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Challenges of Urban Home Gardens: Perspectives on Vertical Living Walls as an Alternative in Colombo, Sri Lanka

Amandra Senalankadhikara[a*], C. D. Udawatthe[b], Prathap kaluthanthri[c]

[a] *Research Assistant, University of Sri Jayawardenepura, Sri Lanka*
[b c] *Senior lecturer, University of Sri Jayawardenepura, Sri Lanka*

Abstract

Due to significant urbanization, Colombo is vulnerable to rising temperatures due to the lack of green spaces, development of construction and other explicit problems. The concept of home gardens could be a solution for a sustainable livelihood. A research survey has been conducted to study and identify the garden experiences among residents of 13 Colombo District Secretariats. The "Statistical Package for the Social Sciences" (SPSS) program 17.0 and Microsoft Excel are used to analyze the data and 100 responses were selected. 85% of participants occupy a garden space, however, results show a high percentage of unavailability of garden space and above-ground garden spaces around Colombo city. 70% of the participants are familiar with LWs but their perception is low due to the Cost, and maintenance. Nevertheless, 52% of the individuals agreed with the fact that LWs can be implemented in affordable ways which are easy to install, use or maintain.

Keywords: Colombo DS; Living walls; perception; Urban Gardening; User Survey

Introduction

Through appropriate architectural designs, it is now necessary to make better use of the earth's finite resources. Never before has it been clearer than it is now. Informally planned regions of the capital can be adopted in a sustainable environmentally friendly manner in order to deal with the concrete jungle. It was estimated that by 2030, 70% of the Sri Lankan population will live in urban areas according to a climate vulnerability assessment by the Ministry of Environment. However, this expansion may bring numerous problems such as environmental and air pollution which increased due to rising commercial industries and vehicular traffics. Construction, food storage, and transportation, all contribute significantly to greenhouse gas emissions (Dubbeling, 2015).

In 2015, the per capita value for green space in Colombo city was recorded as 7.16m2 which is lower than the WHO standard of 8m^2 (Li & Pussella, 2017). Also, the per capita green space that was demarcated by United Nations (UN) should be more than 30m2 and European Union (EU) declared a minimum value of 26m^2 (Khalil, 2014) in any city. A study on the per capita green space shows a drastic decline in the green area of the Colombo district, from 272.361 m^2 to 248.811 m^2 (Figure 1). There has been a significant change in the Kaduwela, Moratuwa, and Maharagama DSDs, and Avissawella, Homagama, and Padukka show an improvement (Lin & Pussella, 2016). The conclusion that follows is that Colombo is not in a secure position with regard to protecting its green spaces.

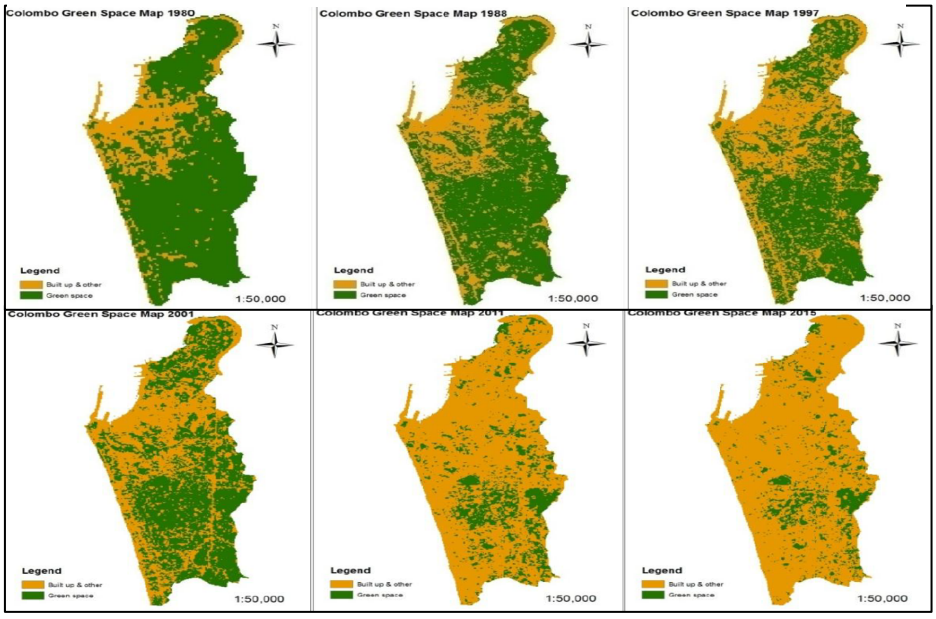
**Corresponding author: amandra.gayathri@gmail.com*

Home gardens occupy more than 13% of the land area in Sri Lanka (Yapa, 2018). Plots owned by individuals can be indicated as 'Home gardens', and are used for various tenacities (Mattsson et al., 2017). These gardens bring numerous benefits to people and the environment in terms of cross-functionality and complexity in the structure. According to the Global Hunger Index of 2021, Sri Lanka is in the "moderate" category (Global Hunger Index, 2022) and the growth of home gardens can be a win-win approach to the food shortage and sustainable community-level socioeconomic activities.

Nevertheless, Governmental and corporate initiatives have recently resulted in the emergence of numerous projects around the urban metropolis with the aim of making it greener. One of the significant developments in this field is the use of green walls, for the reduction of energy consumption, carbon emissions, and urban temperatures in major metropolitan areas. Vertical green walls are a trend that Colombo has also embraced and this requires a strong understanding of the advantages of green walls and facades throughout Colombo from an economic, social, and environmental perspective. By utilizing these possibilities, a suitable ratio of green spaces can be attained in these locations.

In megacities like Colombo, "living walls" can be a substantial effort to enhance the urban environment in terms of both aesthetics and ecology. "Living walls" can be a significant effort to improve the urban environment in megacities like Colombo in terms of both aesthetics and ecology. Despite all these advantages, residential dwellings reflect a low profile in implementing living walls. This may be the reason for the lack of knowledge of the advantages of living walls. By assessing the individuals' knowledge and the perception of living walls' aesthetic values and performances, this gap can be replenished.

Figure 01: Colombo Green area map from 1980-2015



Source: Li & Pussella (2017)

The Objective of the Study

The purpose of this study is to survey individuals' experiences in home gardening in the urban context of Colombo District. Also, it aims to understand the perception and acceptance of vertical living walls as an alternative approach concerning the matter of inadequate space for gardening. The survey consists of 21 questions looking at the following aspects:

- Demographic data focusing on the location, age, employment nature
- Individuals' information about tenancies
- Available garden experiences
- Awareness of the vertical garden concept
- Perception toward vertical living walls
- Attitudes towards future acceptability on vertical living walls

The study emphasizes how crucial it is to accurately determine people's precise requirements when creating urban integrated sustainability concepts.

Literature Review

Green Facades and Living wall systems

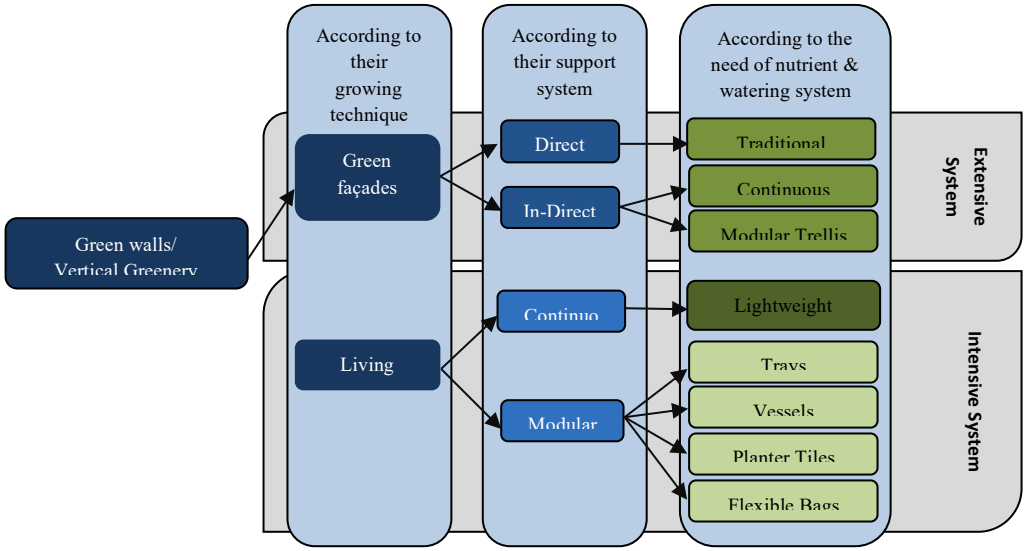
All types of green wall surfaces are referred to as 'Green Walls', which are also known as "Vertical Garden" in some studies (Udawattha, et al., 2022). It is the outcome of covering vertical surfaces in plants that are either rooted into the ground, in the wall material itself, or in modular panels attached to the facade. According to their growing method, it can be divided into "Green Facades" and "Living Walls" systems (Costello, et al., 2009), as shown in Figure 2. Climbers that are directly connected to the building surface or supported by cables or trellises are categorized as 'Green Facades' (Köhler, 2017).

Numerous materials, including steel (coated steel, stainless steel, galvanized steel), and various types of wood, plastic, or aluminium, can be used as support for climbing plants in the case of an indirect greening system, where cables or meshes support vegetation. At various heights of the façade, indirect greening systems can be integrated with planter materials. If the rooting space is insufficient, the system will need nutrients and a watering system separately (Dunnett & Kingsbury, 2008). These systems, which are also referred to as "Green Walls" or "Bio-Walls," are built using modular panels that each contain their soil or other artificial growing environments. They are based on hydroponic culture, which uses balanced nutrient solutions to meet all or some of the food and water needs of the plants (Stav, 2016). Likely Green roof systems, Extensive Systems of Green Walls, which are simple in installation and require little ongoing maintenance, and Intensive Systems, which require more difficult installation and extensive upkeep, can be distinguished from one another (Jonathan, 2003) (Figure 3).

Living walls are a relatively new area of innovation in the field of wall cladding. They were designed to make it possible to incorporate green walls into high-rise buildings. To reach higher areas and adapt to all types of buildings, living walls enable rapid coverage of vast surfaces and more uniform growth along the vertical surface (Manson & Castro-Gomes, 2015). Additionally, a wider variety of plant species can be adopted in combination with shrubs and grasses and also, and the living wall system helps in creating artistic patterns with plant species which are different in colour, texture, leaves forms, density, strength, and growth (Cheng, et al., 2010). This caters for the formation of new aesthetical perceptions of green walls (figure 4). Vertical gardens are

increasingly regarded as a field of landscape design since they can convey status, wealth, and perceptions of the environment, climate, and surroundings (Swaffield, 2022).

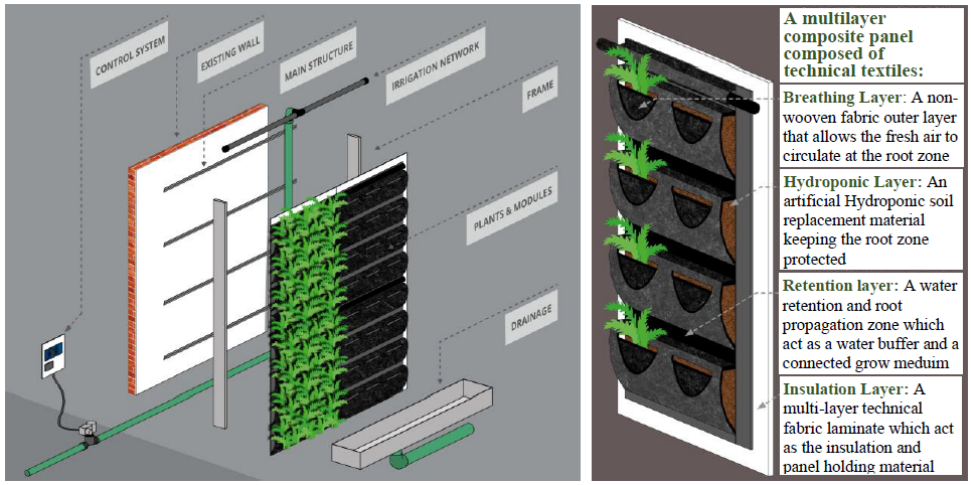
Figure 02: Green Wall classification



Source: Gawad (2018)

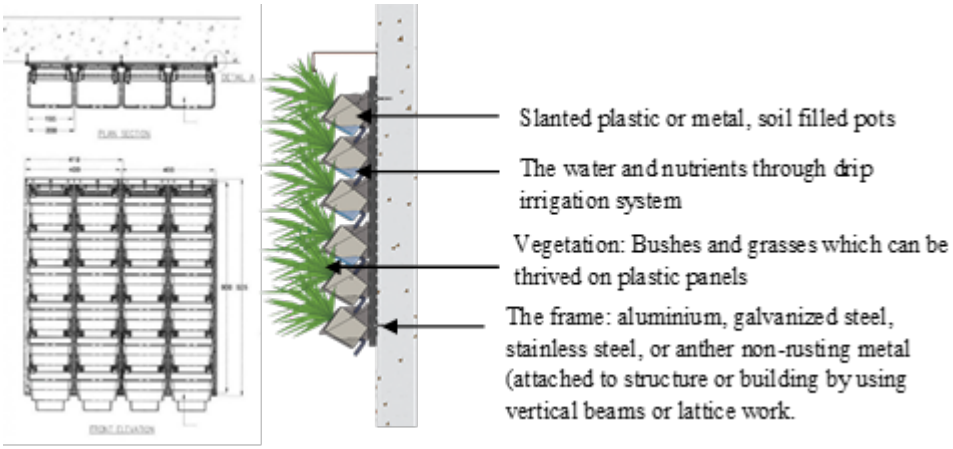
The sustainability of some Living Walls Systems, however, has been called into doubt, according to studies on their life cycles. The total environmental weight can be significantly impacted by variations in the types of materials utilized, their longevity, recycling possibilities, vegetation durability, and water usage. Each green wall system is different and has advantages and disadvantages based on its aesthetic potential, price, and upkeep requirements. The characteristics of the building (orientation, accessibility, height), as well as the climatic conditions, directly influence the choice of the most appropriate system (sun, shade and wind exposure, rainfall) (Gawad, 2018). Consequently, it's critical to comprehend how they differ in composition and their primary characteristics (Surosova, 2015).

Figure 03: Detailed System of Flexible Bag; Living Walls System Base



Source: Gawad (2018)

Figure 04: Detailed Modular Living Wall System



Source: Wall Span, (2017)

Urban Greening challenges in Sri Lanka

The tropical climate of Colombo with significant urbanization growth. The transfer of green spaces to concrete blocks has caused microclimatic changes and phenomena like Urban Hear Island, despite the fact that Colombo has become a popular place to live on. Incorporating vegetation into building envelopes, green walls, or structures that are perpendicular to the ground, can bring back greenery to urban areas. They act as an air purifier, and also it has long-term economic and social advantages, such as low energy usage for cooling systems, and advantages for visiting and enjoying places. Buildings that support a green economy or vertical gardening would be awarded points in the Sustainable Site category of Sri Lanka Green Building Council's (SLGBC), Green SL® Rating System for green building certification. There used to be green walls, but they had to be removed for a number of reasons (Temple Trees boundary wall, Movenpick Hotel, Hilton Colombo Residencies and Shirohana Petal Guru). High maintenance costs were the primary cause (De Silva et al., 2021).

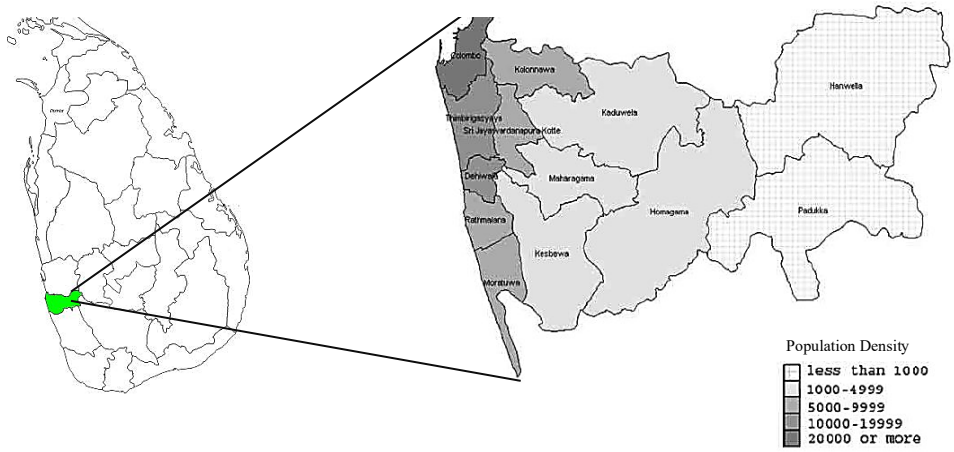
According to Daily Mirror, it was decided to dismantle the green wall at Temple Trees in 2015 because it was costing millions of rupees a month to maintain and was not helping the people or the nation. However, there would have been a resounding achievement and cost savings if the green wall had been correctly planned. Climate (humidity, temperature), orientation, wind, type of vertical gardening system, plants to be used, environmental factors (the surrounding ecology), the height of the building, budget, and level of maintenance are all things that need to be taken into account when thinking about vertical gardening technology. The flexibility to modify, the availability of resources and technology, and the project's timeline must all be taken into account (Tan et al., 2009).

Methods

Context study

The Colombo district consists of 13 Divisional Secretariat Divisions (DS Division), such as Colombo, Dehiwala, Homagama, Kaduwela, Kesbewa, Kolonnawa, Kotte, Maharagama, Moratuwa, Padukka, Rathmalana, Seethawaka and Thibirigasyaya are located in an area of 699 Km^2, have been earmarked for the study (Figure 5). The Colombo DSDs has a higher population density, approximately 2.3 million (Saparamadu, et al., 2018) compared to other districts.

Figure 05: Colombo Divisional Secretariat Divisions



Survey design

A survey has been conducted concentrating on Colombo District's urban population by circulating a questionnaire. The survey study consisted of 21 quantitative and qualitative questions categorized into 3 sections. To grasp direct and understandable responses, the questions had to be concise and simple so that responders could understand and respond to them easily. Also, all questions were in the multiple-choice format to avoid any potential misinterpretation. Several questions were provided with answers where respondents could choose from given choices without spending time to think and write. There are no open-ended questions in the survey, which could make it take longer to complete. Moreover, the questions were composed so that the survey could be completed within 2 to 5 minutes.

The classification of the paper into three sections highlights the following;

- In the first section, the respondent's demographic data were involved and information on the area of residence, gender, nature of the employment and the salary scale.
- In the second section, questions were aimed at personal garden experiences. Respondents were asked to rate their interest in gardening through the Likert scale (with a range of 1 to 10). Also, this section contains sub-sections, where respondents will be questioned about the availability of space for gardening, the area of the garden and reasons for the unavailability of garden space and their impulses toward future gardening. Additionally, the reasons for the resistance to a garden space will be assessed at the end of the section.
- The last section concentrated on the application of 'Living walls' in an urban context where responders' senses and values on living walls were examined respectively. Also, a determining question on how living walls helps in future food crises and respondents were asked to rate their agreement and disagreement on the matter. Moving to preferences of responders towards several plant species from given options, such as vegetables, and herbs. At last, on the question of whether living walls can readily and affordably accommodate future home gardens, respondents were asked to evaluate their agreement and disagreement (strongly agree, agree, undecided, strongly disagree, disagree).

For those residing in the city, the questionnaire was distributed by simple random sampling method in various parts of the Colombo District. The questionnaire survey was shared on Google forms in English language and it took a month (June 2022) to complete the field study of the survey. A total of 100 individuals were chosen as respondents to the survey from 103 responders. To assess the data, 'Statistical Package for the Social Sciences (SPSS) program and Microsoft Excel have been initiated and the results were displayed and analyzed from the collected data.

Results and Discussion

Demographic Data

Colombo City marks the highest responded area representing 17% out of 100 participants. While Dehiwala represents 8%, Homagama 6% and Kaduwela represents 11% of the total. Also, Kesbawa 6%, Kolonnawa represent 2%, Kotte 13%, Maharagama 18%, Moratuwa 5%, Padukka 2% and Ratmalana, Seethawaka and Thibirigasyaya represent 4%,3% and 5% respectively (figure 6).

Moreover, 22% of the participants' age ranged between 16-25 years old, 45% were between 26-35 years old, 17% were between 36-45 years, 10% were between the years of 46-55, while 5% represents the years 56 to 65. Only 1% represents 66 or older years of age. However, out of all the participants 57% were fully employed. Part-time employees and full-time students represent 11% each respectively. 7% were housewives, 5% were business owners, and respondents who are part-time students, interns and retired represent 2% each. Also, 3% were freelancing, unemployed and looking for employment. Furthermore, in figure 9, the survey determined that 76% of participants live in their own houses while 13% live in rented houses, 10% live in apartments and 2% in boarding houses.

Additionally, the data gathered on the number of people living in the household shows a contrast in statistics. No single-person living household within the survey responses. The majority of the households consist of four members with a percentage of 31% of the whole. 22% represent three-person and 19% represent two-person households. Over and above that, 16% and 12% represent five person and six or more person households respectively. Furthermore, 88% have mentioned their salary scale ranging from 1 to 5 and between $1 and $1355. Table 1 concludes that 34.7% of the respondents received a monthly salary between $ 325 and $ 583 representing a mean value of 2.83.

Table 01: Respondents' Monthly Salary Scale

What is your monthly income?					
Options		Frequency	Percent	Valid Percent	Cumulative Percent
Salary scale	1	5	5.0	5.7	5.7
	2	30	29.7	34.1	39.8
	3	35	34.7	39.8	79.5
	4	11	10.9	12.5	92.0
	5	7	6.9	8.0	100.0
	Total	88	87.1	100.0	
Non-respondents		13	12.9		
Total		101	100.0		

The findings of the second section

The survey results show that the rate of interest in gardening ranges with an average mean of 6.4. The majority of the respondents show a medium and a high scale of interest. Out of all the respondents, 40% showed a 0 to 5 lower range of interest while 60% were on a higher scale of interest ranging from 6 to 10.

Furthermore, out of all respondents, 85% possessed a garden space while 12% were not practising gardening. 3% have failed to answer the question. Also, the respondents were asked to indicate the location (figure 8) of their garden space, such as; a) 23% occupy a garden space at the front of the house, b) 12% at the rear side of the house, c) 15% at both front and rear side, d) 10% at the front, rear and sideways, e) 7% represent at balcony and rooftops, f) only at sideways and

courtyards represent 9%, g) at the front, rear, balcony and roof terraces represent 11% respectively.

Figure 06: Participants' responses on the Divisional Secretariat they are live in.

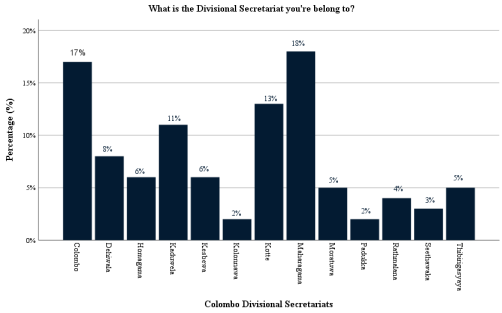


Figure 07: Participants' responses on the area of the available garden space.

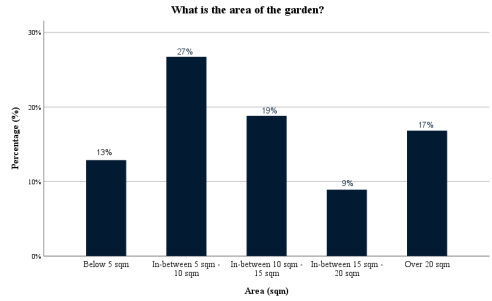


Figure 08: Participants' responses on the location of the garden space

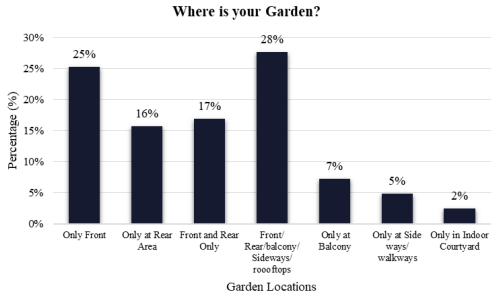


Figure 09: Participants' responses on the type of residencies they are live in

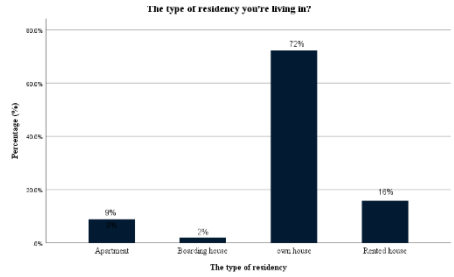


Figure 7 shows the area distribution of garden spaces where the most participants occupy a garden space between 5- 10 sqm of an area. Furthermore, out of 12% who do not occupy a garden space, the main concern of 85% was the unavailability of space to garden. Following, participants highlighted other issues such as maintenance, no permission to garden, time consumption, inadequate light, no access to water and irrigation, and cost are the moderate concerns which take a low percentage compared to the main issue, inadequate space. Moreover, among participants who do not possess a garden space, 92% wished to have one in the future. The rest have concerns about time management, lack of skill and management and hard maintenance.

The findings of the third section

In the third section, individuals were questioned about their familiarity with living walls. However, 70% were familiar with living walls while the rest of the 30% responded as "No'. Another study conducted by Farooq and Kamal concludes that 63% of individuals were familiar with GLW (Green Living Walls) while 24% have a moderate answer and 3% answered 'not at all' in the urban context of Pakistan (Farooq & Kamal, 2020). This shows that the urban population in Colombo has a higher essence on living walls. Furthermore, participants were on the perception of living walls. Figure 10 shows the individuals' knowledge of the cost-of-living wall products in the local market. 17% strongly agreed with the fact that living walls are a high-cost product while 44% agreed, 32% undecided about the fact, 6% disagreed and only 1% strongly disagreed.

The simplicity and the complexity of the structure of the living walls ranged from 1 to 5 where 5 represents the complexity. However, 41% have a moderate mean value and a high percentage towards the complexity. Also, figure 11 shows 99% have responded on their perception of whether living walls need high maintenance. Out of the respondents, 28.3% strongly agreed, 52.5% agreed, 9% disagree and 10% responded with 'No idea'.

Additionally, 68% of the participants agreed with the statement 'with the country's food crisis, do you think Living walls help in food production?' and 8% disagreed and 24% have no idea about the statement. Finally, 99% have acknowledged the statement, 'Do you think living walls can easily accommodate your future home garden affordably?'. 8% strongly agreed, 44% agreed, 40% were undecided, 3% strongly disagreed and only 4% disagreed with the statement. This shows a high demand for living walls where people can implement them at their premises with low-cost products.

Figure 10: Participants' responses on the cost-of-living walls in the market

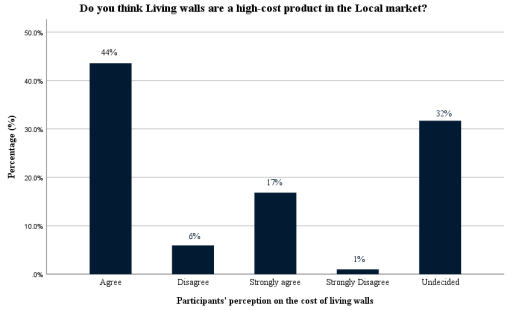
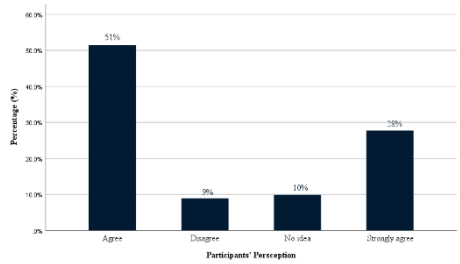


Figure 11: Participants' responses on ' do you think living walls need high maintenance?'



In the research study, statistics show that the majority of the participants occupy a garden space at their residences. However, only a few participants occupy the ground level, and many have planted on the balconies, rooftops, terraces and in courtyards due to the lack of space at the ground level. Moreover, figure 12 shows how the area of the garden varies according to the location. More towards the Colombo metropolitan area (CMC), the garden size reduces. Many possess a garden space with an area between 5 to 10 sqm, more towards the city. Colombo, Dehiwala, Homagama, Kaduwela, Kolonnawa, Kotte and Maharagama areas occupy garden spaces below 5sqm. Other areas which are located away from the Colombo Metropolitan area occupy an area of more than 5sqm. By studying the demographic data, figure 13 shows the employment nature within different age categories. Between the age of 16 and 25, a high percentage of respondents were full-time students and employees, while the majority of participants between 26-35 years old are full-time employees. Also, above 26 years old, there are housewives and retired individuals who are above 56 years. The time capacity is in contrast with these categories where housewives and retired communities have more time during the day for gardening. Figure 14 shows how the monthly income has affected the availability of a garden area. Respondents with low salaries show a high rate of unavailability. However, the majority are falls into the 3rd level category of salary.

Figure 15 shows a fluctuation in different age categories' familiarity with living walls. 65 and above have high knowledge of that, but the 56 and 65 age group shows a low rate of familiarity. The younger generation shows a low rate of unfamiliarity.

Figure 12: Analysis of the participants' responses on the availability of home garden space around Colombo Divisional Secretariats

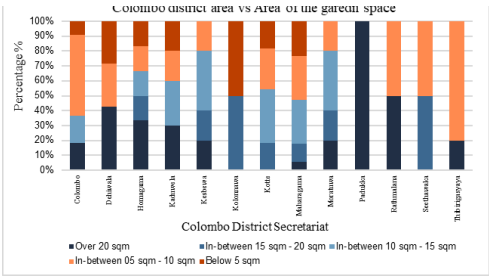


Figure 13: Analysis of the individual's age and employment nature

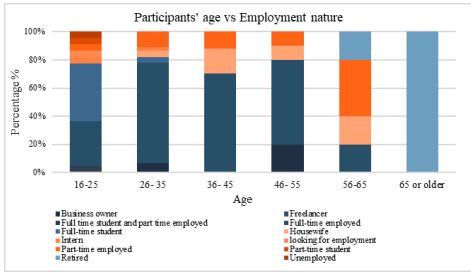


Figure 14: Analysis of the participants' monthly income and availability of a garden space

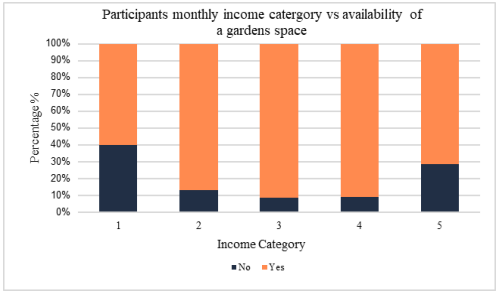
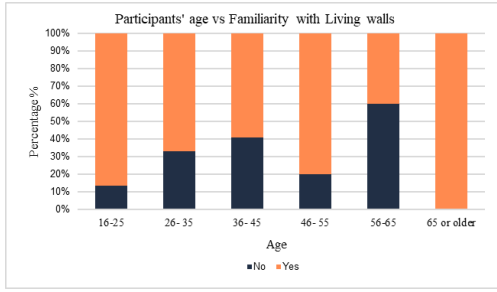


Figure 15: Analysis of the participant's age and familiarity with Living walls



Conclusion

The vegetated land surfaces of the Colombo District deteriorate day by day. Urbanization and development are also lessening the focus on home gardens. This study investigated the availability of garden spaces and the experiences in gardening of urban residents in the 13 Colombo District Divisions. 85% of 100 participants possessed a garden space and the remaining participants would like to have a garden space in the future. Further, through the analysis, it can conclude that, for the possession of a garden space demographic data matters such as location, age, employment nature and income level. Out of the 100 individuals 12% do not possess a garden area at their premises and 11% out of then are going through space limitation issues. Also, results show that the plot area of the garden reduces towards the city. The use of vertical living walls might be the best strategy for people who have trouble with a lack of space. However, participants presented a low rate of perception towards living walls as they are high in maintenance and cost. The emergence of novel products should be catered to the local market with less complexity addressing a low profile in cost, maintenance and durability. Many uses living walls on buildings due to the demand for sustainability and visual aesthetics. However, we should question these living walls in the local market are delivering the projected benefits.

Acknowledgements

Centre for Real Estate Studies (CRES), Department of Estate Management and Valuation, University of Sri Jayewardenepura.

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