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Prospective Customer Preference Toward Service Robots: A Discrete Choice Model Approach

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Abstract. *One major technological development pertains to the service robot industry. In Indonesia, the development of robots is increasing. Telkom will begin to explore new opportunities with companion robots, which can respond to and chat with humans and move around. Therefore, more analysis is needed based on market research and prospective user surveys. The present study aims to obtain information on the features of service robots significantly influencing customers' desire to purchase them and on the types of service robots they are likely to choose. The discrete choice model method is used to understand and predict a decision from a discrete alternative, based on a set of choices constructed with the help of the Ngene software and the D-efficient design method. We processed questionnaire results using the Python-Biogeme software to look for significant attributes and their elasticity. The significant attributes of companion robots defined by T-test are basic robot look (3.86), battery life (5.45), robot price (9.16), walking-computer look (6.10), and robot weight (8.38). The suggested strategy, among the three types of companion robots, is to focus on the personal assistant robot with the highest T-test score while paying attention to the resources a company already has.*

Keywords: *Service Robot, Discrete Choice Model, Significant Attribute, Elasticity*

1. Introduction

The 21st century heralded the development of automated technology, now central across society. One of such technologies is robotics, under constant development and competing with other technological advances. Robotics can also improve the quality of human life: Robots have gained importance in today's world for being able to carry out tasks and functions flexibly to help humans work (Putro & Litouw, 2017).

Service robots have developed in various countries. They are equipped with artificial intelligence (AI), which gives them human-like abilities. AI was created and entered into computer systems that aim to perform human tasks. Among other tasks, service robots can sweep floors, vacuum carpets, answer questions, chat, and help keep humans healthy.

Three types of service robots are well-known to the public: cleaning robots, telepresence robots, and companion robots. Each has a different market, as their functions are different. Companion robots are a broader category to study, since they can have various types of attributes. They can become study buddies, chat buddies, playmates, or personal assistants at home.

Among its digital push, the telco company Telkom Indonesia is presently exploring companion robots. As their name suggests, companion robots are meant to provide companionship for human beings, with their target markets including the elderly and single children. In the future, such robots might go beyond providing friendship, with the addition of features designed to check on a family member's vital signs or to help administer medications (Frumer, 2020).

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Before entering a market, a company ought to understand market conditions thoroughly. Companion robot abilities revolve around interacting with humans and moving around; further analysis based on these attributes, market research, and prospective user surveys is needed to assess the marketability of these types of robot.

Three types of companion robots are explored here in determining the attributes to be analyzed. Attributes that could influence potential buyers are found to be basic robot look, robot battery life, robot price, walking-computer look, and robot weight. To help with our assessment, we obtained information regarding the features of service robots significantly influencing a customer's desire to purchase such products and what type of service robot they are likely to choose. Thus, the objectives of this research are as follows:

1. To provide insights into service robot features significantly influencing customer desire to purchase them.
2. To discover the most suitable type of robot to market.
3. To determine the target segment in the marketing of service robots.

2. Literature Review and Hypothesis Development

Attributes

According to Kotler et al. (2016), attributes are additive properties, the basic functions of a product. Stanton et al. (1991) described product attributes as including price, brand, packaging, product warranty, color, name, good seller, seller service, product quality, and physical characteristics.

Companion Robot

A companion robot is a robot that "(1) makes itself 'useful', i.e. is able to carry out a variety of tasks in order to assist humans, e.g. in a domestic home environment, and (2) behaves socially, i.e. possesses social skills in order to be able to interact with people in a socially acceptable manner" (Dautenhahn, 2007).

Marketing Mix

Kotler and Armstrong (2016) classified the major marketing-mix tools into four broad groups, or the four Ps of marketing: product, price, place, and promotion. To deliver on its value proposition, the firm must first create a need-satisfying market offering (product). It must then decide how much it will charge for the offering (price) and how it will make the offering available to target consumers (place) and communicate product advantages and persuade target customers to buy it (promotion). The present research focuses on the product element, and the attributes chosen are based on scholarly findings, to be discussed in the next sub-chapter.

Market Segment

According to Kotler and Keller (2016), market segmentation divides a market into well-defined slices. A market segment consists of a group of customers who share a similar set of needs and wants.

Consumer Decision Making Process

Kotler and Keller (2006) maintained that consumers went through five stages: problem recognition, information search, evaluation of alternatives, purchase decisions, and post-purchase behavior. The buying process begins long before the actual purchase and has consequences long after. However, consumers do not always go through the five stages of buying a product. They may skip or reverse some stages.

Elasticity

In this context, the observed prices contain information about the demand for products and price elasticity. Elasticity depends on all prices, since the elasticity for a product is different at different prices (and hence different quantities) for that product as well as other products (Train, 2009). The basic equation for elasticity is Equation 1.

$$\eta_{X_{ik}}^{P_i} = \beta_k X_{ik}(1 - P_i)$$

Equation 1.

Elasticity Basic Equation (Koppelman & Bhat, 2006)

Where,
$\eta_{X_{ik}}^{P_i}$: Elasticity
β_k : Attribute coefficient
X_{ik} : Attribute level
P_i : Probability

Among the types of service robots, the present research focuses on companion robots. Three companion robot categories will correspond to the choice set, as three alternatives for potential users, each with different attributes. In formulating the research design, we use the discrete choice model (DCM), which describes decisions among a set of alternatives based on their utility value. The choice or response is in the form of nominal data, and a respondent is to choose the one with the highest utility value (maximum). Decision-makers in this sense can be people, households, companies, or other entities. The set for all options and alternatives is the "choice set" (Train, 2009).

3. Methodology

As Figure 1 shows, the first step of the research framework is defining the problem. In this step, the current problem faced by PT Telekomunikasi Indonesia Tbk is explained.

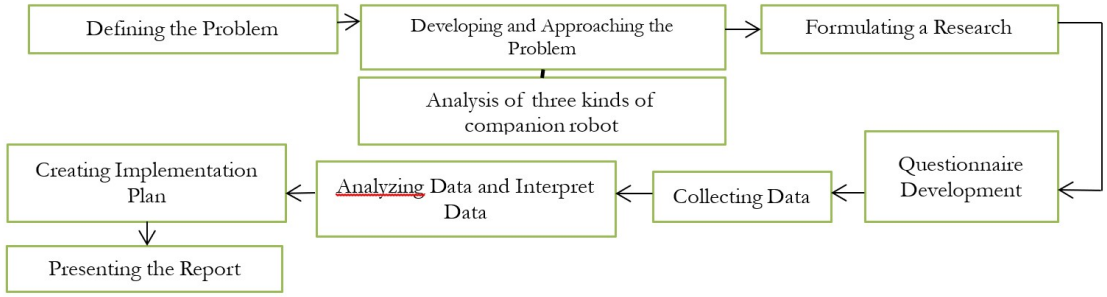

Figure 1.
Research Framework

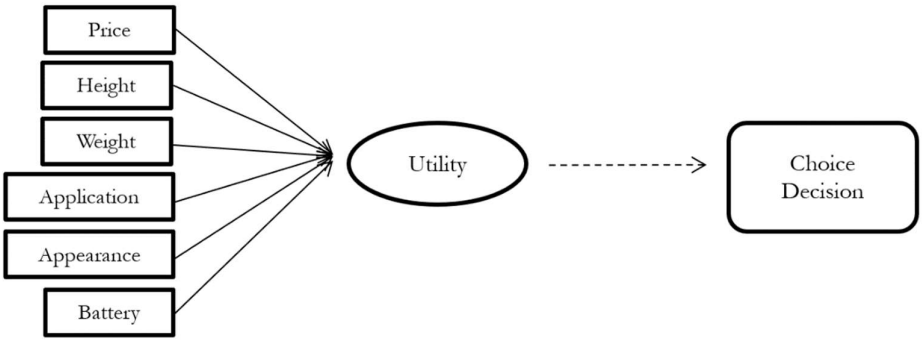

Figure 2.
Conceptual Design

The next step is developing and approaching the problem, which consists of the analysis and explanation of service robots present in the market, although few exist in Indonesia. This method is used to predict decisions for one discrete alternative in a choice set. For empirical data collection, we conceptualized a survey containing a choice set to be distributed to the target market.

We employ the DCM in this study as the data used are nominal data or categorical data. Data retrieval is based on the process of grouping several different objects according to certain characteristics. The last stage is data analysis, via Phyton-Biogeme, to arrive at results answering the research question. Figure 2 explains our conceptual design.

Attributes that are looking forward to be chosen by the author will have an effect on utility.

To simplify the making of questionnaires and experiments, we applied the efficient design method (Rose & Bliemer, 2009) using the Ngene software. The amount of utility will influence prospective buyers' decisions.

As mentioned, three companion robot categories correspond to the choice set, as three alternatives for the potential user with different attributes each (Table 1).

Table 1.
Attribute Comparison for Each Companion Robot (Source: Author)

	Companion Robot 1	**Companion Robot 2**	**Companion Robot 3**
Price	$540	$749	$499
Height	38 cm	56 cm	40.1 cm
Weight	1.72 kg	5 kg	1.56 kg
Application	*Stein-O-Matic* offering games, videos, and lessons. It can be downloaded from Google Play.	Its tablet is Android-based, its app will also work with iOS and Windows mobile devices.	Compatible with Windows, iOS and Android
Appearance	Human-like	A walking computer; has a touch screen	Basic robot look
Battery	Hours	Hours	1 hour

The choice decision will be selected from the utility that is the largest of the three alternatives. This study aims to find which attributes of companion robots are likely to be most in demand after launch, by gauging the attributes significantly influencing potential buyers in choosing the type of companion robot.

Table 1 lists the robots' different attributes for the research which, as mentioned, draws from the discrete choice model (Train, 2009). The questionnaire used for data collection is divided into four types, with eight choice sets each. Each choice is presented as an image corresponding to the appearance attributes, to make it easier for respondents to visualize them. The appearance attribute on the questionnaire will be the robot's preferred form of each alternative. For the last stage, that of data analysis, we process the data using multinomial logit (MNL); our modeling techniques employ Python-Biogeme (Bierlaire, 2005). Through MNL, we look for significant attributes and then carry out simulations to gauge the elasticity of demand for each attribute.

$$\beta_{i0} \times ASC_i + \beta_{i1} \times S_{1t} + \beta_{i2} \times S_{2t} + \cdots + \beta_{iM} \times S_{Mt}$$

Equation 2.
Utility Function (Koppelman & Bhat, 2006)
Where, β_iM is the parameter which defines the direction and magnitude of the incremental bias due to an increase in the mth characteristic of the decision-maker (m = 0 represents the parameter associated with the alternative's specific constant).
S_Mt is the value of the mth characteristics for individual t.

The negative value and more than 1.96 for basic robot look (B_basic) with -3.86 imply that people will be less interested in buying companion robots with a basic robot look. The positive value and more than 1.96 for battery life (B_battery) with 5.45 imply that the longer the battery lasts, the more interested people will be in purchasing companion robots.

4. Findings and Discussion

This study of companion robots uses six attributes—i.e., height, weight, application (android or iOS), appearance (human look, walking computer, basic robot look), battery life—to find significant product attributes as identified by 206 questionnaire respondents. Their profiles are presented in Appendix 1.

Significant Attributes

In this study, we set "companion robot for entertainment" as the reference alternative. This is used to look at the significance of the preference for companion robots, for education and companion robots, and for personal assistants. Via Python-Biogeme, we can estimate model parameters, test hypotheses about these parameters, and then estimate with maximum likelihood various random utility models. The simulation results will show a number for the t-test and P-value (Table 2).

Table 2.
Significant Attributes
(Source: Author)

Name	Value	Std err	t-test	p-value	Rob. Std err	Rob. t-test	Rob. p-value
B_app	-0.07	0.06	-1.23	0.22	0.06	-1.22	0.22
B_basic	-0.23	0.06	-3.86	0.00	0.06	-3.85	0.00
B_battery	0.09	0.02	5.45	0.00	0.02	5.37	0.00
B_height	0.00	0.00	0.20	0.84	0.00	0.21	0.84
B_human	0.01	0.06	0.17	0.86	0.06	0.17	0.87
B_price	-0.17	0.02	-9.16	0.00	0.02	-9.27	0.00
B_walkcom	-0.37	0.06	-6.10	0.00	0.06	-6.12	0.00
B_weight	0.36	0.04	8.38	0.00	0.04	8.15	0.00
CRA	0.49	0.08	6.00	0.00	0.08	5.98	0.00
CRB	0.13	0.01	12.00	0.00	0.01	11.90	0.00

The negative value and more than 1.96 for robot price (B_price) with -9.15 imply that the higher the price is, the less interested people are likely to be in purchasing a companion robot. Similarly, the negative value and more than 1.96 for walking-computer look (B_walkcom) with -6.10 imply that the more the companion robot has a walking-computer look, the less interested people are likely to be in buying it. Meanwhile, the positive value and more than 1.96 for robot weight (B_weight) with 8.38 imply that the heavier the weight is, the more interested people are likely to be in buying a companion robot. Finally, the positive value and more than 1.96 for educational robots (CRA) and personal assistant robots (CRB) imply that people are more likely to choose CRA or CRB than entertainment robots (CRC).

Elasticity of Demand

Elasticity is another measure of the probability of choice. Each alternative will change in response to alterations in the value of an attribute (Koppelman & Bhat, 2006). The Biogeme software helps us measure the elasticity of an attribute. In this case, we measure how much the attribute influences the customer's decision (Table 3).

Since personal assistant robots (CRB) have the highest value among the three types of companion robots, we elaborate on the interpretation of elasticity for personal assistant robots only:

1. *Price*
   If the product price increases by 10%, the probability of people buying it will decrease by 6%.

2. *Battery Life*
   If the product's battery life is longer by 10%, the probability of people buying it will increase by 3%.
3. *Weight*
   If the product's weight increases by 10%, the probability of people buying it will increase by 7%.
4. *Basic Robot Look*
   If basic robot look increases by 10%, the probability of people buying it will decrease by 2%.
5. *Walking Computer*
   If walking-computer look increases by 10%, the probability of people buying it will decrease by 2%.
6. *Human Look*
   If human look increases by 10%, the probability of people buying it will increase by 0.5%.
7. *Height*
   If the product's height increases by 10%, the probability of people buying it will decrease by 0.4%.
   Willingness To Pay

Furthermore, Python-Biogeme can measure willingness to pay (WTP) for each attribute. Here we measure how much consumers are willing to pay for a price increase connected to a decrease or increase in an attribute. The result of calculations on willingness to pay by Python-Biogeme are provided in Table 3.

Table 3
Willingness to Pay
(Source: Author)

No	Attributes	Companion Robot 1	Companion Robot 2	Companion Robot 3
1	Battery Life	0.52779436	0.5277943	0.52779436
2	Weight	-2.10920331	-2.1092033	-2.10920331
3	Height	-0.00416	-0.00416	-0.00416
4	Application	0.437014	0.437014	0.437014
5	Basic Robot Look	1.384174	1.384174	1.384174
6	Walking Computer Look	2.164	2.164	2.164
7	Human Look	-0.05989	-0.05989	-0.05989

Here, once again, we elaborate on the interpretation of elasticity for personal assistant robots only, due to their prevalence.

1. *Battery Life*
   When a longer battery life is added, people will be willing to pay an additional IDR527,794.36.
2. *Weight*
   As the robot is made lighter, people will be willing to pay an additional IDR2,109,203.32.
3. *Height*
   As the product is made shorter, people will be willing to pay an additional IDR4,161.03.
4. *Application*
   When the product's app can be operated on both iOS or Android, people will be willing to pay an additional IDR437,014.
5. *Basic Robot Look*
   If the educational robot has more of a basic robot look, people will be willing to pay an additional IDR1,384,173.91
6. *Walking-Computer Look*
   If the educational robot has more of a walking-computer look, people will be willing to pay an additional IDR2,164,000.02.
7. *Human Look*
   If the educational robot is not of a human look, people will be willing to pay an additional IDR59,891.60.

Potential Market

The potential market is the set of consumers who profess a sufficient level of interest in a market offer (Kotler, 2002). The target markets in the present study are divided into four categories based on age. The findings indicate that age may determine the potential buyers of companion robots for new adopter markets. Adoption is an individual's decision to become a regular user of a product (Kotler, 2002). This segmenting and targeting are required to clarify who will compose the target markets in this product research, being based, as mentioned, on age range, as well as calculated statement averages (Table 4).

Table 4
Calculated Target Market
(Source: Author)

	A	B	C	D
Age	**18–25**	**26–32**	**33 – 40**	**Over 40**
Luxury goods	Agree	Neutral to Agree	Neutral to Agree	Neutral to Agree
Cool to have	Neutral to Agree	Neutral to Agree	Neutral to Strongly Agree	Neutral to Agree
Important to have	Disagree to Neutral	Neutral	Disagree to Neutral	Disagree to Neutral
Expensive to maintain	Neutral to Agree	Neutral to Agree	Neutral to Agree	Neutral
Makes work easier	Agree	Agree	Neutral to Agree	Neutral to Agree
Entertaining	Neutral to Agree	Neutral to Agree	Neutral to Agree	Neutral to Agree
Innovative goods	Agree to Strongly Agree	Agree to Strongly Agree	Neutral to Agree	Neutral to Agree
Scary thing	Strongly Disagree to Neutral	Strongly Disagree to Disagree	Disagree	Strongly Disagree to Disagree

Analysis of Age Category

18–25 Years Old

Average Occupation: College Student
Average Income:
<Rp3.000.000 – Rp3.000.000

In this age range, the consumers are found to strongly agree that robots can make work easier and are innovative. However, they also agree that this is an item that needs expensive maintenance and is a luxury item, which they are unsure they can afford at this age. If this age range is to be targeted, it is advisable not to make the product too high in price and to provide sufficient warranty for maintenance. In addition, having brand ambassadors or influencers who are on the rise in this age group can attract more attention. Some of their parents could still provide for their needs and wants, including a service robot, as long as their kids could convince them.

26–32 Years Old

Average Occupation: Civil Servants and Private Employees
Average Income:
Rp3.000.000 – Rp.13.000.000

Similarly to the previous age range, consumers in this one are found to strongly agree that robots can simplify human work and are an innovative product. They can be approached with robotic abilities that make work easier. However, they do not really agree with the statement on expensive to maintain and luxury goods. It can be indicated that at this age, the greater the income, the greater the ability to afford such products. If this age range is to be targeted, it should be with robots that can entertain or facilitate work. At this age, people tend to spend more time working outside the home and need a little entertainment at home.

33–40 Years Old
Average Occupation: Private Employees
Average Income:
Rp18.000.000 – Rp25.000.000
The ability to afford products tends to improve in this age range. The consumers of this age tend to agree more on the "cool to have" statement than other statements. Moreover, they do not really consider the maintenance costs. At this age, they tend to have children at home; therefore, if this age range is to be targeted, it can be approached with robotic abilities for both taking care of children and becoming a medium of entertainment which can interact with them.

> 40 years old
Average Occupation: Private Employees and Entrepreneurs
Average Income: > Rp25.000.000
Conversely, people in this age range are not found to agree on the high cost of treatment. However, other statements are similar to those in the previous age range. Affordability for this group is already established, although opinions about service robots are not as enthusiastic as those of the other three, younger groups. If this age range is to be targeted, it should be with the ability of robots to entertain, facilitate work, or provide innovative items.

Overall, potential sales targets are those in the categories A (18–25 years old), B (26–32 years old), and C (33–40 years old). Respondents as a sample of prospective buyers in these categories have ambitions at a level above respondents' in category D (over 40 years old). This is measured from the statements made by the average respondent according to the Likert scale.

5. Conclusion

We find that the attributes most likely to influence potential buyers to buy or not to buy the product are basic robot look, the robot's battery life, the price, the walking-computer look, and robot weight.

Battery life
Battery life is an important attribute in deciding whether to buy an electronic device. In the previous section, we measured the elasticity of battery resistance. According to the results, people will be willing to pay more if battery life can be prolonged. Lithium polymer batteries (Li-Po) are known as the most widely used in robot technology.

Price
Price is a significant factor and is the most sensitive attribute, as well. When a consumer intends to make a purchase, price will often determine the decision. In addition, as shown by the results of the elasticity calculations in the previous section, if the price goes up, people's interest in buying a companion robot product tends to decrease drastically. If the set price will be high, it must be accompanied by attractive and satisfying features to prospective buyers. Such robot features could include Bluetooth, Wi-Fi, a camera, artificial intelligence, quality components, and apps to facilitate operation.

Weight
The weight of the robot is a significant attribute. Based on the results in the previous section, it turns out that the heavier a robot is, the higher demand for it is likely to be. Customers tend to think that a heavier item is of better quality in this case.

Robot's look
Of the three kinds of robot appearance included in this study, two are significant: the basic robot look and walking-computer look. The findings indicate that the availability of too many choices for a companion robot is likely to reduce buyers' interest. A good strategy would be to offer appearance variations within these two significant types.
Among the three types of companion robots examined in this study, educational and personal assistant robots are found to be preferred to entertainment robots. As the t-test scores for the personal assistant robot are higher than for the educational robot, the former is the companion robot expected to have the most prospective customers.

In other words, the personal assistant robot has won over more enthusiasts than the entertainment robot and has more sales potential than the education robot. Results indicate that if the personal assistant robot is made into a superior product, its sales will be stronger, because it has a higher t-test value than the educational robot. It is also found that if the personal assistant robot has a walking-computer look, prospective buyers' interest will likely increase.

The age categories of 18–25, 26–32, and 33–40 are found to display a higher level of enthusiasm for companion robots, based on statements in the questionnaire in the form of a Likert scale. Therefore, customers in this age category will likely become prospective buyers and should be considered the target markets. The over-40 age category appears to have a lower level of enthusiasm for the robots than the other three, younger categories.

Limitations and Further Research

This research is limited to types of companion robots, while several other types of robots have hit the market, such as cleaning robots and telepresence robots. The collection of questionnaire data is limited to 206 respondents, which should be expanded upon in the future. Further research should be carried out on other types of robots, and generate preferences from each customer segment for each robot, as opposed to our focus on one result for which companion robot type will be a fit for the market.

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Appendix
Table 1. Respondent Profile

Demographics of Respondents	Frequency	Percentage (%)
Gender		
Male	87	42
Female	119	58
Age		
18 - 25 years	157	76
26 - 32 years	19	9
33 - 40 years	12	6
Above 40 years	19	9
Education Background		
High School	8	4
Diploma	8	4
Bachelor degree	173	84
Master degree	16	8
Domicile		
Bandung	136	66
Jakarta	23	11
Tangerang	6	3
Bogor	8	4
Bekasi	2	1
Yogyakarta	4	2
Denpasar	4	2
Jawa Timur	8	4
Makassar	6	3
Sumatra	8	4
Occupation		
Student	62	30
Private employees	80	39
Government employees	14	7
Housewife	8	4
Entrepereneur	27	13
Doctor	8	4
Freelance	6	3
Income Per Month		
< IDR 3 Million	66	32
IDR 3 Million - IDR 8 Million	95	46
IDR 8 Million - IDR 13 Million	14	7
IDR 13 Million - IDR 18 Million	12	6
IDR 18 Million - IDR 25 Million	6	3
> IDR 25 Million	12	6