1. INTRODUCTION

Mobile application technology is developing very rapidly. Based on statistical data, the number of applica-tion downloads in 2021 will reach 150 billion [1]. Which shows that the need for mobile applications is so high. Android and iOS are the most widely used mobile operating systems (OS) and even control 99 per-cent of the market share [2]. However, the increased demand for mobile applications is accompanied by data that users' satisfaction responses to poor performance applications tend to delete applications [3]. Therefore, mobile applications must have good performance to increase user satisfaction in using mobile applications [4].

Devices for running mobile applications have limitations in power and resources, so there needs to be performance efficiency in mobile applications. Previous research reinforced this with user frustration with mobile applications stemming from performance problems [3]. ISO/IEC 25010 states that for mobile appli-cations to produce efficient performance, it is necessary to have efficiency in CPU usage, memory, and how fast the application can execute programs [5]. One of them is by applying architecture patterns [6].

Several architectural patterns are used to build mobile applications, namely: Model View Controller (MVC), Model View Presenter (MVP), and Model View ViewModel (MVVM). In this paper, we test the MVVM architecture to see how much it improves in terms of performance efficiency. Architecture pattern is an architectural element that provides a packaged strategy to solve some of the problems faced by the system [7]. Architecture describes the elements, forms of interaction, and rules used to solve problems. The architecture pattern also has a framework. This framework aims to build the system incrementally to avoid the simultaneous integration of elements. This makes it easier to find problems at the beginning of development.

The MVVM architecture pattern was chosen because, in previous studies [6], it was stated that MVVM had better performance efficiency on CPU usage and execution time. However, it is necessary to conduct further research on performance issues because in previous research [6], the application used was only a sample application to-do list. Each application has different characteristics, so it is better to use an applica-tion with characteristics relevant to the problem to be tested. An architecture pattern is one alternative to improve performance on mobile applications because it can affect resource usage and execution time on mobile applications [6]. Among them is the high use of resources.

Many studies have been conducted related to this research problem. A related study by Lou, T [6] A comparison of Android Native App Architecture MVC, MVP, and MVVM. This study conducts a thorough analysis of the MVC, MVP, and MVVM architecture patterns from the aspects of testability, modifiability, and performance. The analysis results show that MVP and MVVM are better than MVC. MVP and MVVM require less time to run tests, lower coupling levels, and use less memory. Another study was conducted by B. Wisnuadhi [8] Performance Comparison of Native Android Application on MVP and

MVVM. This study analyzes the MVP and MVVM architecture patterns in the Point of Sales application regarding per-formance efficiency. The results show that the application of the MVVM architecture pattern on the android application produces better performance than MVP. The analysis results show that MVVM is better than MVP in CPU usage and execution time. However, MVVM in android applications uses more memory due to the additional databinding library. Based on related studies that have been done. The MVVM architecture pattern is better than MVP in terms of CPU usage and execution time [8]. This is due to the third-party li-brary databinding that improves performance on the MVVM architecture pattern. However, this results in the use of more significant memory.

This study aims to apply the MVVM Architecture pattern to the AR Ruler application to improve perfor-mance efficiency. For the purpose research, we used the AR Ruler application. AR Ruler is an iOS-based application used to measure the length of an object by utilizing Augmented Reality technology. AR Ruler was chosen as a case study because it has many users and has been downloaded millions of times [9]. This application also applies Augmented Reality technology, which burdens CPU and memory performance [10].