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Interaction Design For Implementation *Multi-Window* on *Smartphone*

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Abstract —The use of smartphones varies from person to person, and one of the uses that requires attention is multitasking using a smartphone . Multitasking is usually done on computers , but the increase in smartphones ' screen size and RAM capacity makes it an options for multitasking . Theimplementation of multitasking on smartphones still has weaknesses , and this final project aims to create an interaction design that overcomes these weaknesses . The method used is user-centered design with problem analysis through questionnaires and current implementation analysis , followed by determining needs , followed by creating low fidelity and high fidelity designs , and finally testing those designs . Two iterations of the design resulted in a final design that has a SUS score of 91 (Grade A), an ease of use scores that is not lower than 6.3 out of 7, a task completion rates of 100%, and icons that 's almost entirely easy to find with a time-to-locate time of 0-5 seconds . The final design can be implemented on Android, but implementation on iOS needs to wait for its software to support the proposed solutions .

Keywords— smartphone , multitasking , floating window , split screen , user-centered design

I. INTRODUCTION

Having a smart phone or what is often called *a smartphone* is increasingly becoming a new standard in everyday life. Almost everyone in the world has at least one cellphone, and many of them fall into *the smartphone category* . Quoted from bankmycell.com, according to technology company Ericsson, it is estimated that there are 6.64 billion people in the world who currently have *smartphones* . This figure means that around 83.32% of the people in the world have *smartphones* [1] . With this fact, you could say that *smartphones* are part of everyone's lives in the world.

Smartphone users in Indonesia are dominated by people of productive age. The definition of productive age is people aged 15-64 years [2] who are considered still able to work and produce something [3] . A survey conducted by the Ministry of Communication and Information showed that 75.95% of the Indonesian population aged 20-29 years had *a smartphone* . Apart from that, 68.34% of the Indonesian population

aged 30-49 years also own *a smartphone* [4] . In this productive age, *smartphones* can help in work and personal life.

Both in work and daily life, users in the productive age sometimes need more than one application to do something. This phenomenon is usually called *multitasking* . *Multitasking* can be defined as the ability to switch between applications quickly to combine information from various sources [5] . Before *smartphones* became widely used, users usually used computers to do *multitasking* . This is possible with the *multi-window concept* . This concept allows users to open more than one program simultaneously on one computer screen. However, today's users increasingly *multitask* using *smartphones* rather than using computers [6] . Even so, the *multitasking method* on *smartphones* has several problems.

multitasking method today is *split screen* and *floating windows* . However, each *smartphone manufacturer* has different implementations. Each brand *of smartphone* with the Android operating system has an implementation with a different appearance. Meanwhile, Apple's iOS operating system does not have a *split implementation screen* and *floating window* for Apple iPhone *smartphones* . Not only that, the current interaction design is influenced by the system navigation method used. Users may use a *button navigation system* (Home , Back , and Recents buttons) or use a *gesture* navigation system . When using this feature, users also need several steps to change the currently open application. Effectively, users are only using two applications simultaneously. Another way to change the application you are currently using is to use the " Recent" feature Application " which is available on various *smartphone operating systems* [5] . The *multitasking* feature also needs to be explored and studied by users themselves. *Smartphone* manufacturers who are currently implementing this feature do not show how to use it or provide clear access to the feature.

Created interaction design in journal This expected can help reduce various the obstacles expressed previously . One design that works with the same way between system operations and inter brand *smartphones* can help user become more familiar . Users don't either need learn feature This return if change device . The designs created are also arranged to be easy studied and recognized user .

II. LITERATURE REVIEW

A. Users Centered Design

Users centered design (UCD) is one approach that can be used to create a solution in the form of an application. The principle emphasized in UCD is to create applications that put users first, so that user needs are met. This principle is important for developers and designers to use, so that the applications created are effective in helping users [7] .

There is a number of necessary stage done in make design interaction . Stages This done Because a number of matter . Often design interactions created at the start No Enough For fulfil all over need user . Therefore , you can also concluded that often needs that have been obtained from user before the design process started usually Not yet finished . Various needs addition Possible appear after design interaction start formed . Users also vary , well different individual nor different grouping certain , and all matter the need considered in making design interaction . Therefore that , is needed four stages following in make design interaction [8]:

1. Understand and determine context use design interaction
   Stage This useful For know various aspect from the solution will be developed . Some of them is environment place solution will use , user , circumstances technical from solution already there is (if there is), and others . Information This Can obtained from the solution has been There is previously For determine the minimum performance limits from the solution will be made . Information is

also possible obtained with take information from similar solution if desired solution made Still truly new and not some are the same .

1. Determine need user
   Stage This is one of the stage big , because will determine whole making design interaction . Need user can determined in a way explicit and connected with needs business and context use solution in something organization or user . In more scope big , stage this is possible too used For plan change in A organization . For example is change business processes or other process changes inside organization . Need user focus on what you want achieved by users . In deciding need user , necessary considered context use the solution has been obtained from stage previously .
2. Create solution design interaction
   One of important thing For done moment make design interaction is make part design interaction in accordance needs that have been mention and context use the solution has been obtained . Apart from that , design interaction can made become prototype order more concrete since stage This . Stage this is also included do revision based on evaluation carried out . Throughout stage this , UX must always considered in order to produce a design felt Good moment used .
3. Do evaluation on results design interaction
   UCD focuses on users , and because That evaluation is also required directly by the user . Evaluation This Can done as early as Maybe it can also be revised done as early as Possible . Evaluation done No only For revision design interaction , but also for the more understand need user . Evaluation is also useful For know is design created Already fulfil need user .

B. Usability Test

Usability test is one of the interaction design testing methods that can be used to ensure that the interaction design of an interface can be used properly by users. This test involves the user as an interface tester. In this test, generally there are a series of tasks that the examiner needs to go through. Briefly, the following are the stages that need to be passed in usability test [9] :

1. Get a group of testers to be respondents in this test, even better if the respondents are users or potential users.
2. Provide a list of tasks that need to be performed by testers using the existing interface
3. Observe behavior user throughout testing going on , and paying attention point difficulties encountered user .

C. Icon Testing

In a design interface, users need to interact with something in order to control the interface. Often , users perform these interactions with an icon. An icon is generally a button that depicts something, and when the user interacts with the icon, something will happen that is related to the icon. Icons are usually used to save space on the screen and to make it easier for users to recognize the purpose of interacting with a button [10] .

There are various important aspects that need to be considered when creating an icon. Examples of these aspects are *findability* and *information scent* [10] . The *findability* aspect ensures that the icon can be found by the user. *Information* aspect *scent* shows that users can predict what will happen if the user interacts with an icon. This can generally be guessed from the image on the icon.

There are two types of testing that can be done to test icons, namely *out-of-context* and *in-context* . *Out-of-context* testing means showing icons outside the context of the rest of the

interaction design and guessing the usefulness of each icon based on the image shown on the icon. *In- context* testing means showing icons in an interaction design environment so that users have an idea of the associated purpose of an icon. Aspects *of findability* and *information Scent* can be tested using the *in- context testing method* . The *findability* aspect can be tested using *time-to-locate* , or testing the length of time it takes to find an icon. The faster the icon can be used by the user, the better the *findability aspect* of the icon. Meanwhile, *the information aspect Scent* can be assessed by making direct observations regarding the user's guess of the function of interacting with an icon. Icons that are difficult to understand or use can indicate that *the information aspect The scent* of the icon is not good.

D. Multitasking and Multi-Window

Basically, the human brain is intended to work on one work goal at a time. Meanwhile, if another goal appears in the brain, the brain will shift its attention to work related to the new goal. The term multitasking refers to the behavior of someone who tries to carry out more than one goal simultaneously [11] . This definition is important to understand because the multitasking mentioned in this journal is slightly different. The multitasking that this journal wants to bridge is doing more than one job for the same goal. One way to do multitasking is to use the multi-window feature .

Android developer documentation describes *multi-window* as a feature that allows users to have more than one app on the screen at the same time. Applications will share the screen side by side, stacked, as small windows within other applications, windows that can be resized, and separate applications that can be moved around [12] . This documentation also states various possible implementation methods on the Android operating system for *multi-window* . Users sometimes need more than one application when carrying out a task. Not only that, users sometimes do several things at once apart from carrying out their main task. This can be referred to as media *multitasking* , where users interact with a lot of information at once and carry out other activities [13] .

Switching between applications manually is time-consuming and requires additional effort. On a computer, users can overcome this by arranging several application windows in such a way that more than one application can be displayed at the same time [14] . On *smartphones* , this is possible with *multi-window* which is explained in the Android documentation. However, there is no easy way to make changes to applications used in *multi-window mode* . Users are limited to using only two applications. Users often use two or more applications and habitually switch from one application to another when using *a smartphone* [15] .

III. Design Process

A. Problem Analysis and Current Implementation

The title of the paper should be concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulas where possible. Author names should not contain academic title or rank. Indicate the corresponding author clearly for handling all stages of pre-publication and post- publication

A. Abstract

Currently, the features on smartphones for users who want to do multitasking are not yet optimal. The background of this journal explains that smartphones are increasingly being used and are increasingly capable of carrying out various kinds of work, at an affordable price too. One way to do multitasking is with multi-window . However, smartphones currently do not have features for multitasking with multi-windows .

On a computer, two programs can be displayed simultaneously by placing the two programs side by side. One operating system, Windows, has a ' Snap ' feature windows '. This feature is useful for automatically dividing the size of an application window so that one screen is large enough to display two or more applications simultaneously. To change the application that is currently using the ' Snap' feature window ', users only need to select the application and use the ' Snap' feature window ' in the application window.

On a smartphone , the most common method for multitasking using a concept similar to multi-window is to use the split feature. screen . As explained in the background, this feature allows users to view two applications simultaneously. However, users cannot replace the two applications easily. Changing the applications viewed on the screen requires additional steps. For example, by closing the entire split feature screen to be able to change the two applications displayed. This method is less effective in helping users multitask . Additionally, each smartphone manufacturer has its own implementation of the multitasking concept . Implementation can be differentiated from how to change applications, how to access, how to exit multitasking mode , as well as different implementations of the home button. The existing variations make the user experience in multitasking not uniform. It takes additional effort and time for users to learn how to multitask on each device.

Smartphones have been around since around 2000, and for most of that time, smartphone screen sizes were smaller than they are now. However, smartphone screen sizes doubled from 2007 to 2014 [16] . This size does not yet reflect the size of the average smartphone today, 8 years later. The size of the smartphone screen has increased, but the overall size of the smartphone itself has not changed significantly in size. This is due to the home button changing from physical to digital, as well as the use of thinner bezels or screen borders [17] . The implementation of multi-window on smartphones as a way of multitasking may not yet have a solution because the use of large screens on smartphones is still relatively new. Because of this, this feature has not yet become the main focus of smartphone manufacturers . Apart from that, because the use of large screens is relatively new, users are also less exposed to this feature and do not multitask on smartphones . However, it can also be argued that this feature is not the main focus because users don't use smartphones to do things that require multitasking .

For strengthen the points above are carried out survey use questionnaire . Questionnaire spread For know characteristics user related to multitasking on smartphones. Questionnaire this is also shared For validate problems that have mentioned previously as well as know other possible problems There is . Needed at least 100 respondents Android and iOS based smartphone users in Indonesia. Apart from that , it's done analysis implementation multitasking features on current smartphones This . Analysis carried out on five smartphone brands , namely Apple, Samsung, Xiaomi, Oppo and Vivo. Table 1 shows problems encountered from results analysis questionnaire and implementation moment This .

Table l 1 Problem User

ID	User Problems
MP-01	current *multitasking* feature makes the device screen feel too small for *multitasking*
MP-02	*Multitasking* feature does not allow switching to more than two applications quickly
MP-03	Independent exploration is required to understand the *multitasking feature* different implementations
MP-04	*multitasking* feature is difficult for users to find
MP-05	The current interaction buttons do not describe their use through images on the icons

B. Determination Need User

In accordance ISO 9214-210 guide , necessary steps done next is determine need user . Determination need made based on analysis questionnaire and implementation that has been done explained previously . Determination requirements are also created For finish various problem user . There is four need specified users , which are shown in Table 2.

Table2 Need User

ID	User Needs
K-01	Create a multitasking feature with an interface that doesn't take up screen space
K-02	Added the capability to open more than one app at a time, or a method for quickly switching apps
K-03	Has an interface with interaction buttons that is easy to understand and use
K-04	Set access to multitasking features so that they are easy for users to find

IV. IMPLEMENTATION AND EVALUATION

A. Low-Fidelity & High -Fidelity Design I

In accordance User-Centered Design stages , stages furthermore is making design solution . There are two parts making design , that is *low-fidelity design* and *high-fidelity design* . Design process will done as many as two iterations . Implementation design made based on needs that have been determined previously . Designs are also created For overcome problems faced users and implementation moment This . There is a number of limitation implementation in development high-fidelity prototype design , namely :

1) Implementation done with size resolution 390x844 with orientation portrait screen .

2) Implementation made with prototyping tools courtesy of Figma.

3) Implementation only will made in accordance with need multitasking features and not implement whole appearance Home Screen screen and notification shade.

4) Text used on the interface use English .

5) Manufacturing design done two iterations , with condition results evaluation on SUS metrics achieves Grade A category .

6) Display the applications seen in the high-fidelity prototype are catch screen (screenshot) and not can used by users .

7) Prototype only can accept input in the form of click, drag and swipe, as well as tap and hold accordingly ability Figma prototype .

High-fidelity design iteration 1 can seen through https://bit.ly/TAMultitasking1 .

B. Evaluation of First Iteration Design

Testing in the first iteration used the *usability testing method* . *Usability testing* helps measure the effectiveness of the interaction design that has been created in carrying out various *tasks* which will be determined first. *The tasks* used in testing have their own scenarios so that the flow of using the feature makes sense. Metrics used is *success rate* , SUS, and SEQ. Apart from *usability testing* , *time-to-location* testing will also be carried out . Metric This measures the time it takes a user to find an icon button that corresponds to an action that completes a *task* from *usability testing* . Testing will also observe user comments or opinions regarding user understanding regarding each icon button. This test is carried out to obtain aspects *of information scent* of an icon.

Amount respondents used For testing This totaling 10 people with use theory courtesy of Laura Faulkner [18]. Amount respondents This used For targeting the average of problems found around amounting to 94.686% with mark Lowest problems found by 82%. Range age respondents is 20-27 years old . Respondents are also specific for ever Work previously in fields and positions whatever . Respondents were also selected based on operating system, so there were five respondents who used the Android operating system and five respondents who used the iOS operating system. Entire selected respondents is student level undergoing undergraduate year fourth lectures . Major lectures respondents is Systems and Technology Information , Economics, and Agrotechnology . Gender respondents divided into five men and five women .

Based on tests carried out , there are a number of points findings . Bullet points This will become consideration For repair design in iterations second . Table 3 shows findings the .

ID	Component	Important Findings	Improvement Plan
PD-01	*Floating windows*	The additional controls in More Options are not large enough, so users cannot see each image on the icon	Makes the controls in More Options bigger and fills the *floating one window* when used
PD-02	*Split screen*	The additional controls in More Options are not large enough, so users cannot see each image on the icon and it is difficult to press the buttons	Made the controls in More Options bigger with simpler icon images
PD-03	Icon	Users think the interaction is Quick App Switching is *a tap* , because *the gesture* is usually used by iOS users only	• Change the interaction type in Quick App Switching becomes *tap* • Create Quick controls App Another switching that uses *gesture* interaction plus *tap and hold*
PD-04	Icon	• Move icon button is generally less necessary. The dots next to the Move symbol are not understood. • On *floating window* , the	• Changed the Move interaction to *floating window* to be more similar to the implementation on Windows and macOS without using icon buttons. • Creates a new icon button that is used to swap the positions of the two apps in *the split*

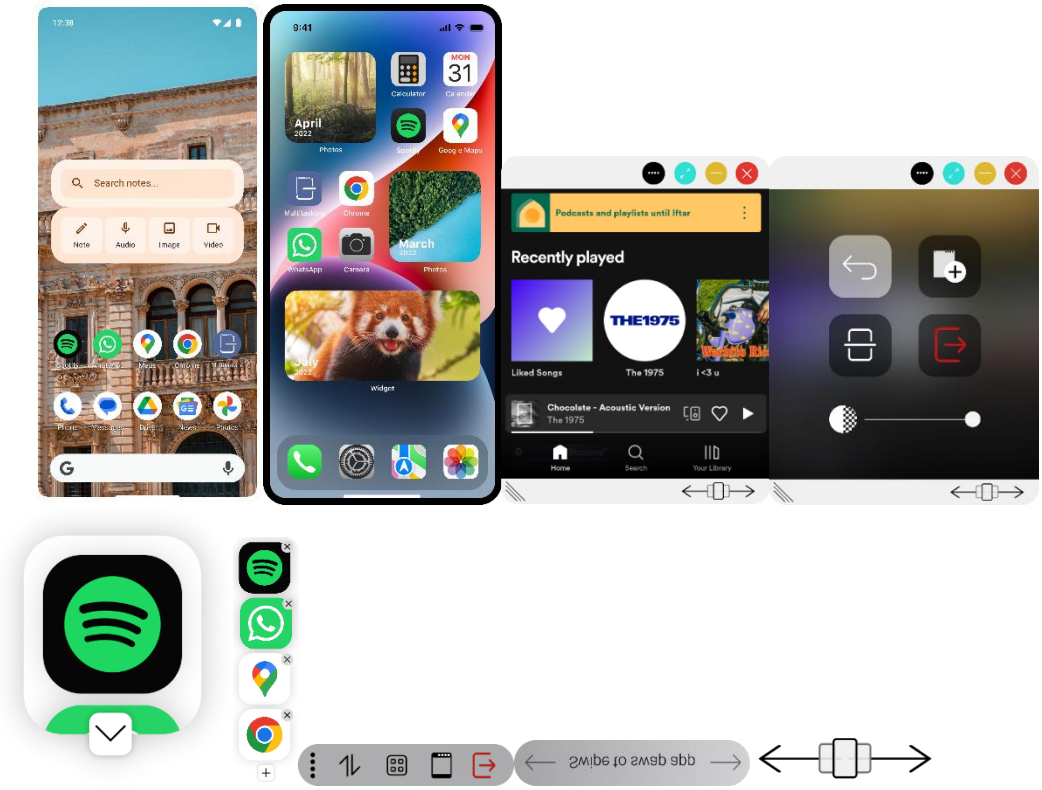
		window concept used is quite intuitive with the same concept as on computers and other implementations, so the existence of this icon button is not important. • On *splits screen* , the usability of this icon button is not intuitive for its intended functionality, namely swapping the positions of the two *split apps screen* .	*screen*
PD-05	Icon	Switch icon button to Split Screens and Switches to Floating Window looks too complex and makes it more difficult for users to understand	Simplified the Switch icon button to Split Screens and Switches to Floating Window
PD-06	Icon	Change icon button Split Screen The application has an image that does not match the functionality it has	Change the image on the Change icon button Split Screen Application
PD-07	Access	Access to *multitasking mode* is not easy to find for users who are using this feature for the first time, as if this feature is a hidden feature	Create access to *multitasking mode* from the main or Home screen Screen
PD-08	Other	Almost all respondents agreed that a tutorial was needed at the beginning of using each *multitasking mode method*	Create tutorials for each *multitasking mode method*

Based on the list of findings and recommendations , design *high-fidelity* iteration second made For overcome problems found . Improvement results can seen via the link https://bit.ly/TAMultitasking2 or in Figure 1.

A. High-Fidelity Design 2 and Evaluation Iteration Second

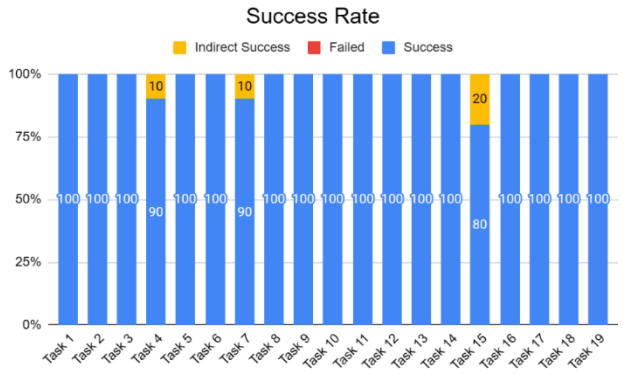
High-fidelity design iteration second will evaluated return . Evaluation done For ensure the problem you want resolved Already resolved . Evaluation is also carried out For ensure No There is problem new one has appeared . Evaluation done to the same

respondent . Evaluation is also carried out use the same user *task* , with A little differences in discussion *play task* . Following is every component designs tested in evaluation iteration second .



High-Fidelity Design Iteration 2 image1

Success metrics *rate* is used to determine the user's success in completing a *user tasks* . User success is determined by observations that see the steps taken by the user and whether the user can achieve the target conditions that have been determined by *the user tasks* . All 10 users did 19 *users tasks* the same one. In this second evaluation, there were no *users tasks* that failed to be carried out by the user . On *tasks* 4 and 7, there is one Android user who completes *the user tasks* in different ways, resulting in *indirect value success* by 10%. *Task* 15 has *indirect success* as much as 20%. *I ndirect success* still exists because users don't pay enough attention to tutorials For through the *task* . Figure 2 shows results *success rate* evaluation second .



Picture2 Second Evaluation Success Rate Results

Single Metric *Ease Questions* are used to find out user opinions for each *user tasks* . SEQ consists of 3 questions, with a rating scale of 1-7 to find out users' opinions regarding the convenience of a *user tasks* . In the second evaluation, none of the SEQ scores were below 6.3. The maximum value of this metric is 7, which means that most of *the tasks* assessed are very easy for users to do. This can mean that the changes made help users, both in interaction design and *user language tasks* . This can also mean that the tutorials provided help users better understand what can be done. Figure 3 shows SEQ evaluation results second .

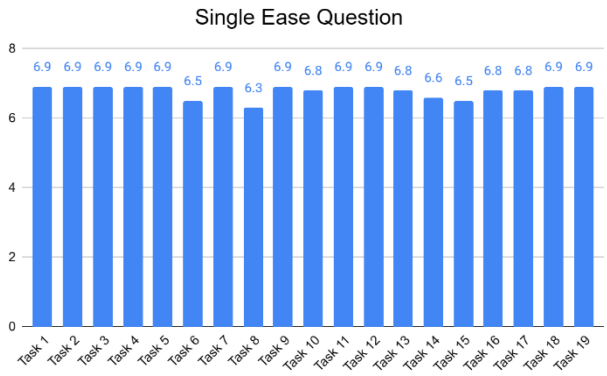


Image of 3SEQ Evaluation Results Second

System Usability Metrics *Scale* (SUS) is used to determine user assessments for the entire system being tested. The SUS consists of 10 questions, with a rating scale of 1 (disagree) to 5 (strongly agree). In the second evaluation, the average SUS was 91. This score is included in the *Grade A category* and is included in the *Best Imaginable category* or the best design imaginable. The SUS score in the second evaluation also indicates that the interaction design is in the *Acceptable category* . The results of this assessment can be interpreted as design changes made to make users feel the system is more usable. Figure 4 shows SUS evaluation results second .

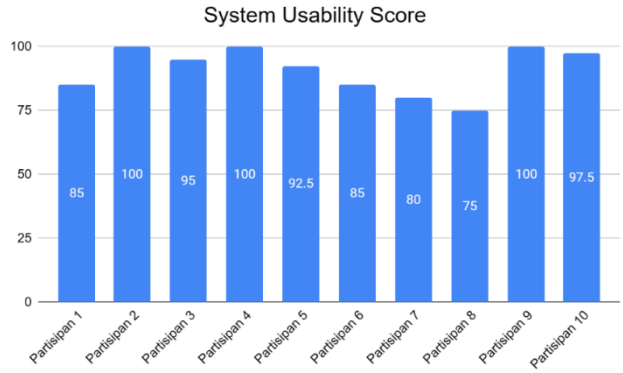


Image of 4SUS Evaluation Results Second

Time Metrics *to Locate* is used to find out the time it takes the user to find the icon button associated with completing *the user tasks* . Time is calculated from the time the user finishes reading the *user command task* and start using or viewing the display design. Downtime is calculated when the user successfully finds the icon button and interacts with it in the correct way. Criteria First is 0-3 seconds to find the icon button instantly . The next criterion is 4-5 seconds if the user needs a short time to understand the image on the icon button first. The final criteria is an icon button that takes 6 seconds or more . Criteria This indicates user difficulty in finding the icon button, or using the correct type of interaction on the icon button. On evaluation secondly , partially icon button can found

in time 5 seconds . However , still There is a number of icon button that requires about 6 seconds . Figure 5 shows results *time-to-locate* evaluation second .

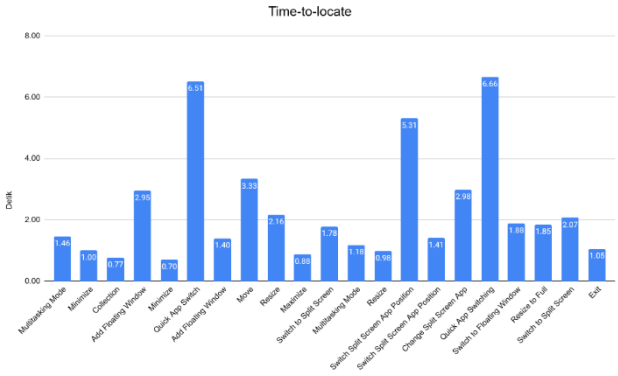


Image 5of Time-to-Locate Evaluation Results Second

V. CONCLUSIONS AND RECOMMENDATIONS

Based on the process that has been passed, the second *high-fidelity iteration was obtained design* with satisfactory test results. These results are shown by several test metrics such as *success rate* , SEQ, SUS, and *time-to-locate* . The interaction design created achieves *the task completion rate* 100% with some *indirect success* . Users can complete all *tasks* with an ease score of no lower than 6.3. Users gave the SUS metric an average of 91, which falls into the *Grade A* and *Best Imaginable categories* . *The time-to-locate* metric shows users can find most icon buttons and use the correct interaction type in a short time (0-5 seconds). Some icon buttons still take longer (around 6 seconds).

There is some suggestions that can be followed For development stage next . Testing respondents can be expanded to other age groups who are also still actively working. The interaction design created does not take into account the different navigation systems, namely *gestures* and *button* , and their influence on interaction with *multitasking mode* . Further development should be focused on other, simpler types of interaction , such as *tap, swipe* and *drag* . Improvements are still ongoing can done with make new Move icon button , as well replace Quick App Switching on *split screen* become like in *a floating window* .

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