

## **ABSTRACT**

*Industry 4.0 transformation is characterized by the use of real time data processing technology to diagnose potential disruptions in production. Companies are difficult to survive in competition if unable to adapt to the industrial era changes, including the transportation industry. Air transportation is important for NKRI since the territory is separated by sea. Flight activities are arranged on interconnected schedules and forms a complex system, hence vulnerable to disruptions. Airport disruption might triggered widespread flight cancellations. The popularity of industry 4.0 has an impact on changing the characteristics of data, becoming large-scale data. However, in Indonesia, the presence of large-scale flight data has not been processed properly. In fact, this data is able to provide knowledge to support the basic strategy of Indonesia Ministry of Transportation, namely flight and supporting infrastructure development to improve connectivity between regions in Indonesia.*

*This research aims to provide knowledge about the structure and robustness of flight route networks under various disruptions. The findings might be used as basic knowledge in shaping integrated, reliable, and directed national flight system. Data mining techniques are used to process large-scale data to find hidden patterns and generate the un-found knowledge through traditional and statistical techniques*

*Modern network analysis, which is a development of graph based data mining techniques, is used to provide knowledge about the structure and robustness of whote flight route network under various disturbances. This technique begins from business understanding, data understanding, data preparation, data modeling, evaluation, and deployment. Disruptions are modeled through percolation on the network. Flight network robustness is evaluated through network robustness variables, namely giant connected components and survived links.*

*The Indonesian domestic flight network is characterized as a directed, weighted, and scale-free network with a great development opportunity. The importance level of airports varies based on centrality measurements. Based on the proportion of airport connectivity and the proportion of survived scheduled flights) under operational disruptions, the domestic flight route network in Indonesia has greater robustness in facing random failure compared to targeted attacks through all centrality measurements.*

*Based on the findings, scheduling and routing decision between low spoke airports is necessary to reduce operational dependence on the hub airports, which are found to be a point of vulnerability. Thus, it is capable to minimize the risk of mass flight cancellation. In addition, the development of hub airports into two different locations (multi-hubs) is able to obstruct the spread of disruption. In the end, greater security attention is needed for hub airports to prevent economic and social losses for various parties.*

*Keywords: Network Robustness; Flight Route Network; Operational Disruptions; Network Percolation*