Decision Support for for Sustainable Renovation Strategies Aiming at Energy-Efficiency Gains

Abstract

Restoring and retrofitting existing building stock supports excellent opportunities to improve the energy efficiency of buildings and reduce their CO_2 emissions by making smart energy-saving choices. Furthermore, it is necessary that buildings work efficiently and provide the best working environment for occupants.

However, most old buildings exhibit energy wastage because of unsuitable control systems and malfunctioning building elements. In order to attain cost savings and make occupants comfortable in the long term, technical renovation is promoted as a potential solution to these issues.

Computerised tools are capable of gathering and organising information which can provide the kind of overview required. Building Information Modelling (BIM) is a suitable technology enabling storage and management of building data during its life cycle that can be used to analyse Building Performance.

The purpose of this research is to develop an energy simulation model for buildings in need of renovation. Additionally, real-time data from wireless sensors and Building Performance Monitoring Data of the Building Management System will be used for the calibration of the energy simulation model.

Approach

The 3D Geometry and Topology, Material Specifications, Inventory Items etc. were modelled and stored in a dedicated tool for Building Information modelling. Model data for the HVAC and lighting system were added. An integrated plug-in for Energy Simulation was used to simulate the energy consumption and define a certain level of thermal comfort.

Data retrieved from Building Management Systems was used to support data analysis which generated a clear picture about how a building is performing. This data was used to support two research aspects:

(1) To provide decision support for the planning of renovation activities through the usage of calibrated energy simulation models

(2) To provide decision support for the prioritisation of maintenance tasks.

Figure 1: ERI-Building Used for Case Study 2

Case Study 1

The building of the Department of Civil and Environmental Engineering and the building of the Environmental Research Institute, both on the UCC campus, were used as case studies.

The Civil Engineering building is a three storeys structure with 550mm thick, red brick wall covered externally with roughcast, old single glazed windows and very spacious timber roof with two skylights in the middle section.

The ventilation system consists of ventilation shafts running within brick walls reaching the roof where three mechanical ventilation fans were mounted in metal turrets.

Currently, these fans are not operational. The first part of the carbon neutral research is focused on renovation aspects from a structure and materials point of view.

Figure 2: CEE-building

Four scenarios of renovation are taken into consideration:

(1) Renovation of walls by adding an additional layer of external insulation,

(2) Insulation of the roof and attic,

(3) Replacement of old windows with high quality double glazed windows, and

(4) Combining all mentioned scenarios.

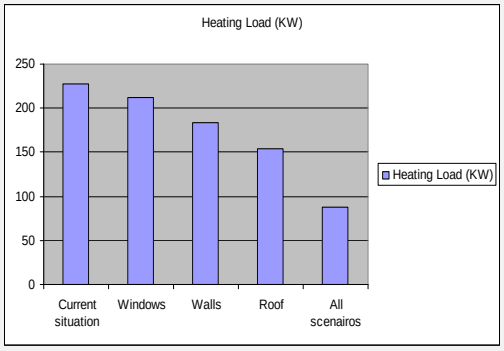

Figure 3: Simulation Results

Case Study 2

The ERI-building is a 3 storey research, It is equipped with a BMS to track various parameters, such as Temperature, Humidity, CO_2, Heat Consumption, Position of Bypass Valves and Position of Under Floor Heating Valves. Real-time data collected from sensors are compared with the simulation results. Results provided by simulation and BMS are quite similar. (3% difference).

Researchers have developed a platform to support facility management activities. Building performance data is monitored, building information can be extracted from BIM. Additional occupancy details are available from an RFID system. An ARIS server is used to supply process information relating to maintenance activities.

To automate the FM tasks, Fault Detection and Diagnosis modules need to detect if or when a failure event is about to occur and to find the solution to solve the event. The Scheduling component can then calculate a schedule according to the preferences, standards, resources and set maintenance tasks collected by the Maintenance Management System. Finally, Building Engineers will be presented with a set of tasks and information describing the renovation and maintenance tasks required

Contact

IRUSE Researcher:
Hang Yin, MEngSc,
2.12, Western Gateway Building,
Western Rd.,
Cork, Ireland

Mentor:
Prof. Karsten Menzel
University College Cork
Informatics Research Unit
for Sustainable Engineering
CORK, Ireland
k.menzel@ucc.ie

UCC University College Cork, Ireland Coláiste na hOllscoile Corcaigh | School of Engineering

http://zuse.ucc.ie/yin