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Mobile Phone Scanner Technology Adoption - A Comparison Analysis

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***Abstract*—With the development of smartphone technology becoming more sophisticated, more developers were trying to increase the capability of smartphone. One of such functionality was the use of camera technology not only as image capturing device, but also as scanner substitution device to increase productivity. This study compared characteristics of mobile scanner app's user based on gender, age, and educational level among Indonesian citizen in some cities. The results showed that educational level was playing crucial of scanner mobile apps usage in Indonesia.**

Keywords—mobile phone, scanner technology, smartphone, comparison analysis

I. INTRODUCTION

Smartphone is becoming more and more inseparable part of human lives [1]. Nowadays, more over 5.19 billion people are using the smartphone for every necessities. In Indonesia, even total mobile device activated and connected are more than total population about 272,1 million people (about 338,2 million active phone connections), while total smartphone ownership rose up to 94% [2] with the most used operating system in smartphone today In Indonesia is Android with total market share more than 93% [3] from various brands. It means, about 317 million android based smartphones were used in Indonesia, while iOS devices that being used were only about less than 20 million devices. More than 170 million people in Indonesia are active mobile internet users, which means almost everybody are now connected each other towards online networks, where the traffic by device are divided into three category as follows (Figure 1) [4]:

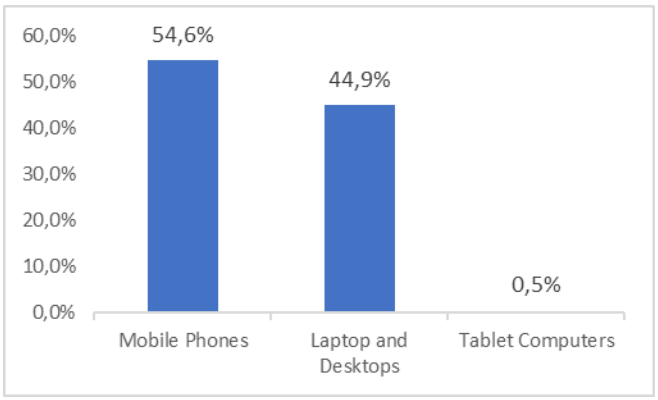

Fig. 1. Share of web traffic by device [5].

Today's smartphones are increasingly capable to carrying out various purposes, including work needs and even could enables mobile workers to leave the conventional PCs and Laptops [6]. Various brands are competing to develop such high end mobile devices that could even do we cannot imagine several years ago [7]. With tons of apps in Androids digital application market such as Google Play [8], no doubt that there are hundreds of productivity tools to increase work capabilities [9]. Workers in general usually need more capable device in the office [10]. Such device for example is digital scanner to scan various kind of documents [4]. Scanners are created from the needs of people to scan documents for later use outside of office [11]. Modern flatbed scanners that introduced in the late 20th century designed to take good quality image with a technology called Contact Image Sensor (CIS). It works like a digital camera taking a picture, but in a closer proximity [12].

Lot of smartphone's engineer developed great quality camera, where it had been used by developer to create

productivity apps to take advantage of it [6]. One of best example, are Digital Mobile Device Scanner Apps that can turn your phones to portable scanner [13]. Such apps could make use of the camera on a smartphone to not only capture pictures, even correct the image perspective, composition and other function to make document as if it has been scanned with conventional scanner [14]. We can find lot of identical scanner application on google play, which the most well known digital mobile device scanner apps are as follow (Table 1) [10].

TABLE I. MOBILE DEVICE SCANNER APPS COMPARISONS

Apps	Camscanner HD	Microsoft Office Lens	Adobe Scan:PDF	Google Drive Document Scaner
Downloaded	100.000.000+	>10,000,000	>10,000,000	> 5.000.000.000
Score Review	4.6	4.7	4.7	4.3
Total Review	2,777,040	501,579	606,634	5,712,266
Output File	PDF	PDF, JPG, .onenote	PDF	PDF
Features	Document, Bussiness Card, Image Scanning with OCR	Document, Whiteboard, Blackboard, Bussiness Card, Image Scanning with OCR	Document, Bussiness Card, Image Scanning with OCR	Very limited. Only part of cloud file storing and other document editing services
Developer	INSTIG Information Co., Ltd	Microsoft Corporation	Adobe	Google LLC

II. LITERATURE REVIEW

Previous study regarding the use of smartphone apps were conducted. Duke and Montag in their study stated that some digital application could increase productivity, especially in the office, while the other application caused addiction where it reduced work productivity due to spending time on the smartphone during work and it depended on the background of work [15]. Khan, et al examined the attitude toward mobile application usage. In their case, the individual's smartphone application choices and behavior came from education and knowledge of technology [16]. Other research by Jadhav and Weis observed the associations between mobile phone ownership use on family planning outcomes. Their findings indicated that age and background have potential related between mobile phone ownership and family planning uptake [17]. Other work about how digital apps could increase productivity came from study conducted by Levi-Bliech, et al [18], where it confirmed the organization to implement fleet-management app to increase driving behavior in fleet industry. According to Knoesen and Seymour [19], employees made use of several apps to improve productivity especially on sales, financial terms, and other information regarding services or products. Thus, the use of apps had positive influence on employee performance on business processes. There were many other studies but none of them discussed about the use of portable scanner application. This study aims to reveal the benefit of the use of mobile scanner technology through comparison of gender and educational background.

III. RESEARCH METHODS

A. Sampling

This research is quantitative-based to verify three hypotheses [20]. As sampling method, this research was used stratified random sampling method with groups based on gender, and educational background and questionnaire created to gather data portable scanner application's user [21]. Survey was conducted using google form in some cities from several schools, universities, and companies in Indonesia with total samples reached out to 312 respondents from several background. These samples were considered sufficient to represent users from various backgrounds.

B. Two-Way ANOVA Analysis with Interaction

Analysis method in this research used Two-Way Analysis of Variance (ANOVA) with interaction to analyze the difference effect of two nominal variables [22], i.e Gender (G), and Educational Background (EDU) [23]. Mobile Device Scanner Apps (MDSA) represents the user's choice of mobile device scanner apps on their smartphones. This article used three hypotheses as follow [24]:

H1. Gender is significantly make the difference on Mobile Device Scanner Apps chosen by user
H2. Educational Background is significantly make the difference on Mobile Device Scanner Apps chosen by user
H3. Gender and Educational has interaction each other in order to significantly make the difference on Mobile Device Scanner Apps chosen by user.

The Basic Formula and calculation of the mean square (MS) for those variables, are as follow [24]:

$$Y_{ij} = \mu + \tau_i + \beta_j + \gamma_{ij} + \epsilon_{ijk} \quad (1)$$

$$Mean\ Square\ MS(G) = \frac{SS(G)}{DF(G)} \quad (2)$$

$$Mean\ Square\ MS(EDU) = \frac{SS(EDU)}{DF(EDU)} \quad (3)$$

$$Mean\ Square\ MS(G.EDJ) = \frac{SS(G.EDU)}{DF(G.EDU)} \quad (4)$$

$$Mean\ Square\ MS\ Error = \frac{SSE}{DF\ Error} \quad (5)$$

Variable G is Gender and EDU is Educational level. Mean Square or MS measures average of the squares of the variables and error. The Sum of Squared or SS is total variation in the data [25]. SS (G) and SS (EDU) the amount of variation of the estimated factor level mean around the overall mean of those variables [21]. SSE or SS Error is the amount of variation of the observations from fitted values [26]. μ is the overall mean response, τ_i is the effect of the i-th level of variable Gender (G), β_j is the effect of the j-th level of variable Educational

Background (EDU), and γ_{ij} is the interaction effect between two variables above [26]. moreover, we have the total (corrected) sum of squares as follows [23]:

$$SS(total) = SS(G) + SS(EDU) + SSE \quad (6)$$

$$SS(G) = nb.\sum_{i=1}^{a}(\bar{y}_{i}..-\bar{y}..)^2 \quad (7)$$

$$SS(EDU) = na.\sum_{i=1}^{b}(\bar{y}_{\cdot i}.-\bar{y}..)^2 \quad (8)$$

$$SS(G.EDU) = r.\sum_{j=1}^{b}\sum_{i=1}^{a}(\bar{y}_{ij}.-\bar{y}_{i}..-\bar{y}_{.j}.-\bar{y}...)^2 \quad (9)$$

$$SS\ Error = \sum_{k=1}^{z}\sum_{j=1}^{b}\sum_{i=1}^{a}(y_{ijk}-\bar{y}_{ij}.)^2 \quad (10)$$

$$SS(TOTAL) = \sum_{k=1}^{r}\sum_{j=1}^{b}\sum_{i=1}^{a}(y_{ijk}-\bar{y}...)^2 \quad (11)$$

Formula for Fit $\bar{y}$, fitted means and residual is calculated through coefficient $\beta 1_i$ and $\beta 2_i$ in the following:

$$\bar{y} = \hat{\mu} + \widehat{\beta 1_i} + \widehat{\beta 2_j} \quad (12)$$

The fitted values $\hat{y}$ used in this research is least square model as follows :

$$\hat{y} = X.\hat{\beta} \quad (13)$$

Estimated coefficients $\hat{\beta}$ for vector is defined in the equation below.

$$\hat{\beta} = (X'.X)^{-1}.X'Y \quad (14)$$

The equation for interaction between two factors namely $\hat{y}_{ijk}$, where the fitted value is the mean $\bar{y}_{ij}$ is as follows:

$$\hat{y}_{ijk} = \bar{y}_{ij}. \quad (15)$$

Anova F-values and P-values as follows:

$$F_{value}(G) = \frac{MS(G)}{MS\ Error} \quad (16)$$

$$F_{value}(EDU) = \frac{MS(EDU)}{MS\ Error} \quad (17)$$

$$P_{values} = 1 - P(F \le f_j) \quad (18)$$

TABLE II. UNIVERSITAS NAHDLATUL ULAMA CIREBON TWO-WAY ANOVA WITH INTERACTION ANALYSIS [27]

Variation Source	SS	Df	Mean Square
Gender	SS(G)	(a−1)	MS(G)
Educational Background	SS(EDU)	(b−1)	MS(EDU)
Interaction	SS (G.EDU)	(a−1)(b−1)	MS (G.EDU)
Error	SSE	(n-1)-(a-1)-(b-1)	MS(ERROR)
Total (Corrected)	SS(Total)	(n-1)	

IV. RESULT AND DISCUSSION

The first tables describe the age range of respondents that took part of questionnaire for this resesarch. Below is the description table 3:

TABLE III. AGE BASED ON GENDER

Gender			
Age	***Female***	***Male***	***Grand Total***
< 17	11	3	14
18 - 27	78	106	184
28 - 37	11	28	39
38 - 47	3	6	9
48 - 57	1	1	2
Grand Total	104	144	248

From table 3, we can get information that most of respondents are in age range 18 – 27 years old. While the least age are coming from range 48 – 57 years old. Total participants in this questionnaire are 312 but stripped down to 248 due to incomplete answers from the rest of participants, so they are excluded from calculations. Below is overview about educational level and purpose of digital mobile scanner app based on gender from gathered samples.

TABLE IV. EDUCATIONAL LEVEL AND APP'S USE BASED ON GENDER

Educational Level and Apps Purpose	Gender		
	Age	***Female***	***Male***
High School Total	**29.4%**	**38.7%**	**68.15%**
Education	20.2%	29.0%	49.19%
Personal	4.4%	5.2%	9.68%
Work	4.8%	4.4%	9.27%
Bachelor Total	**9.3%**	**13.3%**	**22.58%**
Education	3.6%	4.4%	8.06%
Personal	2.4%	0.8%	3.23%
Work	3.2%	8.1%	11.29%
Master Total	**3.2%**	**5.6%**	**8.87%**
Education	0%	0.8%	0.81%
Personal	1.2%	1.2%	2.42%
Work	2.0%	3.6%	5.65%
Doctor or Ph.D Total	**0%**	**0.4%**	**0.40%**
Work	0%	0.4%	0.40%
Grand Total	**41.94%**	**58.06%**	**100.00%**

Table 4 above depicts the sole purpose of digital mobile scanner app is for education, where the other purposes share almost same amounts of percentages used. For descriptive statistics calculation, we have means and variances for each educational level and gender as depicted below (Table 5):

TABLE V. MEANS AND VARIANCE SCORE EACH VARIABLES

Educational Level	Desc	Female	Male	Total
Undergraduate	Means	24.33	32.00	28.17
	Variance	494.33	1201.00	695.77
Bachelor	Average	7.67	11.00	9.33
	Variance	2.33	81.00	36.67
Master	Average	2.67	4.67	3.67
	Variance	6.33	14.33	9.47
Doctor/ Ph. D	Average	0.00	0.33	0.17
	Variance	0.00	0.33	0.17
Total	Average	8.67	12.00	
	Variance	188.97	396.91	

As we use Two-way Anova Analysis with intercation in this article, thus the Replication used in this research as interaction is the purpose of application used by users. The result of calculations can be seen in Two-Way ANOVA with interactions below (Table 6).

TABLE VI. TWO-WAY ANOVA WITH INTERACTIONS

Variation Source	Sum of Square (SS)	Df	Mean Squares	F	P-value
Educational Level	2801	3	933.6667	4.150398	0.023583
Gender	66.66667	1	66.66667	0.296351	0.593685
Interaction	44.33333	3	14.77778	0.065691	0.977293
Errors	3599.333	16	224.9583		
Total	6511.333	23			

With 5% significant level of error (0.05), we have Fcrit for each degree of freedom for each variation source are 4.493 for variable Gender, 3.238 for variable Educational Level and Interaction between both variables (Gender and Educational Level). As we compared with each F-value and P-value from the table we can conclude that F-value for Educational Level is greater than Fcrit while P-value is less than 0.05, where the rest are F-value for Gender and F-value for both variables interaction are both less than Fcrit and their P-value are greater than 0.05.

As for hypotheses testing, we can conclude that:

H1. Reject Null Hypothesis and accept alternative hypotheses, which means that there is significantly difference on Mobile Device Scanner Apps chosen by user based on educational level.

H2. Accept null Hypothesis, that means there is no difference in gender to use Mobile Device Scanner App.

H3. Accept Null Hypothesis, that means there is no interaction between gender and educational level to use Mobile Device Scanner App.

From the result above, gender did not play important role regarding the use of productivity app such as mobile device scanner. It means, there are no difference between men and women, whether to use or not to use this app respectively. In the other hand, education background was crucial in the app usage. Lot of high school student in this research were using this app mostly as educational purposes respectively, while people with higher education level used it for document work as substitution of conventional scanner. This is understandable, because the quality of smartphone nowadays would suffice to run this app smoothly with good output closer or even better to conventional scanner devices. One of the findings in this study was there was no interaction between gender and education level in term of this particular app usage. The use of the Extended Unified Theory Of Acceptance And Use Of Technology (UTAUT) on education and employment background showed positive result for comparative analysis in portable scanner adoption [28].

V. CONCLUSION

At this point, we now have new perspective about use of Mobile Device Scanner App on smartphone from user's point of view. Although at first, gender is allegedly make the difference for using Mobile Device Scanner app, but this research prove it wrong. Male or female has no matter because this apps is being used for everybody. Besides that, the main purpose of this apps as explained before were thoughts that for work purposes as it turned out that is for mainly for educational purposes. This is understandable because with age range from 18 – 27, most people are still fresh graduate worker that perhaps think to raise their educational level to the higher state.

VI. LIMITATION OF THE STUDY

This research has some limitations, i.e. the purpose of it is only to observe differences between educational level, gender and the purpose of Mobile Device Scanner apps used. It was not observed the type and brand of smartphones that were being used either. Moreover, there are more variables to be observed such as what kind of apps they have used, how long did they used it, type of smartphones used, etc. Furthermore, there are several methods to verify the influence of those variables that can be used on next research.

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