



*Project Title:* A Practical Application of Integrated Micro-Environmental Monitoring System for Construction Sites  
*Principal Investigator:* Dr. WONG Man Sing  
*Project ID:* CICR/03/15  
*Research Institution:* The Hong Kong Polytechnic University  
*Subject Area:* Construction Safety and Health

## Objective

- ♦ To enhance the integrated micro-environmental monitoring system
- ♦ To enhance the micro-environmental quality monitoring on-site
- ♦ To develop an analysis tool for environmental impact assessment during construction process
- ♦ To raise awareness of environmental quality in working environment

## Background

With such huge construction demands involving different levels of personnel from workers to project managers on-site, the safety and health issues in construction sites are of great concern. Construction workers are often exposed to physical environmental hazards on-site, such as heat, UV radiation, noise and air pollution. Excessive exposures to these hazards may result in injury, chronic illness, permanent disability or even death.

In current practices, safety officers report and announce weather and environmental indices such as temperature and air quality health index based on the information from the Hong Kong Observatory (HKO) and Environmental Protection Department (EPD). However, the data provided by HKO and EPD are collected at limited locations, representing only at district-scale. Thus, a real-time, automatic and Integrated micro-Environmental Monitoring System (IEMS) can significantly facilitate the safety and health assessment.

## Methodology

Integrated micro-Environmental Monitoring Device (IEMD) is equipped with a microcontroller, wireless communication modules, GPS modules, and environmental sensors including temperature, humidity, PM<sub>2.5</sub>, PM<sub>10</sub>, noise level, carbon monoxide, volatile organic compounds, sulphur dioxide and UV radiation sensors. This system can detect micro-environmental quality on-site, with reasonable accuracy of both indoor and outdoor positioning and environmental conditions. The system can be installed anywhere on-site and can be carried around by safety officers to collect environmental-related data for automatic risk assessment.

The system was used as an analysis tool to evaluate each environmental factor during the construction process at three construction sites, namely the Home Ownership Scheme at Kiu Cheong Road, 3 MacDonnell Road site and The Hong Kong Polytechnic University (PolyU) Block X site. The real-time generated environmental indices and “warning” notice conveyed clear messages to construction workers to take corresponding protective measures.



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## Results and Findings

The analysis of the data recorded by well-distributed IEMD in a construction site can help to understand concentrations of environmental conditions in a day or different days to devise effective policies and guidelines for sustainable and environmentally friendly construction. Examples of data analysis are shown in Figures I & II. Figure I shows trends of concentrations of pollutants during and course of the day (Oct 6, 2017). The trend indicated a decrease in concentrations of PM<sub>10</sub>, PM<sub>2.5</sub> and CO from morning to evening while noise level increased slightly in the evening. Notably, there was a significant drop in concentrations of pollutants during lunch hour.

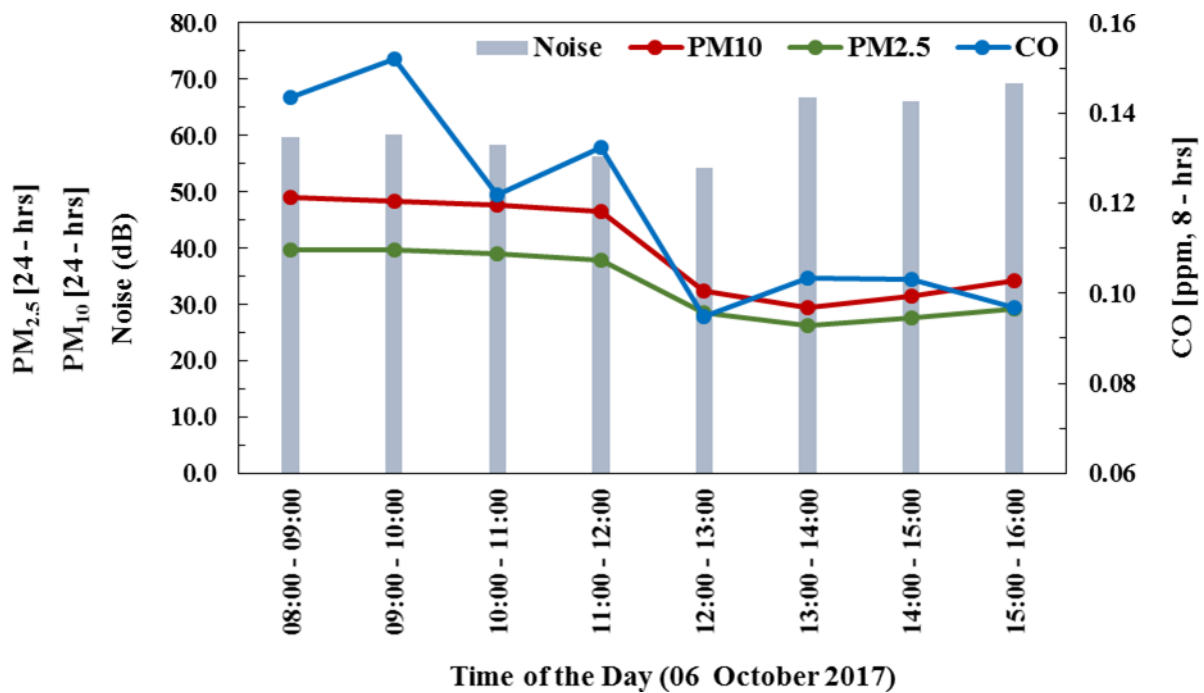


Figure I: Trends of concentrations of environmental pollutants (Noise, PM<sub>10</sub>, PM<sub>2.5</sub>, and CO) during a working day (Oct 6, 2017)

Figure II shows trends of concentration of PM<sub>10</sub> and noise level recorded at different locations which can provide more comprehensive site-specific scenarios for targeted action. PM<sub>10</sub> concentrations at both sites showed increasing trend from morning to evening while noise level was generally stable but slightly higher in early hours at location B

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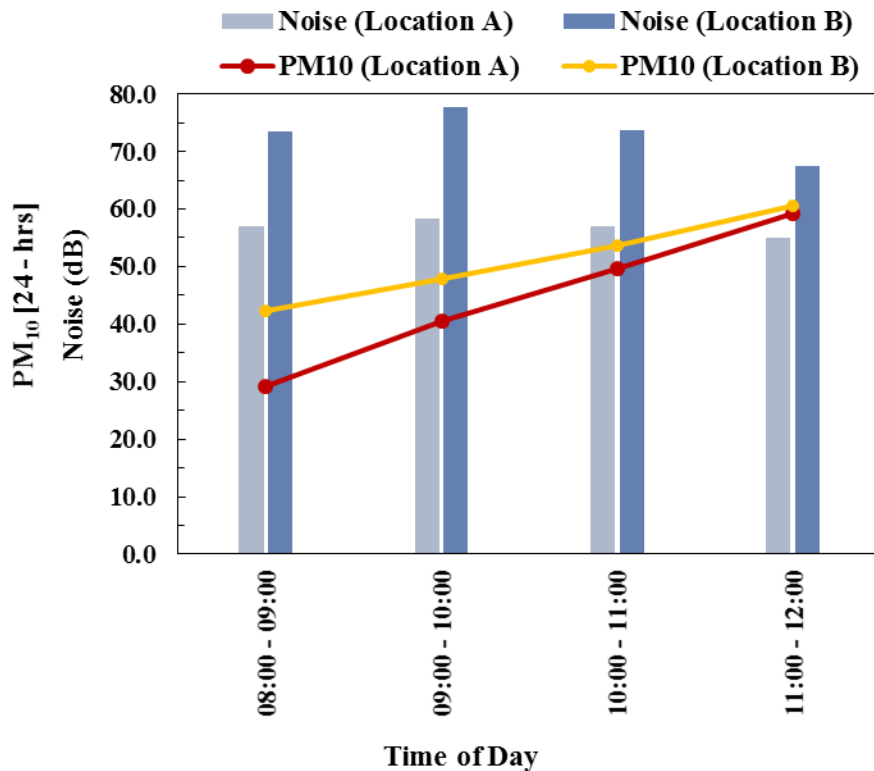


Figure II: Comparisons of trends of hourly concentrations of Noise and PM<sub>10</sub> at two different locations of the construction site on Sep 27, 2017

## Recommendations

1. Development of a “chip-size” IEMD in further research can be integrated with smartphones which can enhance the performance and accuracy of the system as well as the operational benefits;
2. Seminars, workshops, and training on the integrated system of the IEMS to increase awareness of health safety in the working environment;
3. Further analysis of the data collected from different types of construction work as well as at different construction stages can be studied to devise effective guidelines for sustainable and environmental friendly construction.

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