CHAPTER V
CONCLUSION AND SUGGESTION

5.1 Conclusion

This study investigated indoor air quality in a remote rural village in West Sumatra, Indonesia, during a culturally significant period marked by intensive cooking activities. Using low-cost PurpleAir sensors, we monitored real-time particulate matter (PM) concentrations—both mass and number—across three traditional households over six consecutive days. The study area, Jorong V Botung, is a geographically isolated farming community where households rely primarily on solid fuels such as firewood for cooking, often in poorly ventilated indoor environments.

The analysis of real-time PM mass concentrations (PM_1, $PM_{2.5}$, and PM_{10}) revealed substantial variations across households and time. Peak concentrations corresponded strongly with cooking times, particularly during early morning and evening hours, with the most extreme values recorded on March 30th, the day before Eid al-Fitr, when continuous and large-scale communal cooking took place. For instance, $PM_{2.5}$ levels exceeded 200 $\mu g/m^3$ in H-1 during peak periods—well above WHO recommended limits for indoor exposure. These results highlight the acute pollution burden experienced in traditional rural kitchens during intensive cooking activities and festivals.

Size-segregated number concentration data further supported these findings by demonstrating that smaller particles (especially 0.3–0.5 µm) dominated indoor particle counts during cooking hours, with concentrations often reaching above 20,000 particles/dL in households using wood as fuel. A clear size-dependent decline in particle numbers was observed, reflecting the nature of fresh combustion emissions, which are known to produce high counts of fine and ultrafine particles. This trend underscores the elevated risk posed by such particles, given their ability to penetrate deep into the lungs and contribute to adverse health outcomes.

Correlation analysis among PM parameters provided additional insights. Strong positive correlations were observed between PM_1, $PM_{2.5}$, PM_{10}, and AQI across all locations ($r > 0.95$), indicating that mass-based metrics respond similarly to emission events, primarily driven by indoor cooking. Small particle number bins (0.3–1.0 µm) were also strongly correlated with PM mass concentrations, further confirming that fine particles dominate indoor exposure during

cooking periods. Larger particle size bins, on the other hand, showed weaker correlations, suggesting more heterogeneous or background sources.

In conclusion, this study confirms that traditional cooking practices using firewood in poorly ventilated homes lead to high concentrations of fine particulate matter, both in terms of mass and number. The highest pollution events were clearly linked to cooking activities, especially during culturally significant celebrations. The consistent patterns observed across all households emphasize the urgent need for interventions such as improved ventilation, promotion of clean cooking technologies, and public awareness, especially in rural Indonesian settings where such practices remain prevalent. The findings not only contribute to the local understanding of indoor air pollution but also offer relevant insights for other rural communities in Southeast Asia facing similar challenges.

5.2 Suggestion and future direction

Based on the findings of this study, several practical recommendations and research directions are proposed to reduce indoor air pollution and improve public health in rural households reliant on traditional cooking practices.

First, behavioral and technological interventions are urgently needed. Most households still use firewood as their primary cooking fuel due to cultural preferences, cost, and accessibility. To reduce emissions, government or NGO-supported training programs should be developed to educate villagers on the safe and efficient use of LPG stoves, including basic maintenance and fire safety. In parallel, subsidizing LPG stoves and refills for rural communities such as Jorong V Botung could make clean cooking options more accessible and sustainable in the long term.

Structural improvements to household kitchens are also critical. Residents should be encouraged to cook with windows open to enhance natural ventilation and allow pollutant dispersion. Where feasible, the installation of larger ventilation openings or small chimneys should be promoted to create upward airflow and direct emissions away from indoor spaces. It is also strongly recommended that households avoid sleeping in areas directly connected to kitchens, as this increases continuous exposure to elevated PM concentrations, especially among vulnerable populations such as women, children, and the elderly.

In terms of future research, this study provides a valuable baseline but remains limited to three households. For a more representative assessment, future studies should aim to include a

larger sample size of 10–30 households, covering different kitchen layouts, fuel types, and ventilation configurations. This would enhance the generalizability of the findings and support targeted policy recommendations at the regional or national level.

Furthermore, future studies should move beyond real-time measurements of PM mass and number by incorporating filter-based samplers capable of collecting airborne particles for chemical component analysis (e.g., black carbon, metals, organic compounds). This approach would allow for a more detailed understanding of the toxicological risks associated with specific combustion sources and help identify the most harmful particle constituents.

Longitudinal studies and intervention-based research are also encouraged. For instance, monitoring PM levels before and after the introduction of LPG stoves or improved ventilation systems could provide evidence of the effectiveness of these interventions. Finally, interdisciplinary collaborations involving environmental scientists, public health professionals, and social researchers would be valuable to address the complex interplay between indoor air pollution, behavior, culture, and health in rural communities.