

**DEVELOPMENT OF A HYBRID AIR PURIFICATION  
UNIT FOR THE INDOORS IN TROPICS**

Koongamuwe Gedara Nilanka Harshani Weerasinghe

208093C

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Thesis submitted in partial fulfillment of the requirements for the degree  
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December 2023

## DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: ***UOM Verified Signature***

Date: 31/12/2023

The above candidate has carried out research for the PhD/MPhil/Masters thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Prof. R.U. Halwatura

Signature of the Supervisor:

Date:31/12/2023

## **DEDICATION**

"May this thesis serve as a reminder that with determination and hard work, one can achieve their goals. This accomplishment is not just mine; it's a testament to the love and support of all around me, and it's dedicated to each of you.

This thesis symbolizes not only the result of my academic accomplishments but also the embodiment of the affection, encouragement, and faith that enveloped me during this profound journey. Therefore, it is dedicated to my loving family for their unwavering love, support, and encouragement throughout this journey. Your sacrifices and belief in me have been my greatest motivators.

To my devoted husband, I extend to you equal acknowledgment for this achievement, and I offer this thesis as a testament to your immense support and affection. This accomplishment is not exclusively mine but rather a collective triumph that we commemorate together.

To my beloved children, I dedicate this thesis with all my heart. Your presence in my life has been a constant source of inspiration and motivation. Your innocence, curiosity, and boundless love have sustained me throughout this academic journey.

To my friends and colleagues, for the countless discussions, late nights, and shared experiences that have enriched my academic and personal life.

To the countless individuals who have participated in my research, your contributions have been essential to the completion of this work.

To the future generations of scholars and thinkers, may you find as much joy and fulfillment in your academic endeavors as I have found in mine.

This thesis is dedicated to all of you, with heartfelt gratitude.

## ACKNOWLEDGEMENT

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I would like to express my deepest gratitude to my loving parents, husband, my two daughters, sister and her husband, and my mother-in-law for their unwavering belief in me and their endless encouragement. Your love and support have been my constant motivation.

To everyone who played a role in this research endeavor, your contributions have not gone unnoticed and have left an indelible mark on my academic and personal growth. Thank you all for being an integral part of this remarkable achievement."

## ABSTRACT

Indoor air pollution poses a critical concern in today's world, influenced by various factors. Ensuring a safe indoor environment demands addressing the profound impact of pollution. Multiple strategies have been deployed to mitigate indoor air pollution, with a focal point emerging as biofiltration using indoor plants. This prompted a thorough exploration into the capacity of NASA-recommended indoor plants, which had undergone minimal experimentation in tropical climates. Simultaneously, an assessment was made on the efficacy of indigenous herb plants in curbing indoor air pollution. The plant selection process involved using a plant selection matrix to identify the most suitable plants for the study. Individual plant performances were rigorously tested within controlled chamber studies, evaluating their abilities to reduce carbon dioxide and other pollutant gases. The net performance of plant leaf area in carbon dioxide assimilation was measured and compared, resulting in a ranking of plants based on their performances. Among these categories, the Peace Lily (*Spathiphyllum blandum*) and Thippili (*Piper longum*) plants emerged as the top performers. Using these selected plants, a hybrid air purification unit was innovated, combining natural plant-based purification with modern technology and additional functionalities. Subsequently, the actual-scale performance of this developed system was assessed to determine its environmental sustainability. A comprehensive questionnaire was employed to gauge the social sustainability aspect. The plants' performances were also evaluated in air-conditioned settings, followed by an economic comparison to ascertain practical feasibility. The culmination of these endeavors has revealed that employing specific combinations of indoor plants facilitates achieving desired indoor air quality levels, particularly in terms of reducing carbon dioxide levels. This practice is beneficial economically and is highly recommended for indoor spaces where individuals spend approximately 90% of their time. Ensuring indoor safety becomes paramount, and this Hybrid Air Purification Unit not only contributes to energy savings and enhances environmental air quality but also encompasses the immeasurable aesthetic and therapeutic effects of plants.

**Keywords:** Air Purification, Carbon Dioxide, Hydroponic Cultivation, Indoor Air Quality, Indoor Plants

# TABLE OF CONTENTS

DECLARATION .....	i
DEDICATION .....	ii
ACKNOWLEDGEMENT .....	iii
ABSTRACT.....	iv
TABLE OF CONTENTS.....	v
LIST OF FIGURES .....	ix
LIST OF TABLES .....	xiv
LIST OF ABBREVIATIONS .....	xv
LIST OF APPENDICES .....	xvi
1. INTRODUCTION .....	1
1.1 Research Gap .....	3
1.2 Objectives.....	5
1.3 Methodology .....	6
1.4 The main findings .....	9
1.5 The arrangement of the report.....	10
2. LITERATURE REVIEW.....	11
2.1 Global aspects of Air Pollution and Indoor Environmental Quality .....	12
2.2 Indoor Air purification Mechanisms .....	14
2.3 Nature Based solutions for Indoor Air Purification .....	16
2.4 Use of indoor plants and their ability in bio filtration.....	16
2.5 Vertical Gardening as the best method for indoor plant arrangement in limited spaced buildings.....	24
2.6 Categories of Vertical Gardening Systems.....	28
2.7 Vertical Gardening System and it's sustainability aspects .....	30
2.7.1 Environmental Sustainability .....	32
2.7.2 Economic Sustainability.....	33
2.7.3 Social Sustainability.....	34
2.8 Hybrid Air purification .....	35
2.9 Chapter Summery.....	36

3.	OCCUPANT PERCEPTION ON VERTICAL GREENERY SYSTEMS .....	37
3.1	Perception Evaluation Survey of people on Vertical Gardening .....	37
3.2	Sample Selection and collecting responses .....	38
3.2.1	Gender distribution.....	38
3.2.2	Age variation.....	39
3.2.3	Living area .....	39
3.2.4	Education level.....	40
3.2.5	Current employment state .....	41
3.2.6	Family monthly income .....	41
3.2.7	General awareness of urban vertical gardening .....	42
3.2.8	Way of practicing home gardening .....	43
3.2.9	Relationships between demographic factors and home gardening practice	45
3.2.10	The correlation between respondents' demographic factors and their awareness of vertical gardening .....	46
3.2.11	Relationship between demographic factors of respondents and the practice of vertical gardening.....	47
3.2.12	Respondents' overall perception about the system .....	49
3.3	Chapter Summery.....	51
4.	PLANT SELECTION .....	52
4.1	Total plant list summarized based on the literature .....	53
4.2	Plant Selection matrix .....	60
4.2.1	Literature Review.....	60
4.2.2	Information Analysis.....	61
4.2.3	Matrix Development .....	62
4.2.4	Plant Selection based on developed matrix.....	64
4.3	Local herb plants as a possible alternative to NASA-recommended plants under tropical climatic conditions.....	65
4.3.1	What are the “herbaceous plants?”.....	65
4.3.2	What are the “Native plants”?.....	65
4.3.3	Potential of Native Herbaceous Plants in Phytoremediation .....	66
4.3.4	Selecting native herbaceous plants for the study .....	67
4.5	Acclimatization of selected plants before the testing.....	68



4.6	Chapter Summery .....	70
5.	PLANT PERFORMNCE EVALUATION AND PROTOTYPE DEVELOPMENT .....	71
5.1	Measuring the Carbon Dioxide absorption capacities of Plants.....	72
5.1.1	Data Analysis .....	75
5.2	Observed Net CO <sub>2</sub> Emission Patterns of NASA- Recommended Plants.....	78
5.3	Impact of Light Level on CO <sub>2</sub> Removal of Plants .....	85
5.4	Variation between Plant Species in CO <sub>2</sub> Assimilation.....	85
5.4.1	Light Response Curves of Studied Plant Species .....	87
5.5	Observed Net CO <sub>2</sub> Emission Patterns of Local Herb Plants .....	90
5.6	CO <sub>2</sub> absorption capacity with chamber modification.....	95
5.7	Plant performances under different light colour.....	103
5.7.1	Red Light: .....	103
5.7.2	Blue Light: .....	103
5.7.3	Green Light: .....	104
5.7.4	LED Grow lights .....	104
5.8	Variation in Leaf relative chlorophyll content and the leaf thickness with the age of the plant .....	107
5.9	Volatile Organic Compound absorption by different plant species .....	109
5.9.1	Measuring VOC reduction capacity of plants .....	111
5.10	Prototype Development of Hybrid Air Purification System .....	117
5.10.1	Prototype 1 .....	118
5.10.2	Prototype II .....	125
5.11	Chapter Summary .....	129
6.	SOCIAL, ENVIRONMENTAL AND ECONOMIC EVALUATION.....	130
6.1	Social Sustainability.....	131
6.1.1	Perception of building occupants towards Hybrid Air Purification Unit 131	
6.2	Environmental Sustainability .....	139
6.3	Economic Sustainability.....	147
6.3.1	Basic steps of economic Feasibility Calculation.....	148
6.3.2	Cost calculation for occupant/s inside an Air-conditioned room (Case X) 149	

6.3.3	Cost calculation occupant/s inside an Air-conditioned room with increasing inside CO <sub>2</sub> levels (Case Y) .....	150
6.3.4	Cost calculation for occupant/s inside an Air-conditioned room with successfully implemented Hybrid Air Purification Unit (Case Z).....	151
6.4	Chapter Summary.....	155
7.	CONCLUSIONS AND RECOMENDATIONS .....	156
7.1	Conclusions .....	156
7.2	Recommendations .....	158
7.3	Future Work .....	159
	REFERENCES.....	160
	APPENDICES .....	174

## LIST OF FIGURES

Figure 1.1 Flow chart of the research methodology .....	7
Figure 2.1 Summary of literature referred in order to study the various Building Integrated Vegetation (BIV) systems.....	24
Figure 2.2 Vertical greening system designed by Malaysian research team to improve indoor air quality, in Malaysia (Khean et al., 2022) .....	25
Figure 2.3 Schematic of an indoor air biofilter, Canada Life Assurance Company, Toronto, (Dave and Mike, 2015).....	26
Figure 2.4 Landscaped system installed to substitute limestone coating of the wall, in Spain (Andreu et al., 2019) .....	27
Figure 2.5 A Vertical Greening Systems situated at Qingdao University of Technology in Qingdao, China .....	28
Figure 2.6 Classification of green walls, according to their construction characteristics (Manso, 2015) .....	29
Figure 2.7 Types of Vertical Gardens (a) Direct green façade (b) Indirect green façade (c) Living wall system.....	30
Figure 3.1 Gender distribution of the sample.....	38
Figure 3.2 Age variation of the sample in years .....	39
Figure 3.3 Living area of the respondents.....	40
Figure 3.4 Educational level of the respondents .....	40
Figure 3.5 Current employment state of the respondents .....	41
Figure 3.6 Family monthly income of respondents .....	41
Figure 3.7 Respondents who are practicing home gardening vs those who are not practicing at the moment.....	42
Figure 3.8 Reasons for not practicing home gardening .....	42
Figure 3.9 Various home gardening practices among the respondents.....	43
Figure 3.10 Home gardening practice according to living area.....	43
Figure 3.11 Respondents who are currently knowledgeable about vertical gardening .....	44
Figure 3.12 Respondents currently engaged in vertical gardening and those not involved in vertical gardening.....	44
Figure 3.13 Various vertical gardening practices among the respondents.....	45
Figure 3.14 Respondent's perception about the system .....	49
Figure 3.15 Respondent's perceptions about drawbacks of the system.....	50

Figure 4.1 Plants purchased from Royal Botanical Garden Peradeniya with equal size and the age.....	68
Figure 4.2 The potting mix recommended by the Royal Botanical Garden for ornamental plants .....	69
Figure 4.3 The size of the pots used for transplanting .....	69
Figure 4.4 The plants under 50% shading material.....	70
Figure 5.1 The experimental glass chamber prepared for the data collection .....	72
Figure 5.2 Measuring the air tightness of the experimental chamber over 24hrs of period.....	73
Figure 5.3 The experimental chamber sealed with clay.....	73
Figure 5.5 : The airtight glass chamber of volume 0.324m <sup>3</sup> used as the experimental chamber for the study. (a) Graphical illustration (b) before insulation (c) after insulation (Front cover is opened)(a) .....	74
Figure 5.5 : The airtight glass chamber of volume 0.324m <sup>3</sup> used as the experimental chamber for the study. (a) Graphical illustration (b) before insulation (c) after insulation (Front cover is opened)(a) .....	74
Figure 5.6 The airtight glass chamber of volume 0.324m <sup>3</sup> used as the experimental chamber for the study. (a) before insulation (b) after insulation.....	74
Figure 5.7 (a), (b) Digital CO <sub>2</sub> Meter with data logging facility; (c) Lux meter .....	75
Figure 5.8 (a), (b), (d) Top view of the experimental chamber when the plants are kept inside .....	76
Figure 5.9 The setup designed to measure the CO <sub>2</sub> emissions by the potting mix over a continuous 24-hour period .....	77
Figure 5.10 CO <sub>2</sub> emission rate by the potting mix over 24 hours period.....	78
Figure 5.11 Actual CO <sub>2</sub> Change within the chamber when a plant potted in the growth medium.....	79
Figure 5.12 Net CO <sub>2</sub> contribution only by the plant .....	79
Figure 5.13 Net impact on CO <sub>2</sub> concentration by <i>Sensevieria trifasciata</i> .....	80
Figure 5.14 Net impact on CO <sub>2</sub> concentration by <i>Dracaena fragrans</i> .....	81
Figure 5.15 Net impact on CO <sub>2</sub> concentration by <i>Phylodendron hederaceum</i> .....	82
Figure 5.16 Net impact on CO <sub>2</sub> concentration by <i>Spathiphyllum blandum</i> .....	83
Figure 5.17 Net impact on CO <sub>2</sub> concentration by <i>Chlorophytum comosum</i> .....	84
Figure 5.18 Net impact on CO <sub>2</sub> concentration by <i>Aglaonema Communtatum</i> .....	84
Figure 5.19 Light Response Curves of Studied NASA recommended Plant Species	88

Figure 5.20 Net impact on CO <sub>2</sub> concentration inside the chamber by <i>Kalanchoe pinnata</i> , “Akkapana” under different light levels.....	90
Figure 5.21 Net impact on CO <sub>2</sub> concentration by <i>Plectranthus zatarhendi</i> , “Iriweriya” .....	91
Figure 5.22 Net impact on CO <sub>2</sub> concentration by <i>Munronia pinnata</i> , .....	92
Figure 5.23 Net impact on CO <sub>2</sub> concentration inside the chamber by <i>Costus speciosus</i> , “Thebu” .....	92
Figure 5.24 Net impact on CO <sub>2</sub> concentration by <i>Piper longum</i> ”, “Thippili .....	93
Figure 5.25 The grid method used for the plant leaf area calculations .....	95
Figure 5.26 The principal behind the modified experimental chamber .....	96
Figure 5.27 The modified chamber in order to eliminate the effect of potting medium .....	97
Figure 5.28 The performances of <i>Spathiphyllum blandum</i> and <i>Piper longum</i> after chamber modification.....	98
Figure 5.29 Regression Analysis results of eace lilly with respect to Lux level. ....	99
Figure 5.30 Regression Analysis results of Thippili with respect to Lux level .....	100
Figure 5.31 The performances of <i>Spathiphyllum blandum</i> ; natural day vs altered day .....	101
Figure 5.32 The performances of <i>Piper longum</i> ; natural day vs altered day .....	102
Figure 5.33 The performance of <i>Spathiphyllum blandum</i> under different combinations of light colour.....	105
Figure 5.34 The performance of <i>Piper longum</i> under different combinations of light colour.....	105
Figure 5.35 (a) Leaf yellowing of <i>Chlorophytum comosum</i> after 24hr test period under 2000 lux level, (b) Leaf damages observed in <i>Philodendron hederaceum</i> when the leaves touch the chamber walls under high humid condition .....	106
Figure 5.36 The variation of Relative Chlorophyll Content along with the age of <i>Piper longum</i> and <i>Spathiphyllum blandum</i> .....	108
Figure 5.37 The variation of leaf thickness along with the age of <i>Piper longum</i> and <i>Spathiphyllum blandum</i> .....	108
Figure 5.38 Performance of <i>Spathiphyllum blandum</i> in VOC absorption.....	112
Figure 5.39 Performance of <i>Draena fragrans</i> in VOC absorption .....	113
Figure 5.40 Performance of <i>Phylodendron</i> in VOC absorption.....	114
Figure 5.41 Performance of <i>Piper longum</i> in VOC absorption .....	114

Figure 5.42 Summery of the percentage absorbances of VOC by each plant under different light levels .....	115
Figure 5.43 Mixed Coir Chips (a) and Cor dust (b) in 1:1 ratio (c).....	120
Figure 5.44 The sketch of the Vertical Gardening system prototype I .....	121
Figure 5.45 Developed structure of the prototype 1 .....	122
Figure 5.46 The completed Hybrid Air Purification Unit _ Prototype 1 .....	123
Figure 5.47 Daily monitoring of the developed system located in Air-Conditioned room .....	123
Figure 5.48 The dashboard used in the prototype I.....	124
Figure 5.49 The temperature, RH and the lux level displaying panel.....	125
Figure 5.50 Emission of CO <sub>2</sub> by each possible growth media for the developed prototype .....	126
Figure 5.51 The hydroponic set up used for the prototype II .....	127
Figure 5.52 Standing type of the Vertical Gardening Setup with pipe connection suitable for hydroponic media.....	127
Figure 5.53 Hanging type of the Vertical Gardening Setup with tray connection suitable for solid growth media.....	128
Figure 6.1 Two identical air conditioning rooms used Room A is without VGS and room B is with VGS.....	131
Figure 6.2 The two identical rooms used for the survey of the building occupants located in Department of Civil Engineering, University of Moratuwa.....	132
Figure 6.3 A building occupant while participating to the survey.....	133
Figure 6.4 Gender distribution among the study sample .....	134
Figure 6.5 Age distribution among the study sample .....	134
Figure 6.6 The occupants' feeling about the air quality of the room.....	135
Figure 6.7 The occupants' feeling on visual appearance of the room .....	135
Figure 6.8 Occupants' preference to work in this setup continuously without a break .....	136
Figure 6.9 Overall feeling of the occupants about the room.....	136
Figure 6.10 Awareness about the plant-based air purification prior to this survey .	137
Figure 6.11 Occupant's willingness to accept the unit .....	137
Figure 6.12 Hydropic media-based Air purification unit using Pease Lily .....	139
Figure 6.13 Hydropic media-based Air purification unit using Thippili .....	140
Figure 6.14 Interior of the single person bed room.....	141

Figure 6.15 Interior of the dual person bed room .....	141
Figure 6.16 Selected study area for the real scale data collection .....	142
Figure 6.17 Variation in CO <sub>2</sub> level within a sealed room with a single occupant ...	144
Figure 6.18 The CO <sub>2</sub> level variation in single room with the presence of Peace Lilly .....	145
Figure 6.19 Single-person bedroom data with Thippili plants using VGS .....	145
Figure 6.20 The CO <sub>2</sub> level variation in double room with the presence of Peace Lilly .....	146
Figure 6.21 The CO <sub>2</sub> level variation in double room with the presence of Thippili	147
Figure 6.22 Model of the single room created using design builder.....	149
Figure 6.23 The single room setup used for the simulation.....	151

## LIST OF TABLES

Table 2.1 The list of indoor plants summarized based on literature considering their previously reported ability to reduce air pollutants.....	18
Table 3.1 Respondents currently practicing home gardening according to socio demographic profile .....	45
Table 3.2 Respondents' knowledge regarding vertical gardening among different demographic factors .....	46
Table 3.3 Respondents currently practicing vertical gardening along with their sociodemographic profile.....	47
Table 3.4 Agronomic Practices that the respondents like to use with VGS .....	48
Table 3.5 Respondent's preference regarding the features of VGS among different age groups.....	48
Table 4.1 The list of indoor plants that have been reported in the literature for their ability to reduce air pollutants.....	54
Table 4.2 Developed plant selection Matrix .....	63
Table 4.3 The selected pant varieties with their scientific name, common names and the relative importance.....	64
Table 4.4 List of native plants selected.....	67
Table 5.1 Average CO <sub>2</sub> emission rates of tested indoor plants per leaf area per hour .....	86
Table 5.2 Average CO <sub>2</sub> emission rates of local herb plants per leaf area per hour (n=3) .....	94
Table 5.3 Relative CO <sub>2</sub> absorption by Peace lily.....	99
Table 5.4 Relative CO <sub>2</sub> absorption by Thippili.....	100
Table 6.1 Basic details of the survey .....	132
Table 6.2 The required parameters of both room A and B .....	143
Table 6.3 Cost calculation For Case X .....	149
Table 6.4 The cost calculation for Case Y .....	150
Table 6.5 CO <sub>2</sub> absorption by plants per 1m <sup>2</sup> leaf area .....	151
Table 6.6 Initial cost calculations .....	152
Table 6.7 Running cost calculation.....	152
Table 6.8 Maintenance cost calculation .....	152
Table 6.9 Total cost calculation .....	153
Table 6.10 Required plant area calculations .....	153



Table 6.11 Cost calculation as per the customer requirement .....	153
Table 6.12 Cost Estimations of the VGS .....	154

## LIST OF ABBREVIATIONS

<b>Abbreviation</b>	<b>Description</b>
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
BIV	Building Integrated Vegetation
BRI	Building Related Illnesses
CAM	Crassulacean Acid Metabolism
CO <sub>2</sub>	Carbon Dioxide
IoT	Internet of Things
HVAC	Heating, Ventilation, and Air Conditioning
IAQ	Indoor Air Quality
IEQ	Indoor Environmental Quality
LED	Light Emitting Diode
LCP	Light Compensation Point
LRC	Light Response Curve
NASA	National Aeronautics and Space Administration
PAR	Photosynthetically active radiation (wavelengths 400 to 700 nm)
PPM	Potted-Plant Microcosm
ppm	Parts per million; 1/10 <sup>6</sup> of medium; e.g., μL/L air; mg/kg soil
SBS	Sick Building Syndrome

## LIST OF APPENDICES

<b>Appendix</b>	<b>Description</b>
Appendix A	Simple Questionnaire - Perception Evaluation Survey of people on Vertical Gardening
Appendix B	Plant Selection Matrix
Appendix C	The data output from the CO <sub>2</sub> data logger obtained for Aglonema (Example)
Appendix D	Questionnaire on hybrid Air Purification System
Appendix E	Regression Analysis results of Peace Lily and Thippili
Appendix F	Real scale CO <sub>2</sub> data collection (Example)
Appendix G	Design Builder output file
Appendix H	Cost Calculation