CHAPTER V
CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Based on the results of the research conducted, the Agglomerative Hierarchical Clustering (AHC) method was successfully applied to group students based on similarities in learning activities within the Learning Management System (LMS). The clustering process was carried out using several linkage approaches, namely Single Linkage, Complete Linkage, Average Linkage, and Ward's Linkage, in order to identify the method that produces the best clustering quality.

The evaluation results using the Silhouette Coefficient show that Ward's Linkage achieved the highest score of 0.61, categorized as good. This result indicates that Ward's Linkage is capable of producing more balanced clusters with clearer separation between groups compared to other linkage methods. Meanwhile, Single Linkage obtained the lowest score of -0.013 due to the formation of a chaining effect, where most data points were grouped into a single large cluster.

The clustering results show that students can be grouped based on different LMS activity characteristics, such as task completion activities, forum participation, and learning material access. These groupings reflect variations in student behavior patterns during the digital learning process. In addition, validation using Cohen's Kappa produced a value of 0.892, categorized as very good. This indicates a high level of agreement between the system's cluster interpretation and the validator's assessment. Therefore, the clustering results are considered sufficiently representative in describing student activity characteristics within the LMS.

5.2. Recommendations

Based on the results of the research conducted, the following recommendations can be given

1. First, future research is encouraged to use a larger dataset that includes more classes to ensure that the clustering results are more representative and have better generalization ability.
2. Second, future studies are recommended to include additional clustering

methods such as K-Means, DBSCAN, or Fuzzy C-Means as comparative methods in order to obtain a more comprehensive analysis of clustering performance.

3. Third, it is suggested that future research incorporates more in-depth validation processes, such as questionnaires or direct assessments from teachers, so that the interpretation of student activity characteristics can be determined more accurately.
4. Fourth, the developed adaptive learning system can be further improved by adding real-time student activity analysis features, allowing learning recommendations to be generated dynamically based on ongoing student interactions within the LMS.