using Kano model as the quantitative research and combined with the result of sentiment analysis of the customer's opinion regarding the proposed features of the reverse vending machine. Aside of the integration between Kano model and sentiment analysis, this research also utilizes word cloud as the word processing tool to extract the customers' opinion given.

2.2 Deductive Study

2.2.1 Kano

Kano model was invented by a Professor from Tokyo Rika University, Noriaki Kano in 1980s (Kano et al., 1984). Kano model is one of six sigma tools which developed to categorize the attributes of a product or service based on how they impact on the customers' satisfaction (Hutabri, 2017). There are several classifications in the Kano model, which are:

A. Must be or Basic needs or Threshold

This classification contains attributes that become the main reason of people to use the product or service. The attributes in this basic need classification should satisfy the customers. If the attributes in this class have low performance, then the customers will not feel satisfied. However, if the performance of attributes in this class is very high, the customers' satisfaction may not increase more than the average level.

B. One dimensional or Performance needs

The attributes in this category play as the main point that distinguish the product or service from the competitors. In this category, the customers' satisfaction is linear with the performance of the attributes. The more advanced the attributes, the customers will feel more satisfied.

C. Attractive

In attractive category, the existing attributes can boost the customers' satisfaction significantly. However, if the attributes of this category are in poor performance, it will not affect the customers' satisfactions.

D. Indifference

The customers' satisfaction is not affected by this type of attributes. There will be no improvement or reduction of satisfaction although the quality of this type of attributes are increasing or decreasing.

E. Reverse

In this category, the customers' satisfaction is in opposite of the quality of attributes. When the attributes' quality is high, then the customers' satisfaction is low. The increment and decrement of satisfaction are proportional to the quality of attributes.

In order to classify the attributes into Kano model, several steps should be accomplished. The steps are as follows:

Step 1: Customer requirements identification

The first step for plotting the attributes into Kano model is by identifying the customer requirements. The customer requirements data can be obtained from several methods, such as interview and open survey.

Step 2: Kano questionnaire

After accomplishing the previous step, the customers requirement then being assessed by the targeted customers or users. The assessment is established by using Kano questionnaire, to know the scores of each attribute. In the Kano questionnaire, the respondents are asked to give rating in Likert scale, from very positive to very negative. The questions are based on the requirements that have been identified and there are two parts in one attribute, which ask about the functional and dysfunctional.

Step 3: Questionnaire result calculation

After the data from Kano questionnaire has been gained, the responses can be calculated using Tabulation of Survey as in Table 2.2. There are 6 variables that represent the classification in Kano model, which are "O" as one-dimensional requirements, "A" as the attractive requirements, must-be requirements represented by "M", "I" as indifferent, "Q" as questionable requirements, and "R" as reverse requirements. This table perform to know which attributes that already asked in the questionnaire are belong to which requirements (Sauerwein et al., 1996).

Table 2.2 Tabulation of Survey

Customer Requirements		**Dysfunctional**				
		1. Like	2. Must-be	3. Neutral	4. Live with	5. Dislike
Functional	1. Like	Q	A	A	A	O
	2. Must-be	R	I	I	I	M
	3. Neutral	R	I	I	I	M
	4. Live with	R	I	I	I	M
	5. Dislike	R	R	R	R	Q

Step 4: Attributes' analysis

In this step, the attributes can be analysed and mapped based on Kano model diagram. During the analysis, the attributes are mapped based on its satisfaction and dissatisfaction. Based on (Ching-Chun & Shing-Sheng, 2012), the calculation of satisfaction and dissatisfaction are described as follows:

$$Satisfaction = \frac{A + O}{A + O + M + I} \quad \ldots(2.1)$$

$$Dissatisfaction = -\frac{O + M}{A + O + M + I} \quad \ldots(2.2)$$

By classifying the attributes and implement Kano model, there are several advantages after knowing the types of attributes (Qiting et al., 2005):

A. Priorities determination

Based on six classifications of attributes which are one dimensional, attractive, must be, indifferent, questionable, and reverse, the must be requirements are the most important among other attributes. Must be requirements have to be fulfilled before another attribute. If the must be attributes have been accomplished in the desired level, no need to improve the must be attributes since they will not increase the customers' satisfaction. Further improvement in one dimensional and attractive requirements will make the customers more satisfied.

B. Improved requirements recognition

After the implementation of Kano model, it is easier to identify which attributes are more impactful for the customer and lead the customers' satisfaction rather than investing in all types of attributes.

C. Make product formulation based on market segmentation

Kano model provides improvement for a product from voice of customers. Hence, the product development would be customer-centric. It has high advantage to make a product to

be fit in a certain segmentation, so the attributes are following the requirements for just a segment and it will increase the exclusivity of the product.

2.2.2 Sentiment Analysis

In every interaction of humans, either between humans or machine contains emotion. Emotion is the important component of human aims to transfer information along the interaction (Zhang & Provost, 2018). There are several types of information that can be revealed by knowing the human's emotion: the true felt sense, the belief or behaviour, and their interpretation towards others.

In order to analyse the emotion of human, one of the methods is by doing sentiment analysis. Based on Chakraborty et al. (2019), sentiment analysis is important because sentiment is the essential part to assess the human's behaviour. There are three types of sentiment, which are positive, negative, and neutral and sentiment analysis aims to identify and evaluate those sentiments (Wilson et al., 2005). The assessment or analysis of a sentiment should consider the subjects, approach, theme, or character that the people are talking for. Sentiment analysis cannot be separated from opinion mining, where the output from opinion mining will be used as the input of the sentiment analysis. The general steps to accomplish text sentiment analysis in general are as follows:

a. Define dataset domain

The dataset of opinions that will be analysed should be collected. The dataset can be derived from various sources, such as online reviews, websites, social medias, or in form of surveys.

b. Pre-processing

The dataset then being transformed to make it clean and tidy. There are several methods that can be utilized such as tokenization, stop words removal, and stemming.

c. Feature Selection

This step includes the classification of data, to minimize the data that will be analysed.

d. Classification

The text classification and computation of its sentiment. Naïve Bayes, K-Nearest Neighbor, and SVM are several methods that can compute the sentiment classification.

There are many tools to conduct sentiment analysis, one of them is TextBlob, a Python library on NTLK (Natural Language Tool Kit). TextBlob has many features and advantages to perform Natural Language Processing tasks. Execute task in TextBlob can be done by creating the TextBlob object then call the commands for TextBlob to execute.

Sentiment analysis is the ordinary task that mainly done by TextBlob (Ranjan & Sood, 2018). The output of the analysis carried out by TextBlob are polarity and subjectivity, where polarity is the position in the limit from -1 (pure negative sentiment) and 1 (pure positive sentiment). Subjectivity returns the value within the limit from 0 (highly objective) and 1 (highly subjective).

2.2.3 Word Cloud

Word cloud, text cloud, or tag cloud is a method to visualize string data according to the data frequency, organize the data for easily understand visualization because it transforms the visuals into different font and size for different data (Huang et al., 2019). Based on (Jin, 2017), the font size layout algorithm of a word cloud is based on its appearing frequency.

There are several advantages of using word cloud visualization, which are: the visualization is from unstructured data and follows the most repeated words, it facilitates the user to know the most common word appears in the dataset, and it is very user friendly and no need advance skills (Murthy & Madhav, 2020).

CHAPTER III

RESEARCH METHODOLOGY

3.1 Research Subject

The subject of this research is a reverse vending machine that will be developed to collect plastic bottle waste.

3.2 Research Object

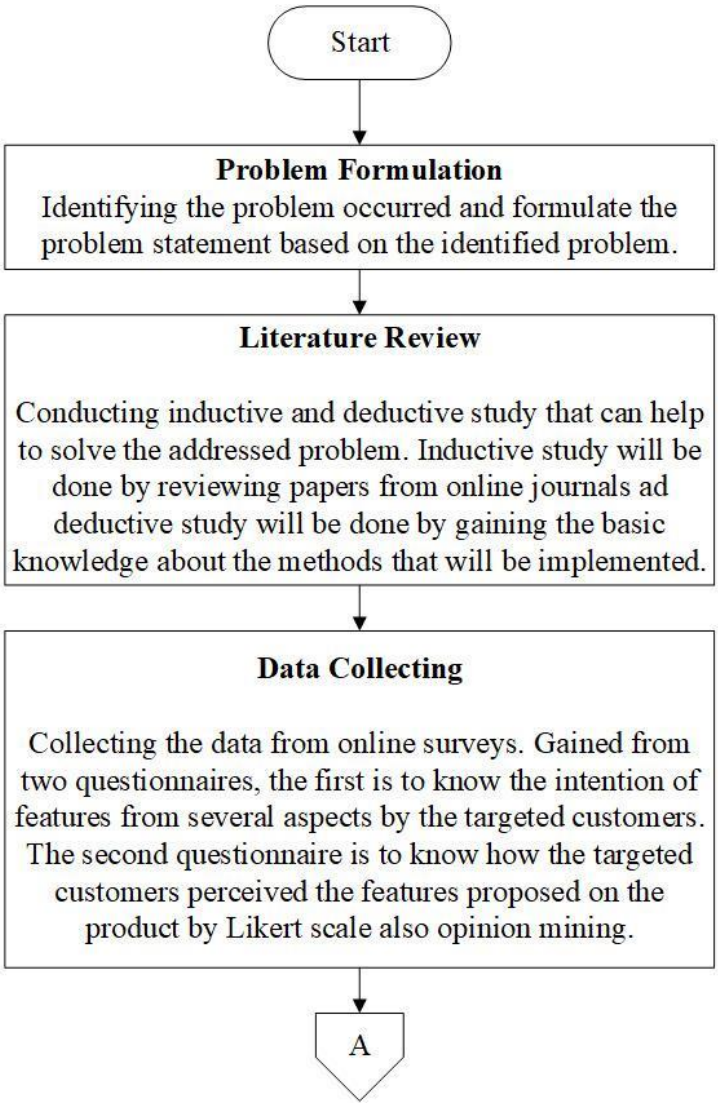
The object of this research is the features design of the reverse vending machine. Since the machine needs development on its features, this research is conducted to identify what features are needed and wanted by the targeted customers.

3.3 Data Types

This research will use primary data to be processed. Primary data are the data obtained to solve the research problem. The primary data in this research are collected by employing online surveys on the features of the machine, how they perceive the features, and their opinion regarding to the proposed features.

3.4 Research Flow

The research is accomplished by performing several steps. The steps are represented in Figure 3.1 as follows:



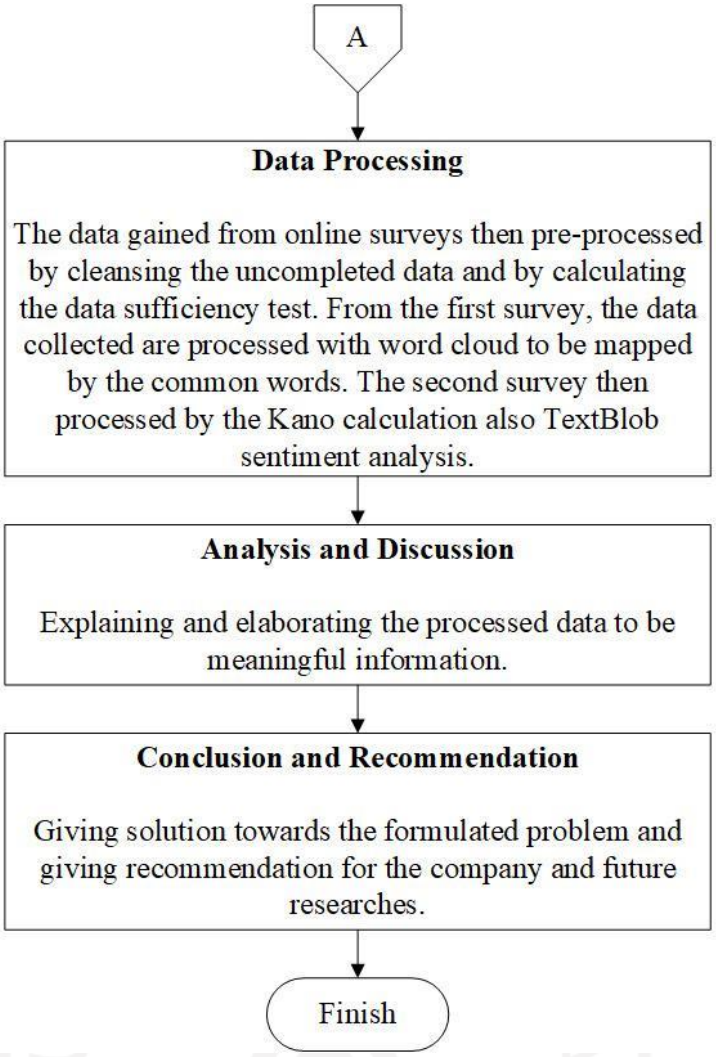


Figure 3.1 Research Flowchart

1. Problem Formulation

Problem formulation is the starting point of this research. Before determining the problem formulation, problem identification should be done. The method for identification is by conducting observation, later after that, the problem formulation can be generated.

2. Literature Review

Literature review is the foundation that supports the research. There are two kinds of literature review, which are:

a. Inductive study that contains several past studies about the things related to the research, which are accessed from online journals.
b. Deductive study which contains several sources or guides of the methods that will be used, and those studies will be the theoretical basis on this research.

3. Data collection

This step is done by collecting the data required that have been accumulated from the previous step. The data collected are based on the goal of the research and the method that is going to be used, which are Kano model and sentiment analysis.

a. Kano Model

To conduct research using Kano model, which aims to determine the features importance, several data from the targeted customers are needed as follows.

a1. Identification of Features Suggested from Targeted Customers

The first data that should be identified is the features that are needed and preferred by the targeted customers. The question type is open-ended questions that delivered in four aspects: appearances, time, accessibility, and feedbacks. These data are gained by conducting online survey.

a2. Kano Questionnaire

After the features data have been accumulated from the targeted customers, then another data are needed to map the features into their categories using the rating from the targeted

customers. The data will be obtained using Kano questionnaire, which consists of two aspects: functional and dysfunctional. The data collection will be carried out by online.

b. Sentiment Analysis

Sentiment analysis is used to calculate the polarity of the opinion stated by the targeted customers in the questionnaire. The data will be collected using online questionnaire, which consists of open-ended questions about the proposed features.

4. Data Processing

The data processing step is designated to convert the data collected into meaningful information that can be used to solve the research problem. The steps to accomplish data processing are as follows.

a. Data Pre-processing

The data pre-processing step aims to prepare the data before going to be processed. First, the data will be cleansed from the uncompleted items. Then, a sufficiency test is done to calculate the minimum number of data to be processed. A reliability test also should be conducted before processing the second survey result.

b. Word Cloud Data Visualization

Word cloud data visualization will be performed to know which are the most common suggestions from the respondents at the first survey. A python code will be built to transform the data into meaningful visualization. The result of the common suggestions and opinions will be processed to the next survey.

c. Kano Calculation

Kano calculation is done to categorize the features that have been suggested by the customers. Based on the Kano categories, then the important features can be detected and implemented.

d. TextBlob

TextBlob is used to analyse the category of the opinion. From the opinion obtained in the second research, the polarity of the sentence will be notified, such as positive, negative, or neutral towards the proposed features.

5. Analysis and Discussion

In this step, the analysis of the result of Kano calculation and sentiment analysis is initiated to the reverse vending machine that is already in line with the voice of customers.

6. Conclusion and Recommendation

Finally, to conclude all the research, the problem formulation is answered. Moreover, the recommendation for the company and for the future research is provided in this step.

CHAPTER IV

DATA COLLECTING AND PROCESSING

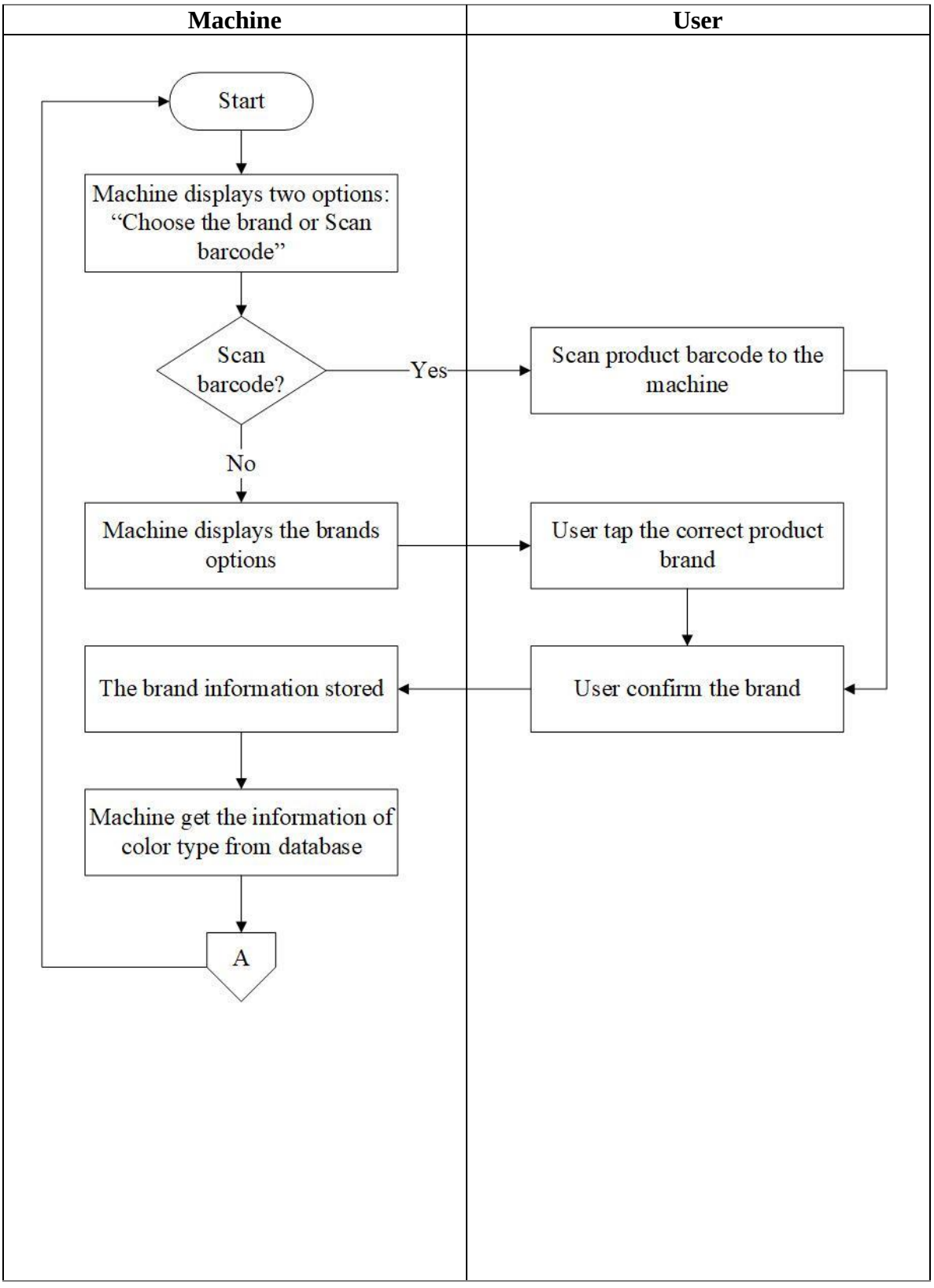
4.1 Data Collecting

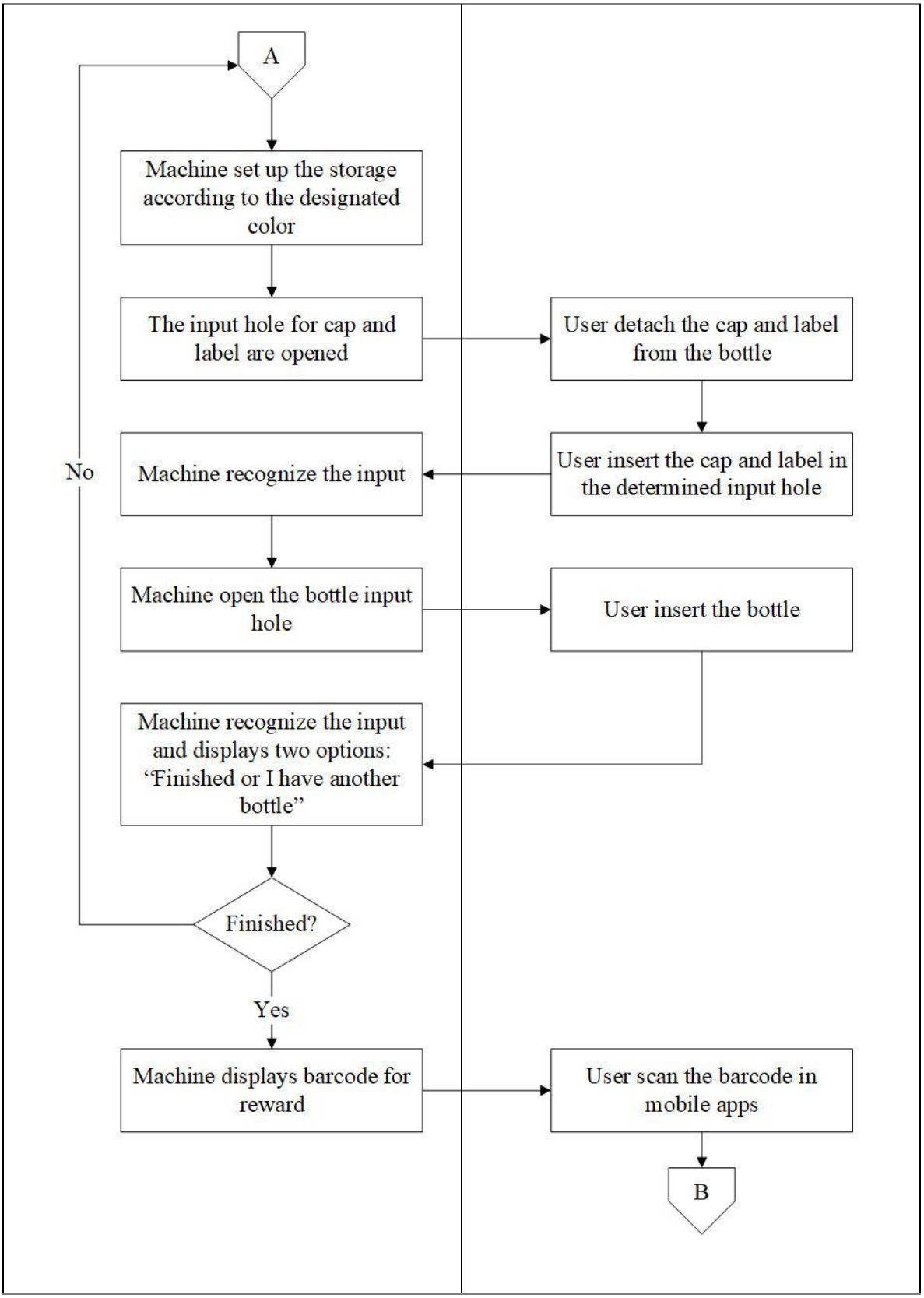
The data collecting process consists of two parts, which are conducting the first online survey in order to attain the voice of customers regarding to the features determination and conduct the second online survey to gain the opinion of targeted customers towards the selected features and the importance of it from the customers' point of view.

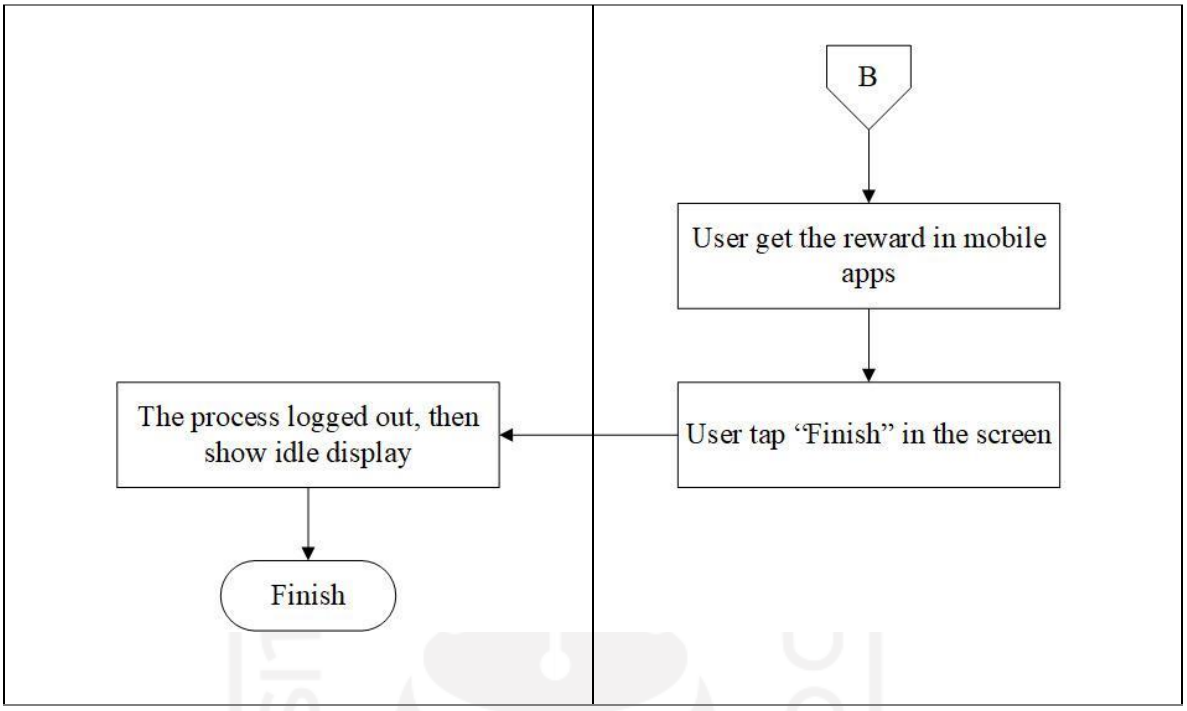
4.1.1 The Reverse Vending Machine

The reverse vending machine plays role in collecting and sorting PET bottle waste. The user will be people who have empty bottle. The concept of process that will be implanted in the reverse vending machine is described as follows.

Table 4.1 Process Diagram




A
Machine set up the storage according to the designated color
The input hole for cap and label are opened
User detach the cap and label from the bottle
User insert the cap and label in the determined input hole
No
Machine recognize the input
Machine open the bottle input hole
User insert the bottle
Machine recognize the input and displays two options: "Finished or I have another bottle"
Finished?
Yes
Machine displays barcode for reward
User scan the barcode in mobile apps
B



4.1.2 Identification of Features Suggested from Targeted Customers

The data collection is started from the identification process to identify what are the preferences and requirements of targeted customers on the features of the machine. The data are collected by online survey that involve 71 respondents. The respondents are ranged in the age of 17 to 50 years old and 60.6% of them are women. This survey consists of three parts referring to four aspects that will be studied.

a. Appearance

Appearance is defined as what the targeted user firstly sees and perceives towards the product. A good appearance may lead to excitement and interest, so that the targeted user wants to get closer to the product and try to operate it. In this survey, the desired appearance is asked to identify what kind of appearance that the targeted customers refer to.

Table 4.2 Appearance Survey Data

No	Appearance
1.	Include the usage tutorial and has interesting design.
2.	I want the machine's appearance is interesting and colorful. Besides that, I want the appearance is having clean look even though it is used to process bottle waste.
3.	I want the simple design and color to make the model sustainable.
4.	I want this machine is not too big so it does not need huge spaces and also having neutral color.
5.	Bright color and interesting.
6.	Has minimalist and simple design.
7.	Has simple and elegant design.
8.	Simple but still representing its function.
9.	User friendly, not having much menus or buttons.
10.	I want the machine's appearance is simple and easy to understand for the new users. Using one interesting color like soft or bright color.

b. Usage time

Usage time is the whole-time needed by user to operate the machine, started from walking in until finishing the reward system. The usage time can determine the attractiveness of the product, because if the process takes long time, the targeted user might not be interested anymore. Thus, this section aims to discover how many minutes the targeted customers are willing to operate it.

Table 4.3 Usage Time Survey Data

No	Usage Time
1.	One bottle maximum two minutes.
2.	As fast as possible.
3.	Two to three minutes.
4.	One minute.
5.	Not too long because I will be bored. Maybe the machine should have some entertainments so the user will not feel waiting.
6.	For a 600ml bottle, approximately three minutes.
7.	Faster and more efficient.
8.	One minute.
9.	Less than one minute.
10.	The time that I expect in waiting the process is three minutes.

c. Access

This section aims to project on which demographic of ages are the targeted user want to recommend this product. Within the response, some additional features can be added if there are special people that will use the product.

Table 4.4 Access Survey Data

No	Access
1.	Young people and children.
2.	Family. I need the information displayed in the screen has big font size and ergonomic design.
3.	Family, friends, and close friends.
4.	Maybe this product can be attractive for children if having the attractive appearance. Maybe can add minigame that can be played while waiting for the process.
5.	Family and friends, need adjustable font size and dictation features.
6.	University students, lecturers, and society.
7.	Children, so the children can be aware of recycling.
8.	Family, neighbors, and friend.
9.	All of my family, so it needs effective display on the screen and has icons to get better understanding.
10.	People in all ages, including children and elderly.

4.1.3 The Opinion of Targeted Customer in Selected Aspects

From the result of previous survey, another survey is conducted to identify how the targeted customer perceives the selected aspects. The selected aspects that are grouped to become seven sections are generated from the result of data processing in the first survey. By this opinion, a sentiment analysis can be done to recognize whether the targeted customers are reacting excited or not about the aspects. This survey is conducted online and involved 325 respondents.

a. Color and pattern of the product

This section aims to identify whether the targeted customers consider that color and pattern as important, also to filter the preference color.

Table 4.5 Color and Pattern Survey Data

No	Color and Pattern
1.	Bright color and eye catching, so people will notice it easily.
2.	Striking colors will be more interesting and reduce the mosquitos to live in.
3.	Bright colors are more noticeable in public places.
4.	With the appearance or the striking and bright color will attract much user, and people will be excited in trying something new.
5.	I am not too concerned about the color in the product because the value of product lies on its functions.
6.	Attractive color can draw attentions of people to look at the product and try to use the product.
7.	More easily recognized when having bright colors.
8.	Some people will say better if the machine has bright color, but I choose neutral color to make it looks elegant and clean.
9.	It is better if designed simply and not having much pattern.
10.	The color is better not too bright and has many patterns.

b. The importance of easy interface in the product

This section aims to know how are the targeted customers reacts to the interface of the product. The importance of an easy interface will can be examined by using this data.

Table 4.6 The Importance of Easy Interface Survey Data

No	The Importance of Easy Interface
1.	This is very important in the operation of the machine because people will use them on their own without assistance.
2.	If it is easy, many people can use this machine.
3.	The easier it is, many people are willing to use this machine.
4.	If it is difficult and hard to understand, user will reluctant to use it, because it is new product.
5.	If the interface is difficult to understand, the user tends to be lazy to use it again.
6.	The product's users are from various backgrounds, so it should be made with simple instructions that are simple and easy to understand.

No	The Importance of Easy Interface
7.	The ease of new user interface can know good and easy.
8.	Simple interface can reach all ages.
9.	Many people including me do not like complicated things. So, it is better if the product is easy to understand and do not waste a lot of time.
10.	The ease of interface on the machine will support the effectiveness of their usage.

c. The importance of informative content displays on the product when in idle

This section aims to discover whether the targeted customer needs the informative content or not and the opinions regarding to it.

Table 4.7 The Importance of Informative Content Survey Data

No	The Importance of Informative Content
1.	It is important for entertainment and new insight.
2.	Informative content is very helpful for the user to know the function of the machine.
3.	Rather than only blank display, why do not display learning medias and campaign to save the earth.
4.	People will be more interested and could help people to understand about the aspects to save the world by using this product.
5.	Machine that has blank display when in idle seems like broken machine.
6.	Information is better displayed when the machine is in idle.
7.	Important for the user guideline information or the information about waste processing.
8.	It is better to not display anything to save the electricity.
9.	If it has informative content at least it can educate people.
10.	Same features as on the ATM.

d. Opinion about the usage time

The opinion about usage time is very critical to identify what is the targeted customer thinks about the usage time.

Table 4.8 Opinion about the Usage Time Survey Data

No	Opinion about the Usage Time
1.	Would have been more fun if the waiting time is short.
2.	The shorter the better.
3.	Less than two minutes will be more efficient.
4.	The disposal of waste that can be directly recycled should not wasting time.
5.	Must be quick to facilitate people with high mobility.
6.	The sooner the better.
7.	Time is not a big problem for me to prevent plastic waste.
8.	Faster so many people will be interested.
9.	I prefer easy and short time in recycling.
10.	I'm neutral about the usage time.

e. Opinion about the font size in the product's display

This section is related to the second section about the interface also related to the seventh section about the elderly-friendly features. Within this opinion mining regarding to font size, the targeted customers can freely give comments related to the size, whether it is better if being big or small or just normal.

Table 4.9 Opinion about Font Size

No	Opinion about Font Size
1.	Large font will make it easier especially for elderly.
2.	Simple and readable.
3.	If it is too small, it is very difficult to read.
4.	Most importantly legible.
5.	Should be made large enough and clear.
6.	Clearly written and easy to read is certainly more convenient.
7.	While they can be read, in my opinion it's okay.
8.	Important to have large font so the elderly can use it.
9.	If it could be large, why not.
10.	Facilitate user with different types of eyes.

f. The importance of child-friendly features on the product

This section aims to know how the targeted customers think about child-friendly features. From the result of first survey that many of the respondents want to introduce this product to

their family, including children, this section is critical to gain more insights about the features.

Table 4.10 The Importance of Child-Friendly Features Survey Data

No	The Importance of Child-Friendly Features
1.	To teach environmental awareness from early age.
2.	Must be safety.
3.	Kid friendly features would be good because it can teach children to care about the environment.
4.	It is better so children could make recycling as a habit.
5.	Not too important.
6.	In my opinion, it is needed to make the product interesting for children.
7.	If it can minimize risk when children are using the product, it is good.
8.	Very important.
9.	It is okay if there is no.
10.	It is good so it can be the learning media for children.

g. The importance of elderly-friendly features in the product

This section aims to know how the targeted customers think about elderly-friendly features. From the result of first survey that many of the respondents want to introduce this product to their family, including elderly, this section is critical to gain more insights about the features.

Table 4.11 The Importance of Elderly-Friendly Features Survey Data

No	The Importance of Elderly-Friendly Features
1.	Elderly can take benefit of this technology.
2.	Better to be used for all ages.
3.	I think elderly also connected to the environment.
4.	Important so that the elderly can use it well if no one helps.
5.	Ordinary.
6.	Important so that the elderly who has bad vision will still can use the machine.
7.	Quite important.
8.	Urgent.
9.	If there is, it is better. If there is not, it is okay.
10.	Important because the elderly also need to dispose the waste.

4.1.4 Kano Questionnaire

From the result of the first survey that is objected to identify what are the needs and desires from targeted customers towards the product, a Kano questionnaire was spread along with the previous opinion survey. There are seven aspects with two questions for each aspect, representing the functional and dysfunctional of the proposed features. The form of questions in Likert scale ranged from 1 to 5, where 1 = I like it that way, 2 = It must be that way, 3 = I am neutral, 4 = I can live with it that way, 5 = I dislike it that way. Below is the list of functional and dysfunctional questions and the number of responses gained for specific answer.

a. Color and pattern of the product

Table 4.12 Color and Pattern Likert Data

Questions	1	2	3	4	5
If the machine is colorful and has attractive appearance, how do you feel?	158	84	55	16	12
If the machine is not colorful and does not have attractive appearance, how do you feel?	37	31	111	73	73

b. Interface display

Table 4.13 Interface Display Likert Data

Questions	1	2	3	4	5
If the screen in the machine has simple and easy-to-use interface, how do you feel?	209	80	19	12	5
If the screen in the machine does not have simple and easy-to-use interface, how do you feel?	16	13	31	80	185

c. Informative content

Table 4.14 Informative Content Likert Data

Questions	1	2	3	4	5
If when the machine is in idle then the screen shows some informative contents, how do you feel?	188	79	42	10	6
If when the machine is in idle then the screen shows some informative contents, how do you feel?	26	16	139	59	85

d. Usage time

Table 4.15 Usage Time Likert Data

Questions	1	2	3	4	5
If the minimum usage time for each user to input the bottle and get the reward is less than 2 minutes, how do you feel?	170	83	56	10	6
If the minimum usage time for each user to input the bottle and get the reward is more than 2 minutes, how do you feel?	29	32	113	81	70

e. Font size

Table 4.16 Font Size Likert Data

Questions	1	2	3	4	5
If the screen of the machine has big font to make it easy to read, how do you feel?	184	87	37	11	6
If the screen of the machine has small font, how do you feel?	21	17	72	100	115

f. Child-friendly feature

Table 4.17 Child-Friendly Feature Likert Data

Questions	1	2	3	4	5
If the machine has child-friendly features, how do you feel?	221	66	26	7	5
If the machine does not have child-friendly features, how do you feel?	15	8	99	76	127

g. Elderly-friendly feature

Table 4.18 Elderly-Friendly Feature Likert Data

Questions	1	2	3	4	5
If the machine has elderly-friendly features, how do you feel?	223	60	28	7	7
If the machine does not have elderly-friendly features, how do you feel?	18	12	84	70	141

4.1.5 Technical Implementation Questionnaire

From the result of the first survey that is aimed to identify the features preferred by the targeted customers, then several ways of implementation are proposed to them by an online survey. There are two to three options for each feature and the results are as follows.

Table 4.19 Technical Implementation Survey Data

Feature 1: Color and Appearance		
White	**Light Yellow**	**Light Green**
64%	12%	24%
Feature 2: Easy Interface		
With Button	**Button-less**	
32%	68%	
Feature 3: Readable Font Size		
Small	**Medium**	**Big**
24%	68%	8%

Feature 4: Informative Content		
Cartoon Pitch Video	**Company Profile**	**Education**
48%	28%	24%
Feature 5: Child-friendly Feature		
Step Stool	**Basketball Ring**	**Drawable Case**
52%	16%	32%
Feature 6: Elderly-friendly Feature		
Adjustable Font Size	**Dictation Feature**	**Additional Handle**
48%	20%	32%

4.2 Data Processing

The data collected from the first survey will be processed using word cloud and the data from the second survey will be pre-processed with reliability analysis and processed by using Kano and sentiment analysis. The detailed process will be explained as follows.

4.2.1 Word Cloud

Word cloud is a tool to plot the most common words appeared in a dataset. In this research, the input data is from the first survey which aims to identify the suggested features from targeted customers. The input data are in form of opinion in four determined aspects. With this tool, the common words that comes from the targeted customers' suggestions will come up in respective size to their occurrences.

After obtaining the data from Table 4.2 to Table 4.4, then they are stored in excel file. The word cloud then created by Python. There are several packages that should be imported, such as numpy, pandas, path, image, wordcloud, stopwords, and matplotlib pyplot. The word cloud can be made using Wordcloud package with additional stop words to increase the clarity of the result.

Table 4.20 Additional Stop Words

Aspects	Additional Stop Words
Appearance	Machine, Want
Time	Bottle, Want
Access	Use, Feature, Machine

Figure 4.1 describes the script of Python code to show the word cloud based on existing data. The difference between aspects lies on the data that imported and the additional stop words in “stopwords.update”.

```
text1 = " ".join(review for review in df)
wordcloud= WordCloud().generate(text)
stopwords = set(STOPWORDS)
stopwords.update(["bottle","want"])
wordcloud = WordCloud(width=1600, height=800, stopwords=stopwords,
                      background_color="white").generate(text1)

plt.figure( figsize=(20,10) )
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```

Figure 4.1 Python Script for Word Cloud

a. Appearance

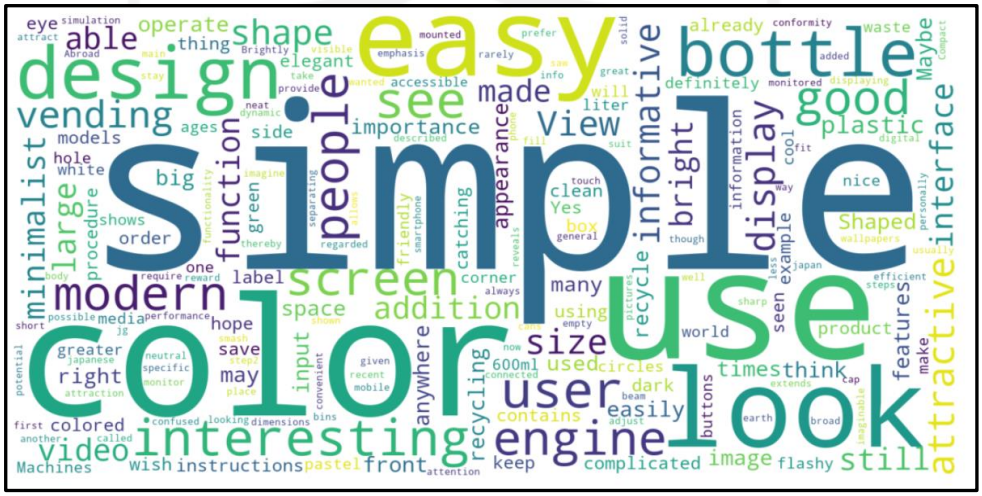


Figure 4.2 Appearance Word Cloud Result

b. Usage Time

Figure 4.3 Usage Time Word Cloud Result

c. Access

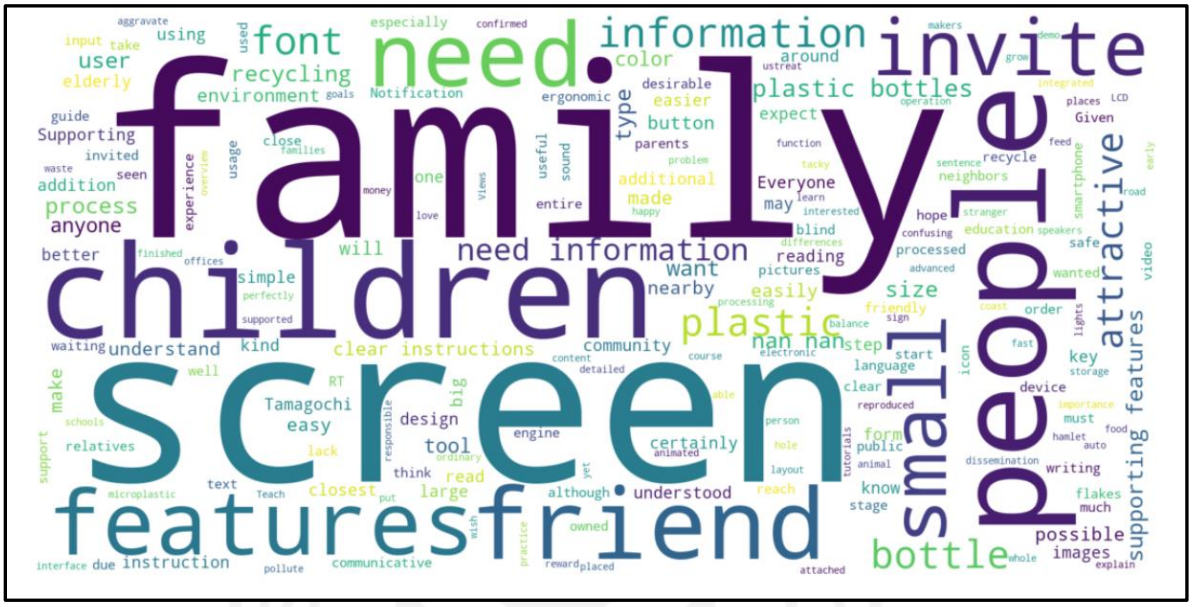


Figure 4.4 Access Word Cloud Data

4.2.2 Reliability Test

Reliability test is used to identify whether the instrument that being utilized for gaining the data is reliable to discover the information as a research tool or not. In this research, the reliability test tool chosen is SPSS software.

Reliability

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	325	100.0
	Excluded[a]	0	.0
	Total	325	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.717	14

Figure 4.5 Reliability Test Result

4.2.3 Kano Calculation and Modelling

The Kano calculation aims to plot the features in the Kano model. From the input of Kano questionnaire, the calculation on features categorization in Kano such as A, O, M, I, Q, R, the satisfaction and dissatisfaction will be formulated. Then, the result will be modeled using the Kano map.

4.2.3.1 Kano Calculation

In this section, the data recapitulation in each feature is needed. Then, the satisfaction and dissatisfaction of each feature can be calculated using the following formula. The lists of

questions on Table 4.19 from Q1 until Q7 represent the bright color, easy interface, informative display, usage time, font size, child-friendly, and elderly friendly features respectively. The calculation of satisfaction and dissatisfaction follows the Equation 2.1 and Equation 2.2.

Table 4.21 Kano Calculation

	A	O	M	I	Q	R	Satisfaction	Dissatisfaction
Q1	102	40	108	30	19	26	0.5	-0.53
Q2	71	125	52	58	15	4	0.64	-0.58
Q3	112	60	101	23	18	11	0.58	-0.54
Q4	100	50	123	18	22	12	0.51	-0.59
Q5	92	81	95	32	13	12	0.58	-0.59
Q6	102	108	80	17	13	5	0.68	-0.61
Q7	89	120	76	18	17	5	0.69	-0.65

4.2.3.2 Kano Modelling

After discovering the value of satisfaction and dissatisfaction from the previous section, then the features are mapped into the Kano graph to identify in which category the features are placed. The type of graph is scatter plot.

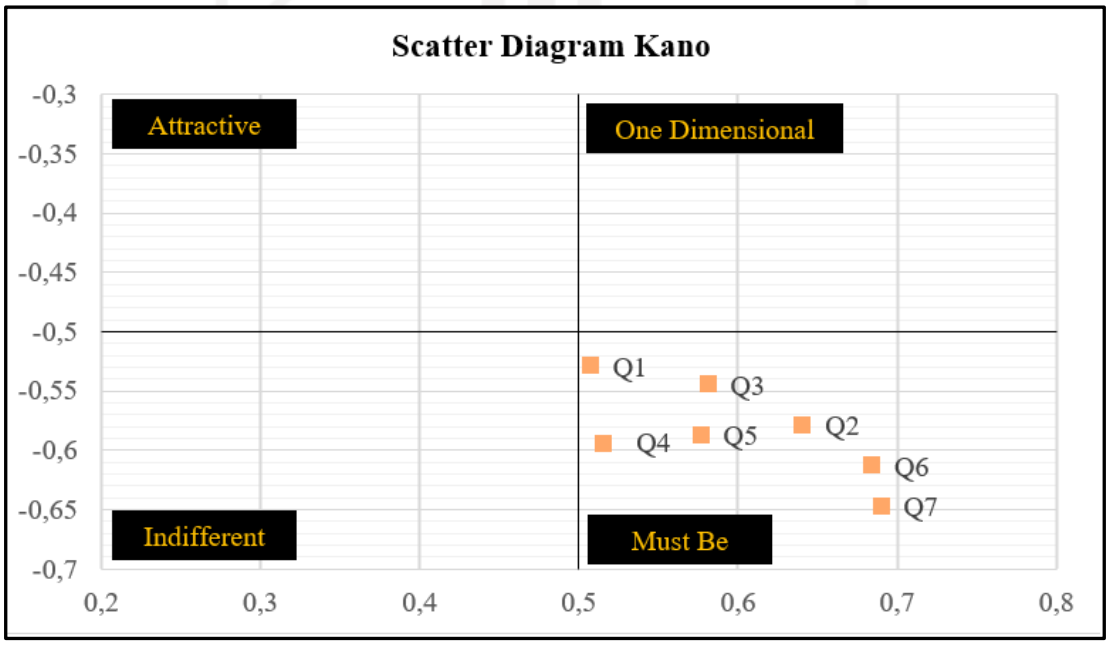


Figure 4.6 Kano Scatter Diagram

4.2.4 Sentiment Calculation

Sentiment analysis is employed to know the tendency of insights given from the opinion of the targeted customers. Based on that, the polarity and subjectivity can be calculated using TextBlob in Python. Later, the results are mapped with the scatter plot and bar chart to reveal the common sentiments from the dataset. In this research, the sentiment calculation will be executed on seven features as in the opinion dataset that has been collected.

a. Color and pattern of the product

In this section, the polarity and subjectivity in the Question 1 about color and pattern of the product have been calculated and mapped into scatter plot in Figure 4.7. From the polarity and subjectivity, it can be determined whether the sentiment is positive, negative, or neutral. The calculation for each types of sentiment has been done and mapped in the bar chart in Figure 4.8.

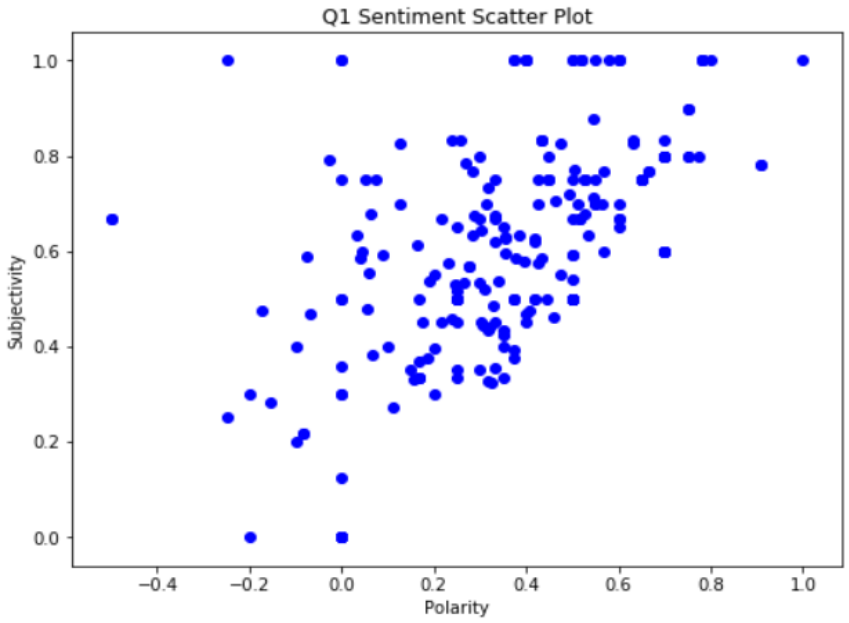


Figure 4.7 Q1 Sentiment Scatter Plot

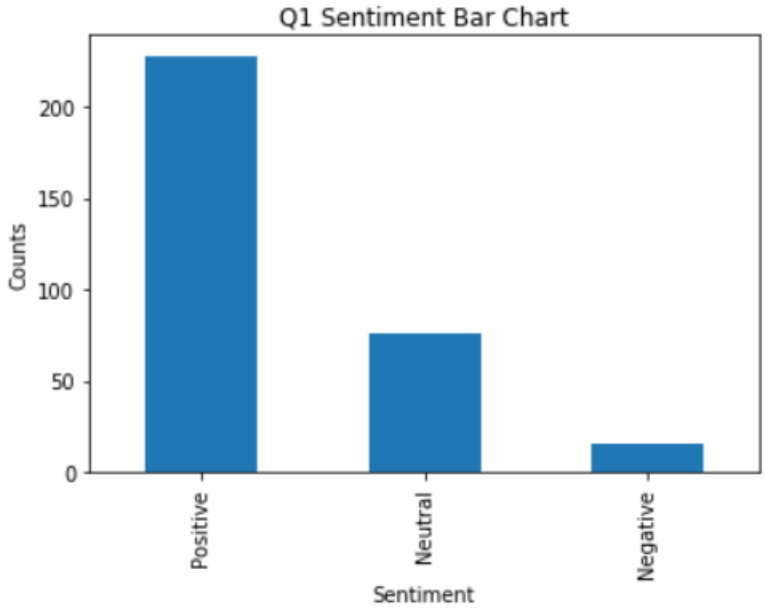


Figure 4.8 Q1 Sentiment Bar Chart

b. The importance of easy interface in the product

After resuming opinions from the targeted customers about the importance of easy interface in the product, noted as Q2 in the data calculation, then the polarity and subjectivity from each opinion can be calculated. The result of the calculation is drawn in the Figure 4.9. The sentiment classification can be discovered from the calculation and grouped to know the numbers gained in every sentiment in Figure 4.10.

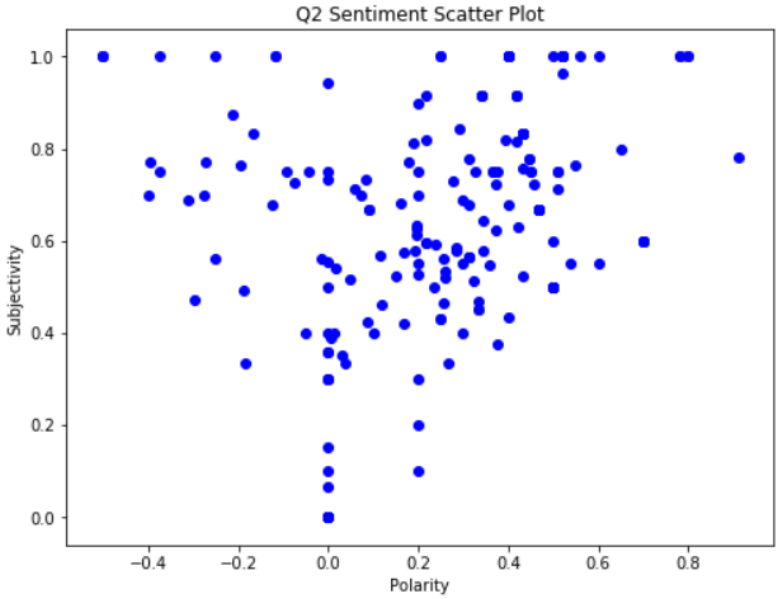


Figure 4.9 Q2 Sentiment Scatter Plot

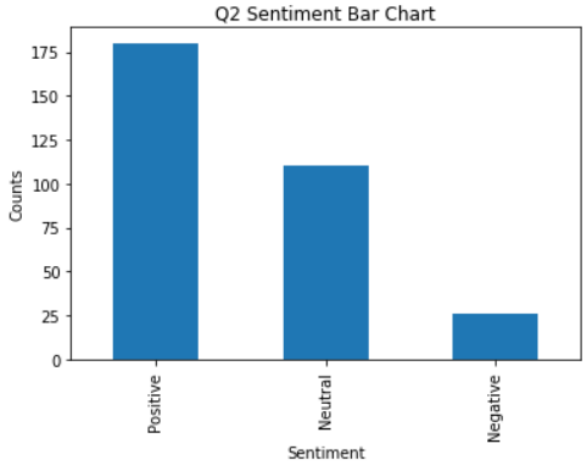


Figure 4.10 Q2 Sentiment Bar Chart

c. The importance of informative content display in the product when in idle

In this section, after the opinion data about the importance of informative content which notated as Q3 are gained, a subjectivity and polarity can be calculated in order to identify the sentiment in each data. A scatter plot is generated to know the data spread as in Figure 4.11.

Then, after the sentiments have discovered from the values of subjectivity and polarity, then a bar plot as in Figure 4.12 generated to clearly seen on which sentiment the targeted customers are into.

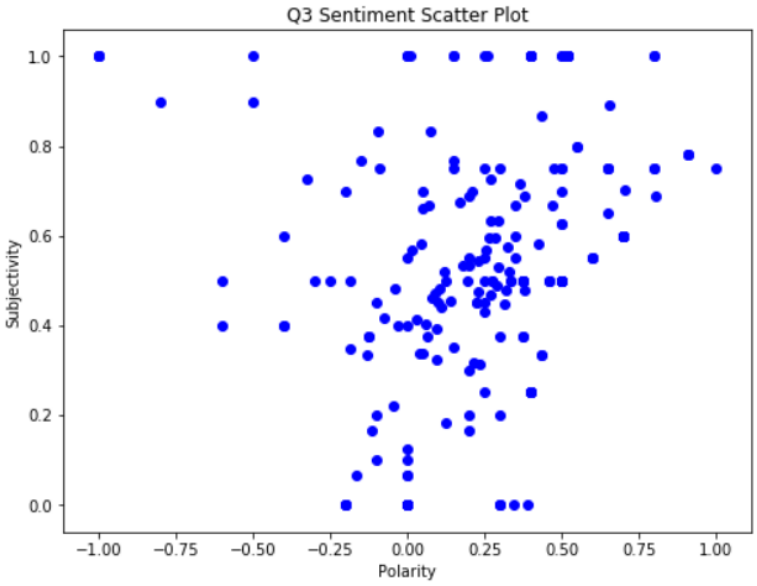


Figure 4.11 Q3 Sentiment Scatter Plot

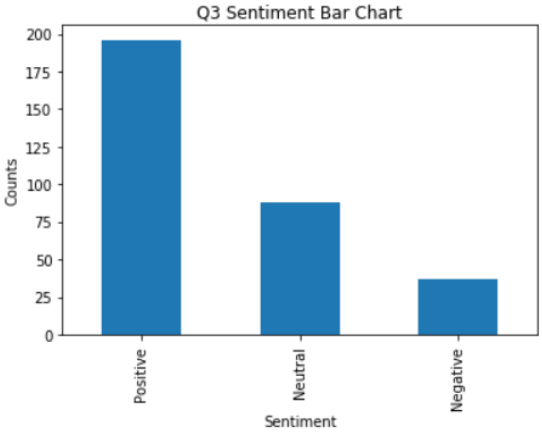


Figure 4.12 Q3 Sentiment Bar Chart

d. Opinion about the usage time

In this section, the polarity and subjectivity in the Question 4 which defines the usage time of the product has been calculated and mapped into scatter plot in Figure 4.13. From the polarity and subjectivity, then it can be notified whether the sentiment is positive, negative, or neutral. The calculation for each types of sentiment has been done and mapped in the bar chart in Figure 4.14.

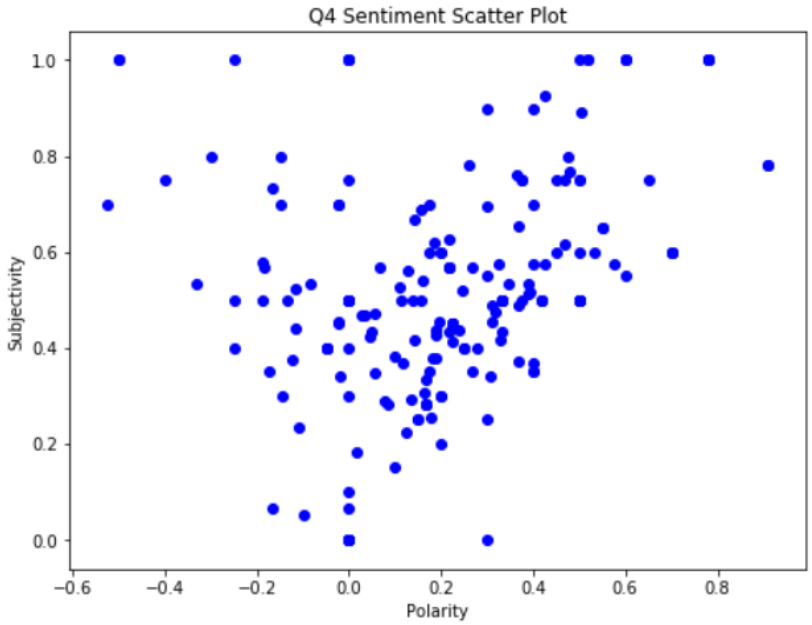


Figure 4.13 Q4 Sentiment Scatter Plot

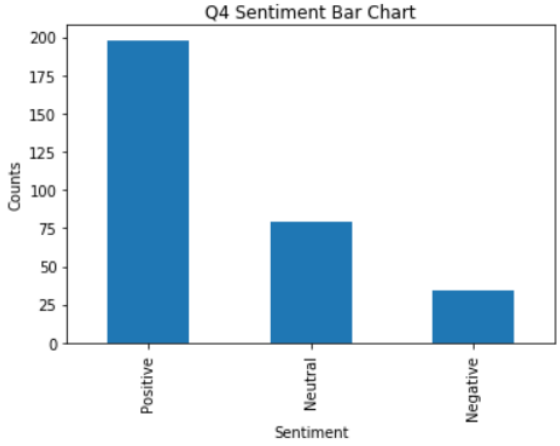


Figure 4.14 Q4 Sentiment Bar Chart

e. Opinion about the font size in the product's display

After gathering opinions from the targeted customers about the font size in the product display, notated as Q5 in the data calculation, then the polarity and subjectivity from each opinion can be calculated. The result of the calculation is drawn in the Figure 4.15. The sentiment classification can be discovered from the calculation and grouped

THESIS APPROVAL OF EXAMINATION COMMITTEE

DETERMINATION OF PRODUCT FEATURES USING KANO AND SENTIMENT ANALYSIS METHOD
CASE STUDY: REVERSE VENDING MACHINE

By

Name : Putri Amalia
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Had been defended in front of Examination Committee in Partial Fulfillment of the requirements for the degree of Sarjana Teknik Industrial Engineering Department Faculty of Industrial Technology

Universitas Islam Indonesia

Examination Comittee

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Winda Nur Cahyo, S.T., M.T., Ph.D
Member I

Dr. Drs. Imam Djati Widodo, M.Eng.Sc.
Member II

Acknowledged by,
Head of Study Program
International Program Industrial Engineering
Universitas Islam Indonesia

Taufiq Immawan, Dr., S.T., M.M.

to know the numbers gained in every sentiment in Figure 4.16.

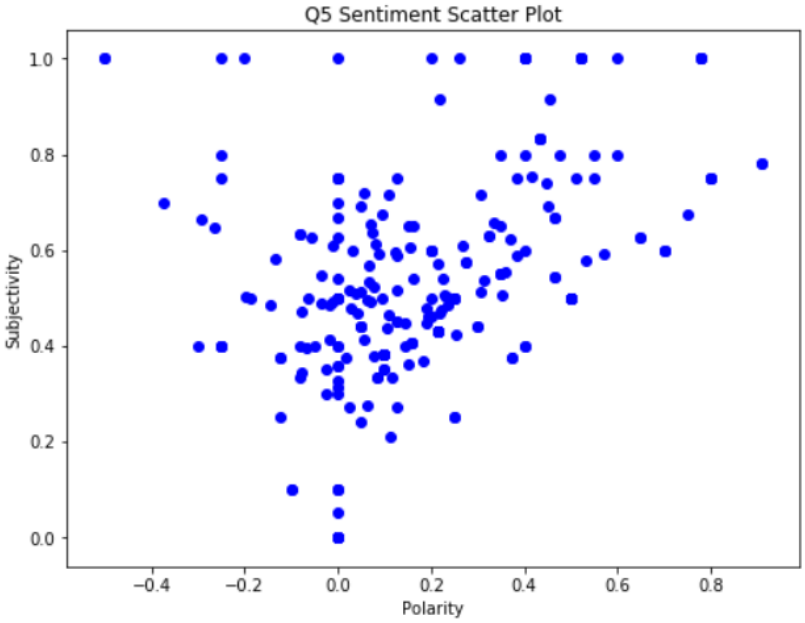

Figure 4.15 Q5 Sentiment Scatter Plot

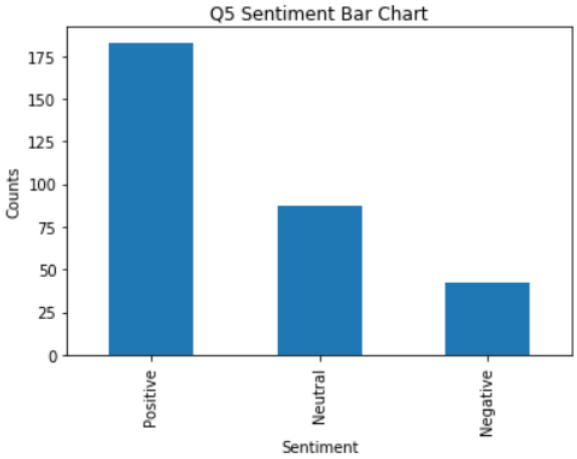

Figure 4.16 Q5 Sentiment Bar Chart

f. The importance of child-friendly features in the product

In this section, after the opinion data about the importance of child-friendly features which notated as Q6 are collected, a subjectivity and polarity can be calculated in order to identify the sentiment in each data. A scatter plot is generated to know the data spread as in Figure 4.17. Then, after the sentiments have been discovered from the values of subjectivity and polarity, then a bar plot as in Figure 4.18 is generated to clearly seen on which sentiment the targeted customers are into.

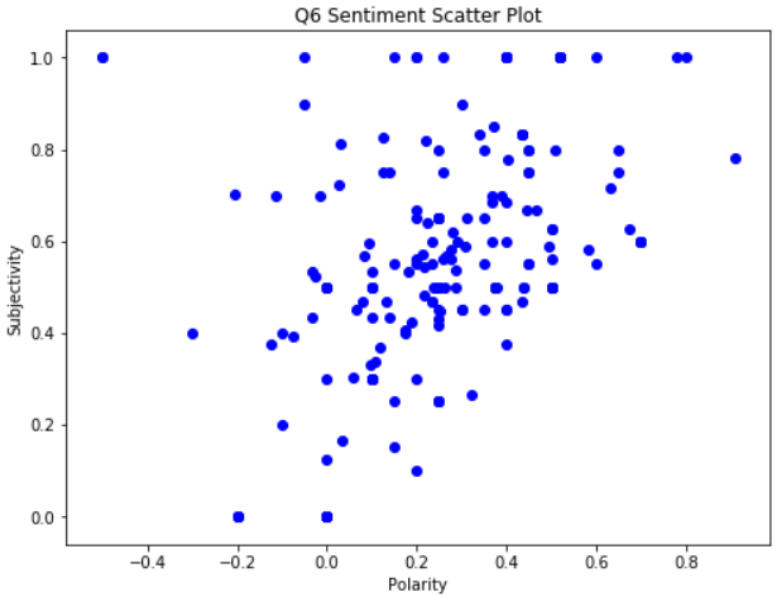

Figure 4.17 Q6 Sentiment Scatter Plot

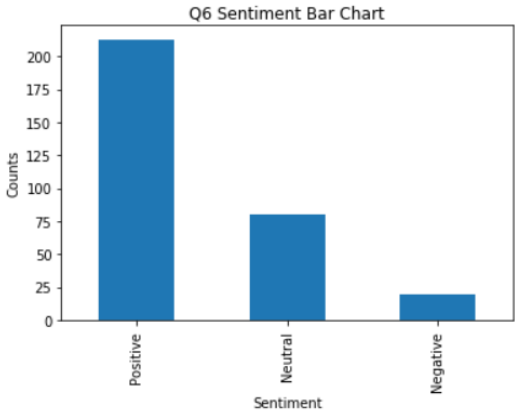

Figure 4.18 Q6 Sentiment Bar Chart

g. The importance of elderly-friendly features in the product

The sentiment calculation for elderly-friendly feature started from the calculation of subjectivity and polarity on the Q7 opinion dataset. After both values have been calculated, the sentiment classification can be performed to see whether it is positive, negative, or neutral. The result of calculation is drawn on the Figure 4.19 and Figure 4.20.

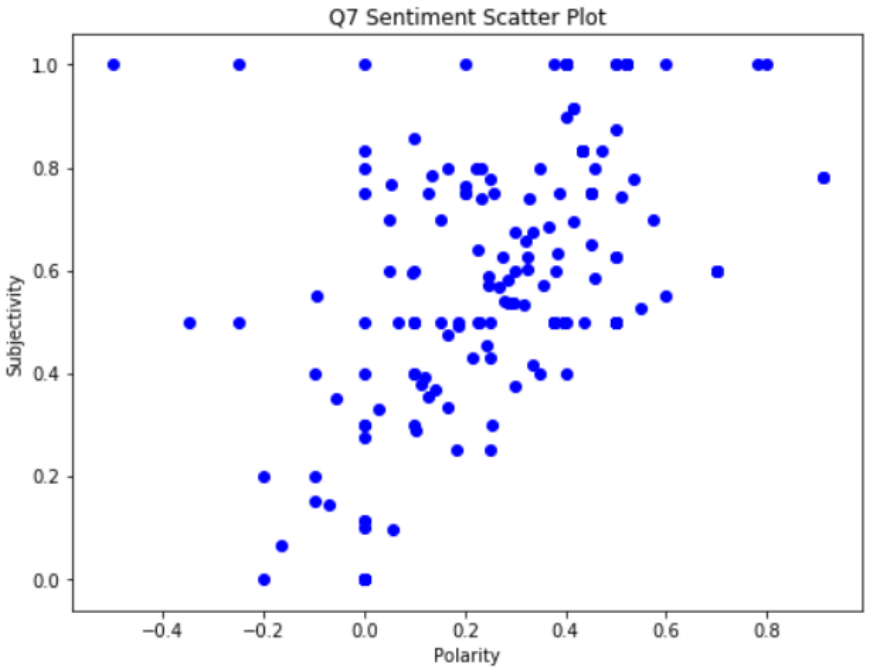

Figure 4.19 Q7 Sentiment Scatter Plot

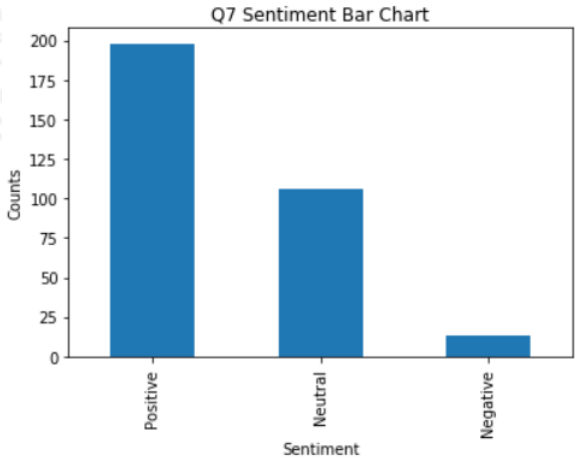

Figure 4.20 Q7 Sentiment Bar Chart

CHAPTER V

DISCUSSION

5.1 Feature Determination

This research is aimed to determine the features that should be developed in the product and determine the importance of developing each feature. To accomplish that, the research is initiated with a feature determination process. The feature determination is originated from opinions of targeted customers and being processed with the help of word cloud.

The voice of customers has been derived from the first survey as described in the section 4.2.3. There are three questions representing different aspects of the product, which are appearance, usage time, and access. The expected output from the appearance question is to identify the features regarding to the appearance that can be developed, according to the voice of customers dataset. Based on the result of data processing by word cloud as a visualization tool in Figure 4.2, apparently simple is the most common word appeared in the dataset. Followed by color, use, look, easy, design, and interesting, the features that can be extracted from this result is the color which affecting the design and interesting look of the product, easy interface for easy use as well as the font size in the display screen.

The second question in feature determination is the usage time. The outcome of this question is to identify the value of time that the targeted customers will spend during product's utilization and their expectations towards the usage time of the product. After being mapped in Figure 4.3, the most common words appeared are minute, less, time, second, maximum, and possible. The features extracted from this question still involves usage time. However, in next survey, the question outputted the proposed usage time, which is 2 minutes.

The last question is about the access with the purpose to identify the people segmentation who will be promoted by the targeted customer to use the product. This section also aims to recognize whether they need special features or not. Based on Figure 4.4, the most common words appeared are family, screen, children, and friend. Thus, the follow up questions for the next survey is the importance of child-friendly feature and also the importance of elderly-friendly features.

5.2 The Features' Importance Analysis

After revealing the features that can be proposed based on the voice of customers in the previous section, the research is continued to acknowledge the importance of each features. From three questions in the first survey, there are seven features to be assessed by the targeted customers using online survey. The features are color and pattern, easy interface, informative display, usage time, font size, child-friendly feature, and elderly-friendly features. The assessment is supported by a Kano questionnaire and added with one open ended question on each feature to get the opinion from the respondents.

After the data from the second survey are established, the reliability test has to be accomplished first. The reliability test has been explained in 4.2.2 which intends to identify the appropriate instrument to do data collection, which is the Kano questionnaire. The data input is the response dataset of Kano questionnaire in Likert scale and tested by using SPSS

software. In Figure 4.5, the result of reliability test is represented by the value of Cronbach's Alpha which is 0.717. Based on Hair et al. (2010), the minimum value of Cronbach's Alpha to be categorized as reliable is 0.50. Based on the calculation on SPSS software, the value of Cronbach's Alpha for this research tool is 0.717, which is greater than 0.50 (0.717>0.50). So, the data collection instrument is reliable.

After passing the reliability test, the calculation for Kano questionnaire can be processed. The recapitulation of result is done, which aims to discover number of responses in every Kano category (A, O, M, I, Q, R). As in Table 4.19, the satisfaction and dissatisfaction can be calculated based on the formula. The result of satisfactions and dissatisfactions values are mapped in scatter diagram as illustrated in Figure 4.6. In Figure 4.6, all seven features are on the must-be category. The must-be category, also known as basic needs or threshold is the category which become the main reason of people to use the product. If the attributes in this class are rated in low performance, then the customers will feel unsatisfied. However, if the performance of attributes in this class is considered very high, the customers' satisfaction may not increase more than the average level. Thus, based on the Kano model, all features proposed are in the must-be category.

The importance of features then being compared with the result from sentiment analysis result. Since sentiment analysis is used to define the tendency of thought given from the opinion of the targeted customers, it can be used as the cross-checking tools between the result of Kano model and the opinions of the respondents which are from the second survey. Using TextBlob as the tool to accomplish sentiment calculation, the first thing to do is to calculate the polarity and subjectivity. The calculation is done by unsupervised machine learning. The result then mapped in Figure 4.7, 4.9, 4.11, 4.13, 4.15, 4.17, and 4.19 by using scatter plot. The scatter plot explains the data distribution for each feature. The neutral sentiment is represented by the dots that linear with the polarity 0.00. If the polarity in the exact 0.00, wherever the subjectivity is, it is categorized as neutral. The positive sentiments are in the right area after 0.00 polarity and the rest is designated for the negative sentiments.

The recapitulations of sentiments for each feature have been plotted by a bar chart in the Figure 4.8, 4.10, 4.12, 4.14, 4.16, 4.18, and 4.20. From those figures, all of the sentiments on each feature are mostly having positive sentiments. Positive sentiment means that the targeted customers are seeking into it, highly appreciating it, and need it. So, it is in line with the Kano model which draws conclusion that all the proposed features in the second survey are grouped in the must-be or basic needs category.

There is an underlying reason that may drive the features into the must-be classification. The targeted customers or the respondents who provide inputs may feel that they need all the features to satisfy them and to make them interested to use the product, since the product is very new to the market and people are still hesitant to utilize the product. If certain features are not performing well, the customers' satisfaction may decrease and lessening the intention of user to use the machine. However, if the features selected such as color and pattern, easy interface, informative display, usage time, font size, child-friendly feature, and elderly-friendly features are considered and arranged well, the user will be satisfied and they may promote the product and increase the number of users.

5.3 The Features' Implementation

Based on the findings, all proposed features are considered important to be applied. Then, a survey was conducted to further explore which implementation of features are more preferable from the several options of available features. From the seven extracted features, two to three options were proposed to the targeted customers. There are three options for the machine appearance, two options for the setup style, three options for the font size, three options for the contents to be displayed when the machine is idle, and three options for child-friendly and elderly-friendly feature, respectively.

The targeted customers then select the features that are preferred most by online survey. The result from the survey found out that the targeted customers or the respondents prefer white color for the appearance, touchscreen LCD or buttonless, medium font size, cartoon pitch video to be displayed in the screen while the machine is in idle condition, step stool for the children to put the bottle to the input hole, and adjustable font size for the elderly, to be more comfortable in using the machine.

CHAPTER VI

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Based on the discussion, it can be concluded that there are seven features that needed and wanted by the targeted customers, such as bright color appearance, easy interface, informative content while in idle, 2 minutes for the maximum usage time, big readable fonts, child-friendly features and elderly-friendly features. All of the seven features are in the must-be category in Kano model and all of the features are having positive sentiment while the targeted customers are giving their opinion towards the features. From the seven extracted features, two to three options were proposed to the targeted customers. There are three options for the machine appearance, two options for the setup style, three options for the font size, three options for the contents to be played when the machine is idle, and three options for each child-friendly and elderly-friendly feature. Based on the discussion, the targeted customers or the respondents are preferred to have white color as the appearance, touchscreen LCD or buttonless, medium font size, cartoon pitch video to be displayed in the screen when the machine is idle, step stool for the children to put the bottle to the input hole, and adjustable font size for the elderly to be more comfortable in using the machine. So, in the development of the reverse vending machine, a great concern about those seven features is needed because

those features are the basic reason why the targeted customers will use the product and if the features have low performance, the targeted customers may not feel satisfied.

6.2 Recommendation

The recommendations for the future research are:

1. Doing more research to explore more features that can be in different Kano classifications.
2. Conduct further research by equipping QFD to discover the technical requirements of the features, so that the reverse vending machine can be efficiently developed after the research.

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