Asia-Pacific Journal of Science and Technology: Volume: 27. Issue: 27. Article ID.: APST-27-04-10. Research Article

APST

Asia-Pacific Journal of Science and Technology

https://www.tci-thaijo.org/index.php/APST/index

Published by the Research and Technology Transfer Affairs Division,
Khon Kaen University, Thailand

Identifying factors that influence customers' interest in buying refurbished smartphones: An Indonesian context

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Received 9 June 2021
Revised 16 July 2021
Accepted 4 August 2021

Abstract

In this paper, we investigated the factors that influence Indonesian customers in buying a refurbished smartphone. The decision model is constructed using the Analytical Hierarchy Process (AHP). There are four main factors: Price, Performance, Benefit, and Risk, with sub-criteria for each factor. Three smartphone alternatives are determined for comparison: flagship, refurbished, and mid-range smartphones. The model was constructed based on the van Weelden model and by interviewing 13 respondents who had either flagship, refurbished, or mid-range smartphones. The respondents' age was between 21 and 59 years old. We surveyed 54 respondents, segmented by age, gender, job, knowledge, and experience using a refurbished smartphone. The results show that age and experience using refurbished products are significant factors influencing customers' decisions to buy refurbished smartphones. Furthermore, younger people consider performance to be the most critical factor influencing their smartphone purchases, while older respondents consider it a benefit. As for performance, both hardware and software are the most critical factors. In all aspects, the flagship smartphone outperforms the refurbished and mid-range smartphones, except in its environmental aspects. In conclusion, only people with concerns for the environment would tend to buy the refurbished smartphones. However, increasing the benefit and hardware performance of refurbished smartphones may drive the younger age groups to switch from buying mid-range to refurbished smartphones, while an increase in risk factors would tend to lower customers' priority of buying refurbished smartphones.

Keywords: Refurbished, Analytical hierarchical process, Group decision

1. Introduction

Smartphones have become essential devices in the modern world, especially during the Covid-19 pandemic, where most activities are conducted through information technology. We face an era where people work from home, students' study from home, and even social and religious activities are carried out remotely. For many people, especially ones with limited access to computers, the next best option is to use smartphones. Hence, the role of smartphones has expanded significantly, not only as a communication device but also in enabling remote activities.

Today, Indonesia is the fourth most populated country globally and the world's tenth-largest economy in purchasing power parity. The number of mobile phone and Internet users is also increasing. According to Badan Pusat Statistik [1], the number of mobile phone owners is relatively high: 69.6% of the urban population and 53.6% of the rural population own a mobile phone. However, due to smartphones' short life cycle, disposal of an increasing number of phones could potentially lead to insufficient availability of landfill sites. In addition, the manufacturing processes associated with increasing demand for smartphones exhaust the supply of limited natural resources [2]. In recent decades, studies of extending mobile phones' lifespans have expanded significantly in their scope to also address sustainability issues. Several potential alternatives can extend

smartphones' lifespans, such as direct reuse, repair-and-reuse, refurbishing, or remanufacturing. The marketing of such smartphones has been considered in several studies, such as in [3-5].

The availability of refurbished smartphones is very limited in Indonesia. This situation is unsurprising as there is no government-led program to promote smartphone reuse, and customers do not habitually recycle their smartphones when they have reached the end-of-use stage [6-8]. The most common approaches at present are retaining used phones at home, giving them to relatives, or selling the phones on the secondhand market [7,9]. Furthermore, refurbishing smartphones is not necessarily desirable from the perspective of manufacturers as it has the potential to cannibalize demand for new products.

This research explores the factors that influence customers' interest in buying refurbished smartphones, categorized into several segments based on age. We also attempt to compare customers' interest in buying refurbished smartphones and new mid-range smartphones. The identified factors can help manufacturers better understand customers' needs, and further improve the refurbished smartphone market to help establish a circular economy in Indonesia. In this paper, note that we use the terms remanufacturing and refurbishing interchangeably because there are numerous cases of both remanufacturing (e.g., upgrading RAM) and refurbishing (e.g., replacing the battery) in smartphones; in the smartphone market, the terms also tend to be used loosely. For example, Apple uses the term "Certified Refurbished Products" for its like-new product with a one-year warranty.

2. Materials and methods

This work aims to investigate the factors that influence Indonesian customers in buying a refurbished smartphone. We started by aiming to understand the recovery process and its options to argue the potential of smartphone refurbishment and its market. Additionally, buying a smartphone is a decision process — consumers must consider many aspects before deciding on one smartphone which they deem to be suitable for them in those aspects. There are many tools in the field of decision analysis that can be used to help guide decision-makers, for example, TOPSIS (Technique for Orders Preference by Similarity to Ideal Solution) is used in some instances for selecting electronics components suppliers [10]. DEMATEL (Decision Making Trial. Evaluation and Laboratory) is also used to analyze the remanufacturing of mobile phones [11]. This study used the analytical hierarchy process (AHP) since this approach helps to resolve hierarchical problems, such as choosing product suppliers and buying a car [12]; the decision-making involved in buying a smartphone, for example, can be considered to be a hierarchy. In addition, using this approach we can check the consistency of decision-makers in comparing one aspect to the others.

2.1 Recovery process

The recovery process is a process that aims to restore or to add to the lifespan of a product. There are several options in the recovery process, i.e., reuse, repair, remanufacture, and refurbishment [13], each of which involves a different process as well as generating a different output. The reuse process is the simplest of the recovery processes. In the context of smartphones in Indonesia, reuse of devices can be commonly found within family groups. When the first owner wants to buy a new device, it is commonplace for them to pass their old smartphone on to another family member [6]; hence, this reuse process extends the lifespan of old smartphones. Another common reuse practice in Indonesia is selling the old smartphone to the secondhand market [8,9,14]. According to King et al. [13], the repair process implies fixing or replacing the broken parts of a product, such that the product can be used properly. The remanufacturing process is a process wherein used products are reproduced; from the customer's perspective, they will have the exact performance specification as a product from the original equipment manufacturer (OEM) [15]. Rathore et al. [3] stated refurbishment is a process in which a professional company collects and restores used products to a functional and satisfactory state. After the refurbishment process, the refurbished products can then be sold to customers.

Several papers have studied the potential of mobile phone reuse, remanufacturing, and refurbishment. Kang et al. [16] studied remanufacturing processes of mobile phones. They developed simulation models and, in doing so, were able to identify process bottlenecks, in addition to proposing an extended model to improve the remanufacturing process. Seliger [17] proposed a process and facility plan for mobile phone remanufacturing using a simulation model that can be adapted in response to rapid changes in product, process, and market constraints. Analysis of the eco-efficiency of remanufactured mobile phones [18] and potential opportunities to improve on the social impacts across the life cycle of mobile phones [19] have also been presented to support initiatives on mobile phone recovery processes.

Consumer behavior and market aspects are both essential for the success of mobile phone reuse, remanufacturing, or refurbishment. The potential to adopt remanufactured mobile phones has been studied based on the influence of product design, end-of-life scenarios, and recovery options [20]; customer acceptance has also been studied in several countries, such as India [3], the Netherlands [21], and Germany [22].

2.2 Analytic hierarchy process

The AHP is one of the decision-making tools developed by Saaty [23]. In the AHP, judgments between one option and the others are made by pair-wise comparisons of many reciprocal criteria. The fundamental scale used in AHP is depicted in Table 1.

Table 1 Fundamental scale of AHP.

Number	Option
1	Equal importance
3	Moderate importance of one over another
5	Strong or essential importance
7	Very strong or demonstrated importance
9	Extreme importance
2,4,6,8	Intermediate values
Use reciprocals for inverse comparisons	

The reciprocal pairwise scale is then transferred into what is known as a reciprocal matrix. In this matrix, the lower triangle of the matrix is reciprocal to the upper triangle, and values on the diagonal of the matrix are equal to one. Let a_{kl} form the elements of matrix $\boldsymbol{A}$:

$$\boldsymbol{A} = \begin{pmatrix} 1 & a_{12} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{pmatrix}$$

Where a_{kl} is the pairwise comparison of AHP factors k and l.

Once a pairwise comparison matrix is constructed, we can derive the priority vector $\boldsymbol{w} = (w_1, w_2, \dots, w_n)$ using the normalized principal eigenvector of matrix $\boldsymbol{A}$. The consistency index of pairwise comparison matrix is given by $C.I = (\lambda_{max} - n)/(n-1)$, where λ_{max} is the max eigenvalue of the respective matrix [24]. In this work, we use the Super Decisions V3 software [25]; additionally, we also apply AHP for group decision-making [26].

2.3 Model construction

The AHP model was constructed using the van Weelden et al. [21] approach. In their model, van Weelden et al. explored the consumer acceptance of refurbished smartphones in the Dutch market by considering several factors: initial response, barriers, benefits, risks, influencing personal factors, contextual factors, and product-related factors. In our study, this model was then adapted to the Indonesian characteristics of buying a smartphone. We also interviewed thirteen respondents aged 21-59 who owned flagship, refurbished, or mid-range smartphones and asked what factors influenced their decision to buy their current smartphones. We also adapt Saaty's AHP Benefit Opportunity Cost Risk model [27] by considering Price as Cost and Performance as Opportunity.

In the Benefit criteria, we consider financial, environmental, and accessories categories. Financial aspects of the Benefit criteria were defined as the ease of obtaining installment payments, bonuses, and discounts. In terms of the environment category, after our interviews, we found that some individuals who are particularly conscious of environmental issues would prefer to buy refurbished smartphones. In addition, we identified that Indonesian consumers who are willing to pay for mid-range or flagship smartphones are also concerned about the additional accessories provided with the smartphone. In addition, we identified that upgraded specification, affordable price, and product warranty are all factors that can drive customers to purchase refurbished mobile phones [5].

Within the Performance (Opportunity) criterion, we proposed three sub-criteria: appearance, software, and hardware. In Indonesia, the aesthetic appearance of devices is crucial for smartphone buyers. This may include, for example, the body material of the smartphone, screen type, screen resolution, and SIM card slots. Consumers who purchase mid-range or flagship smartphones also consider software features, such as the device's processor, picture and video quality, sound, security, and wi-fi connection features. Buyers may also be aware of RAM capacity, internal storage, battery lifetime, and charging time in the hardware. The Price (Cost) criterion in the model does not have sub-criteria.

In the Risk criteria, we proposed three sub-criteria: obsolescence, service and warranty, and endurance. Smartphones can sometimes be seen as a fashion product after they become obsolete; therefore, we proposed

obsolescence as a sub-criterion in the risk criteria. In the service and warranty criterion, we focused on the ease of finding a service center to claim the warranty if the device is damaged during its warranty term. Since warranty is also a sign of product reliability, offering a product warranty may increase customers' perceived quality of a refurbished smartphone [28]. The endurance sub-criterion relates to smartphones' water, heat, and impact resistance. The proposed decision model for buying a refurbished vs. flagship or mid-range smartphone is depicted in Figure 1.

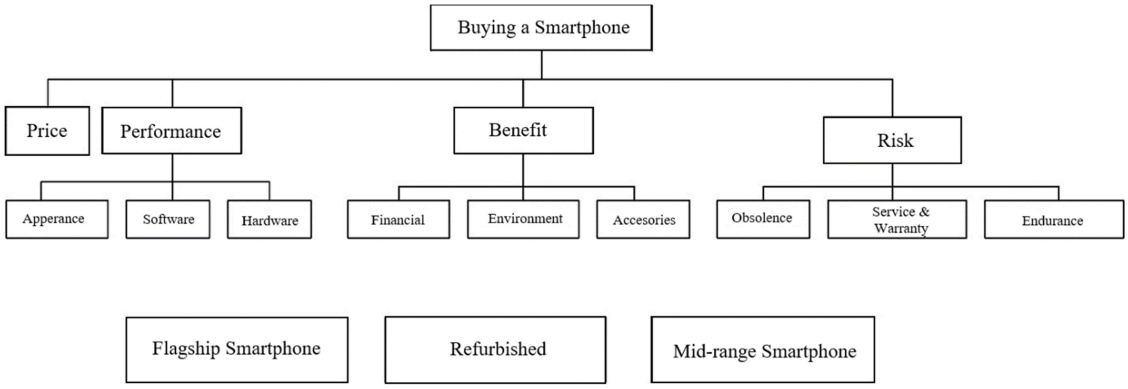

Figure 1 Model for buying a flagship, mid-range, or refurbished smartphone.

2.4 Questionnaire

A questionnaire was designed based on the proposed model depicted in Figure 1, comprising six sections. Section one is about the respondent's background, such as gender, age, education, at what age they first had a smartphone, and their smartphone's brand. The last question of section one relates to their knowledge of refurbished smartphones. Section two includes the comparative judgment of each criterion: Benefit, Performance, Price, and Risk. To perform the comparative judgment, first, we asked which factor is more important for the respondents and how essential the chosen factor is to the others. For example, we ask the respondents to compare pair wisely Price, Performance, Benefit, and Risk in the first instance. We then asked them to compare whether Price or was more important to them on a scale of 1 to 9 (Table 1); this was then followed by equivalent comparisons of Price to Benefit, Price to Risk, Performance to Benefit, Performance to Risk, and Benefit to Risk. In total, there are six pairwise comparisons in Section 2. Section 3 comprises comparative judgments at a sub-criteria level. In this section, i.e., Performance, we asked the respondents to make pair-wise comparisons of Appearance, Software, and Hardware. We explained what factors to consider in each sub-criterion so that each respondent had access to the same information (Table 2). In total, there are nine pairwise comparisons in Section 3.

Table 2 Factors to consider in comparing the sub-criteria.

Performance			Benefit			Risk		
Appearance	Software	Hardware	Financial	Environment	Accessories	Obsolescence	Service and Warranty	Endurance
Body, number of SIM card slots, size of screen, screen type, screen resolution, screen coating	Processor, picture, sound, video quality, security, wifi	RAM, ROM, battery, chipset	Ease of acquiring loans, trade-ins, good secondhand prices	Awareness of environmental waste	Screen guard, headset	The technology obsolescence of the smartphone	The ease of claiming warranty and locating official service counters	Water resistance, fall resistance.

Sections 4 and 5 concern pairwise comparative judgments for each sub-criterion to the alternatives: Flagship, refurbished, and mid-range smartphones. In Section 4, we asked the respondent to make pair-wise comparisons of the Price, Performance, Benefit, and Risk for each of the alternatives. For example, for Price, respondents were asked whether they would choose a flagship, refurbished, or mid-range smartphone. In addition, the respondents used a scale to compare their preference for the chosen alternative relative to the unchosen options. For example, with respect to Price, there will be three pairwise comparisons made between flagship, refurbished, and mid-range alternatives. In total, there are 12 pairwise comparisons in Section 4. Similarly, there are 27 pairwise comparisons in Section 5. Section 6 is the final section in this questionnaire. In the closing

statement, we asked about respondents' experiences using flagship, refurbished, or mid-range smartphones. In addition, we also asked about their preferences regarding smartphone purchasing intent after the survey.

To validate the questionnaire, we distributed the first version of the survey to 10 respondents and then tested the consistency ratio of those small samples. If responses to a question were inconsistent, we rephrased that question and repeated the test on small samples until the questionnaire was valid.

2.5 Data collection and analysis

Participation in this study was voluntary. Due to the Covid-19 pandemic, the questionnaire was distributed online through a Google form between April and June 2020. There were 54 valid questionnaire responses. Since this questionnaire follows the AHP rules, valid questionnaires indicate the respondents' answers were consistent. Data were analyzed by descriptive statistics and AHP using Super Decisions software. The AHP approach is widely applied in decision making, therefore, the number of participants in the AHP surveys was not the main issue. In group decision-making, the critical issue is how to assemble the group [29]. In our study, the decision-makers, i.e., the survey participants, consist of people who have/had either a flagship, mid-range, or refurbished smartphone; moreover, they also represent a range of participants in terms of age, gender, and career stage.

3. Results and discussion

3.1 Participants

The participants of this study are 54% women and 46% men, aged between 15-24 years (56%), 25-45 years (20%), 46-55 years (15%), or more than 55 years (9%). The age segmentation represents students (15-24 years), junior workers (24–45 years), senior workers (46–55 years), and retired (>55 years). Half of the participants were students, and the rest were workers. The majority (53%) did not know about refurbished smartphones. Only 11% of participants had refurbished smartphones, and the remainder (89%) had never owned one. The participants have graduated from university (53%) and high school (47%). The largest proportion of respondents' first had a smartphone at age 13-18 years (41%); the smallest proportion had a smartphone at age 6-12 years (22%) and the rest (37%) first had a smartphone at an age of 19 years or older. When they answered this questionnaire, 54.6% of the participants had mid-range smartphones and 34.4% had flagship smartphones. Additionally, 11% of respondents had refurbished smartphones.

In this study, only 48% of the participants knew about refurbished smartphones. Therefore, before the participants participated in this study, we explained the refurbishment terminology to them. After they had learned about smartphone refurbishment, 35% of participants aged between 15-45 years, 33% of participants aged between 46-55 years, and 40% of the senior participants were interested in owning a refurbished smartphone.

From this background (Table 3), we conclude that the participants of this study are a representative sample.

Table 3 Profile of the participants.

Gender	Percentage
Women	54%
Men	46%
Age	
15-24 (students)	56%
25-45 (junior worker)	20%
46-55 (senior worker)	15%
>55 (retired)	9%
Education	
Graduated from university	53%
High school	47%
Age of first owning a smartphone	
6–12 years	22%
13–18 years	41%
>18 years	37%
Knowledge of refurbished	
Know	47%
Do not know	53%
Current smartphone	
Mid-range	54.6%
Flagship	34.4%
Refurbished	11%
Age of interest in buying refurbished	
15-45 years	35%
46-55 years	33%
>55 years	40%

3.2 Priorities based on age segmentation

We used the Super Decisions software for decision analysis; as an example, we summarize the criteria weight for participants aged 25-45 years (Table 4). Note that in Table 4, since there are four criteria, the random consistency index (RI) value is equal to 0.91 [23,25]. As shown, Participant 1 prioritizes Risk over Price, Performance, and Benefit when he/she wants to buy a smartphone. For the group priorities, we averaged the weight of each criterion. We do not use the geometric mean as its use is discouraged in [30]. We conclude that junior workers between 25-45 years prioritize Performance over Risk, Price, and Benefit when buying a smartphone; in addition, the consistency ratio of all participants is less than 10%, so we can conclude that the decision is consistent. In this survey, if the pairwise comparisons were not consistent, we contacted the participants who had inconsistent answers, explained that their answers were not consistent, and then asked them to reconsider their responses.

Table 4 Weight of criteria decided by participants at the age between 25-45 years.

Participant	Benefit	Performance	Price	Risk	CI	CR = CI/0.91
1	0.064	0.160	0.337	0.438	0.076	0.083
2	0.313	0.387	0.250	0.049	0.069	0.076
3	0.135	0.549	0.232	0.083	0.061	0.067
4	0.276	0.391	0.138	0.195	0.084	0.092
5	0.183	0.576	0.088	0.153	0.078	0.086
6	0.048	0.102	0.326	0.524	0.079	0.087
7	0.120	0.401	0.040	0.439	0.071	0.078
8	0.052	0.294	0.099	0.555	0.089	0.098
9	0.052	0.235	0.126	0.587	0.074	0.081
10	0.348	0.425	0.145	0.081	0.070	0.077
11	0.233	0.561	0.072	0.134	0.086	0.094
Average	0.166	0.371	0.169	0.294	0.076	0.084
Percentage	17%	37%	17%	29%		

Table 5 summarizes the weighted priorities for each criterion and its sub-criteria, which are calculated for segmented ages between 25-45 years. We can see that for junior workers, in the Benefit criterion, financial aspects are the most important to them, followed by environment and accessories. For the Performance criterion, the participants prioritized Software over the Hardware and Appearance criteria. Within the Risk criterion, Endurance is more critical than Warranty and Obsolescence to this group of participants. In general, the junior workers' cohort tended to choose the Flagship smartphone category over the Mid-range and Refurbished smartphone categories. However, Table 5 shows that the weighting between the Mid-range and Refurbished categories is not significantly different; therefore, we can conclude that junior workers still consider buying refurbished smartphones.

Table 5 The weighting of the AHP for participants aged between 25-45 years.

Goal		Buying a Smartphone									
Criteria		Benefit			Performance			Price	Risk		
Weight		0.166			0.371			0.169	0.294		
Sub-Criteria		Financial	Environment	Accessories	Appearance	Software	Hardware		Obsolescence	Warranty	Endurance
		0.468	0.301	0.231	0.201	0.431	0.368		0.151	0.412	0.437
Sub-Criteria X Criteria		0.078	0.050	0.038	0.074	0.160	0.137	0.169	0.045	0.121	0.129
Alternative	Flagship	0.541	0.362	0.681	0.563	0.569	0.583	0.336	0.521	0.511	0.564
	Refurbished	0.299	0.342	0.185	0.119	0.215	0.162	0.292	0.264	0.184	0.143
	Mid-range	0.160	0.296	0.133	0.318	0.216	0.255	0.371	0.215	0.305	0.293
	Decision	Group index									
Flagship	0.513	n = 3									
Refurbish	0.214	RI = 0.58									
Mid-Range	0.277	CI = 0.052									
		CR= 0.089									

Overall, the priorities for buying a smartphone by age group are summarized in Table 6. All participants preferred to buy Flagship smartphones over Refurbished or Mid-Range smartphones. However, for participants aged between 25-45 (junior workers), the decision weight for Refurbished and Mid-Range is significantly different (based on t-test results). In contrast, for other age groups, the weight values are not significantly different; therefore, we can conclude that Indonesian students, senior workers, and retirees would consider Refurbished and Mid-Range options when choosing their smartphones.

Table 6 The main priorities when buying a smartphone, categorized by age.

Criteria	15–24 years	25–45 years	46–55 years	>55 years
	Performance	Performance	Performance	Benefit
Sub-criteria				
Benefit	Financial	Financial	Financial	Financial
Performance	Hardware	Software	Software	Hardware
Risk	Endurance	Endurance	Endurance	Endurance
Buying a Smartphone				
Flagship	0.563	0.513	0.582	0.481
Refurbished	0.208	0.214	0.204	0.253
Mid-Range	0.229	0.277	0.214	0.266
Group index				
n	3	3	3	3
RI	0.58	0.58	0.58	0.58
CI	0.055	0.052	0.049	0.054
CR	0.094	0.089	0.084	0.093

3.3 Priorities based on knowledge of refurbishing

Knowledge of refurbishing does not appear to change the priority of Indonesian respondents in their smartphone purchasing choices. Even amongst those who had experience in using refurbished smartphones, those respondents would prefer to buy a flagship smartphone. Performance, financial, software, and endurance are the main criteria for choosing to buy a flagship smartphone more than the mid-range or refurbished smartphone (Table 7).

Table 7 Respondents' priorities in buying a smartphone, categorized by knowledge of smartphone refurbishment.

Criteria	Using Refurbished	Know Refurbished	Do not know about Refurbished
	Performance	Performance	Performance
Sub-criteria			
Benefit	Financial	Financial	Financial
Performance	Software	Software	Hardware
Risk	Endurance	Endurance	Endurance
Buying a Smartphone			
Flagship	0.535	0.513	0.574
Refurbish	0.236	0.214	0.202
Mid-Range	0.239	0.277	0.228

3.4 Sensitivity analysis

The age segmentation is sensitive in terms of smartphone purchasing decisions. Senior respondents with an age of more than 55 years are consistent in their decisions; they prefer to buy flagship smartphones rather than mid-range or refurbished ones, regardless of any alterations made to the benefit, performance, price, and risk criteria. Junior respondents aged between 15-24 years can switch from buying a mid-range smartphone to a refurbished one, depending on the criteria weighting: a slight weight alteration in the benefit criterion from 0.16 to 0.2 (or more) influences their decision from buying a mid-range smartphone to a refurbished one. Similarly, respondents of working age (25-55 years) are also sensitive respondents. They would consider buying a refurbished smartphone rather than a mid-range model if the benefit weighting of a refurbished smartphone is altered to greater than 0.4 (for age 25-45) and 0.5 (for age 46-55). These respondents would also consider buying a mid-range smartphone rather than a flagship model if the smartphone price was weighted more highly (Figure 2).

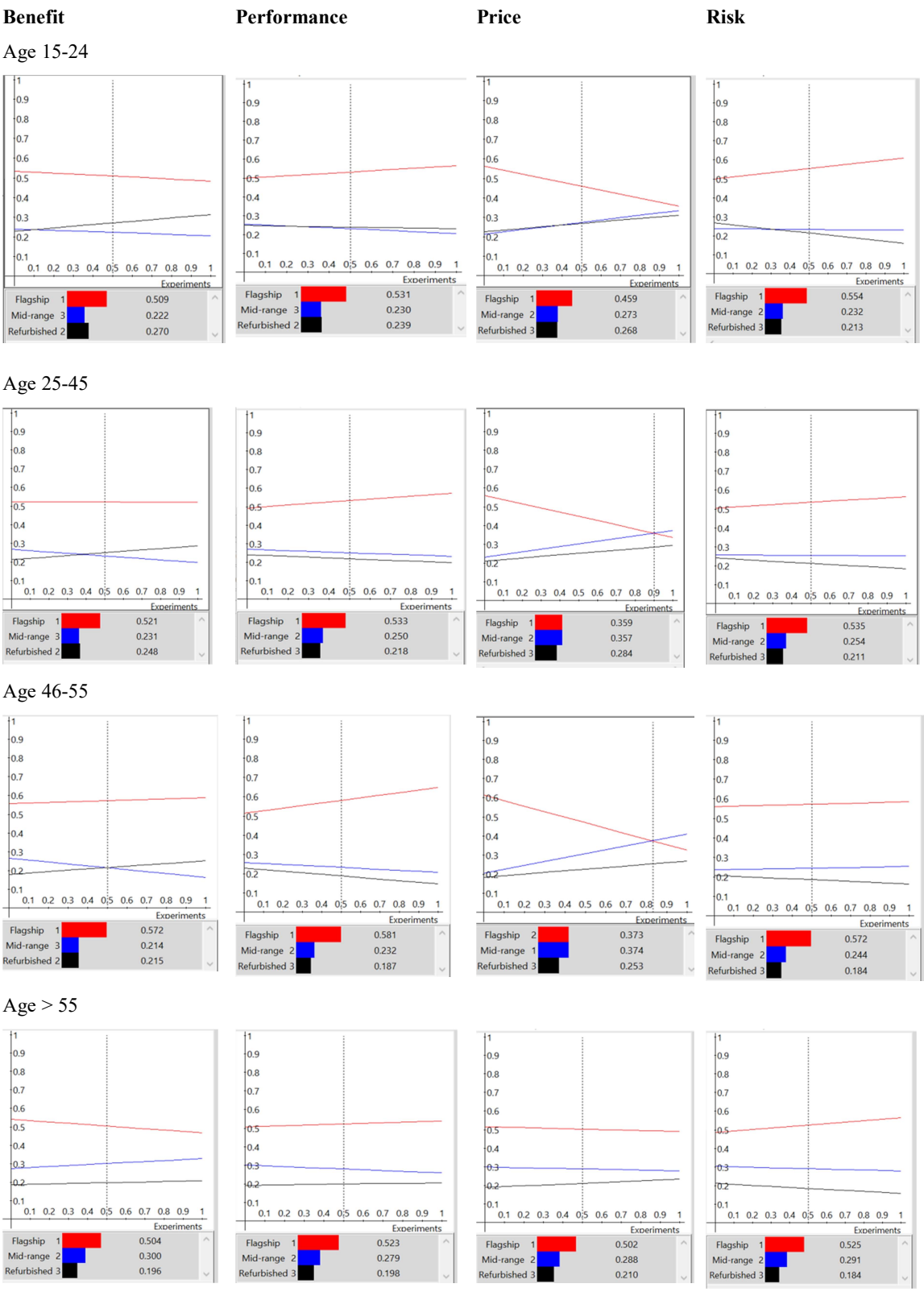

Figure 2 Sensitivity analysis on buying a smartphone based on the age of the respondents with respect to Benefit, Performance, Price, and Risk. In these figures, the x-axis is the Experiments, and the y-axis is the weight.

The results from the decision of priorities in buying a smartphone and sensitivity analysis contributed to the following findings:

- Financial benefit and endurance are the most important factors in the smartphone-buying decision-making process, irrespective of age group.
- Increasing the benefits and hardware performance of refurbished smartphones would drive younger age groups to switch from buying mid-range to refurbished smartphones.
- An increase in risk factor would lower customers' priority of buying refurbished smartphones.

Therefore, to increase the likelihood of Indonesian customers buying refurbished smartphones, companies should offer financial benefits such as bonuses, discounts, or installment programs. Furthermore, upgrading the hardware, such as increasing RAM and ROM storage and replacing the battery, would also increase the attractiveness of refurbished smartphones to customers. A collaboration between financial firms and mobile phone operators could potentially bring attractive offers that serve as financial benefits. Furthermore, to help reduce the risk perception of refurbished smartphones, the companies could provide service centers and offer extended warranty packages.

4. Conclusion

This paper investigated the factors influencing Indonesian customers in buying refurbished smartphones using the AHP. We considered four criteria, namely benefit, performance, price, and risk. Our results show that a refurbished smartphone is not a popular product: 47% of the respondents (54) knew about refurbished smartphones, but only 11% of them had experience buying a refurbished smartphone. Even among consumers who had owned a refurbished smartphone, this cohort would still prefer to buy a flagship than a refurbished one. Knowledge of refurbishment does not change the priority of the Indonesian respondents in buying a smartphone. The highest priorities of respondents were smartphone performance, financial aspects, software, and endurance. The age segmentation is also sensitive in terms of smartphone purchasing decisions. Senior respondents, aged more than 55 years, are consistent in their decisions. In contrast, younger respondents may change from buying a mid-range to a refurbished smartphone if the refurbished smartphone gives more benefit to them. When respondents decided to purchase refurbished smartphones, the influencing factors were financial and hardware aspects; the refurbished models are cheaper than the flagship smartphones, but the hardware is more up to date than new mid-range models. However, consumers are concerned by the risks associated with the endurance aspects of refurbished smartphones. Hardware is the main concern for potential buyers who are interested in buying refurbished smartphones. Additionally, consumers who are concerned about environmental issues also prioritize refurbished smartphones in their buying choices. This study could be further extended by exploring additional factors that could increase customers' preference in buying refurbished smartphones, such as product-service systems, environmental communication benefits, and narrowing the market segmentation categories.

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Appendix 1 The weighted of the AHP based on age.

Goal	Buying a Smartphone (Age 15-24 years)										
Criteria		Price	0.184	Performance (0.424)			Benefit (0.160)			Risk (0.24)		
SubCriteria				Appearance	Software	Hardware	Financial	Environment	Accessories	Obsolesce	Warranty	Endurance
				0.185	0.394	0.421	0.351	0.327	0.322	0.318	0.326	0.357
SubCrit x Criteria			0.184	0.078	0.167	0.179	0.056	0.052	0.052	0.076	0.078	0.086
Alernative	Flagship		0.356	0.592	0.561	0.585	0.520	0.256	0.676	0.594	0.603	0.632
	Refurbish		0.310	0.198	0.237	0.196	0.235	0.515	0.190	0.149	0.178	0.154
	Mid-Range		0.334	0.210	0.202	0.219	0.245	0.230	0.134	0.257	0.219	0.214
	Decision											
Flagship	0.535											
Refurbish	0.236											
Mid-range	0,239											

Goal	Buying a Smartphone (Age 25-45 years)										
Criteria		Price	0.169	Performance (0.371)			Benefit (0.166)			Risk (0.94)		
SubCriteria				Appearance	Software	Hardware	Financial	Environment	Accessories	Obsolesce	Warranty	Endurance
				0.201	0.431	0.368	0.468	0.301	0.231	0.151	0.412	0.437
SubCrit x Criteria			0.169	0.074	0.160	0.137	0.078	0.050	0.038	0.045	0.121	0.129
Alernative	Flagship		0.336	0.563	0.569	0.583	0.541	0.362	0.681	0.521	0.511	0.564
	Refurbish		0.292	0.119	0.215	0.162	0.299	0.342	0.185	0.264	0.184	0.143
	Mid-Range		0.371	0.318	0.216	0.255	0.160	0.296	0.133	0.215	0.305	0.293
	Decision											
Flagship	0.513											
Refurbish	0.214											
Mid-range	0.272											

Goal	Buying a Smartphone (Age 46-55 years)										
Criteria		Price	0.171	Performance (0.373)			Benefit (0.264)			Risk (0.191)		
SubCriteria				Appearance	Software	Hardware	Financial	Environment	Accessories	Obsolesce	Warranty	Endurance
				0.176	0.560	0.264	0.454	0.162	0.384	0.170	0.315	0.516
SubCrit x Criteria			0.171	0.066	0.209	0.099	0.120	0.043	0.101	0.032	0.060	0.099
Alernative	Flagship		0.324	0.717	0.620	0.660	0.586	0.319	0.713	0.607	0.600	0.651
	Refurbish		0.267	0.122	0.151	0.151	0.282	0.454	0.145	0.183	0.221	0.151
	Mid-Range		0.409	0.161	0.229	0.188	0.131	0.324	0.142	0.209	0.179	0.198
	Decision											
Flagship	0.574											
Refurbish	0.202											
Mid-range	0.228											

Goal	Buying a Smartphone (Age > 55 years)										
Criteria		Price	0.138	Performance (0.137)			Benefit (0.402)			Risk (0.324)		
SubCriteria				Appearance	Software	Hardware	Financial	Environment	Accessories	Obsolesce	Warranty	Endurance
				0.249	0.362	0.389	0.518	0.201	0.281	0.139	0.350	0.510
SubCrit x Criteria			0.138	0.034	0.050	0.053	0.208	0.081	0.113	0.045	0.113	0.165
Alernative	Flagship		0.490	0.614	0.570	0.458	0.400	0.354	0.672	0.672	0.396	0.579
	Refurbish		0.232	0.136	0.182	0.268	0.180	0.327	0.169	0.187	0.161	0.148
	Mid-Range		0.278	0.250	0.247	0.273	0.420	0.320	0.159	0.141	0.443	0.273
	Decision											
Flagship	0.499											
Refurbish	0.194											
Mid-range	0.307											