Development of a Decision Support System for the Design of Good Indoor Air Quality in Office Buildings

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ABSTRACT

Office buildings are complex entities. Design decisions can affect the quality of the indoor air (IAQ) throughout the life of the building. Poor IAQ affects approximately 30% of all office buildings and is ranked within the five greatest risks to human health in developed countries.

Despite a vast and growing body of scientific literature on IAQ, there is a large gap between the current knowledge and the application of this knowledge in building practices. The USA Environmental Protection Agency identified a high priority need for design and educational tools to assist building designers who are not experts in IAQ issues to create healthy buildings. In this study a Decision Support System (DSS) for the design of good IAQ in office buildings was developed.

The DSS leads building designers through a structured question database on building attributes that affect IAQ. Full justification for each design decision is given in order to prompt designers to select building features that lead to low indoor concentrations of volatile organic compounds, gaseous pollutants, microbiological contaminants and respirable particulates. The DSS was developed for new office buildings in New Zealand conditions, with either natural or mechanical ventilation.

An exisiting methodology for the development of DSS was used. The problem was approached from the perspective of the building users under the broad headings of site and external factors, building envelope, building infrastructure, interiors, and heating ventilating and air-conditioning. Each of these topics was subdivided into finer layers of detail until conclusions on the potential impact of each building element on the IAQ could be inferred.

The hierarchy for decision-making placed highest priority on the elimination or reduction of pollutants at source. Opportunities for pollutants to enter from outside

or spread within the building were also controlled. If either of these strategies were not found acceptable, then mitigation techniques were recommended.

A panel of independent national and international experts validated the DSS for correctness and completeness. The reviewers reported that the system was very comprehensive, drew correct conclusions and would assist building designers without IAQ expertise, to design office buildings with good IAQ. The DSS was also considered to have a significant educational component for users.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AHU	Air handling unit
AI	Air intake
ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers
BRI	Building related illness
CAV	Constant air volume
CFD	Computation fluid dynamics
CIB	Council for Research and Innovation in Building and Construction
DSS	Decision support systems
EPA	Environmental Protection Agency
ES	Expert system
ETS	Environmental tobacco smoke
HEAD-Start	Healthy Environments – Alternative Designs
HEPA	High efficiency particulate air
HSE	Health and Safety in Employment Act
HVAC	Heating ventilating and air conditioning
IAQ	Indoor air quality
ISIAQ	International Society of Indoor Air Quality and Climate
MMMF	Man-made mineral fibre
NIOSH	National Institute of Occupational Safety and Health
PM	Particulate matter
PM_{10}	Particulate matter within the size range less than 10μm
$PM_{2.5}$	Particulate matter within the size range less than 2.5μm
$PM_{7.5}$	Particulate matter within the size range less than 7.5μm
RA	Return air stream
SA	Supply air stream
SBS	Sick building syndrome
SVOC	Semivolatile organic compounds
TLV	Threshold limit values
TVOC	Total volatile organic compounds
VAV	Variable air volume
VDT	Visual display terminals
VOC	Volatile organic compounds
VVOC	Very volatile organic compounds
WHO	World Health Organisation