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Towards Promoting Sustainability in the Learning Environment

– A Focus on Green Walls and Green Roofs

Environmental concerns have gained international attention as a result of rising urbanisation and population expansion. One of the main sectors responsible for the devastation of the environment is the construction industry. It is responsible for approximately 40% of global energy consumption and nearly 30% of greenhouse gasses. Aside from the energy crisis, climate change, global warming, declining biodiversity, and health issues are some of the challenges facing current society. Those have led to the amalgamation of natural vegetation into the built environment. Amongst several

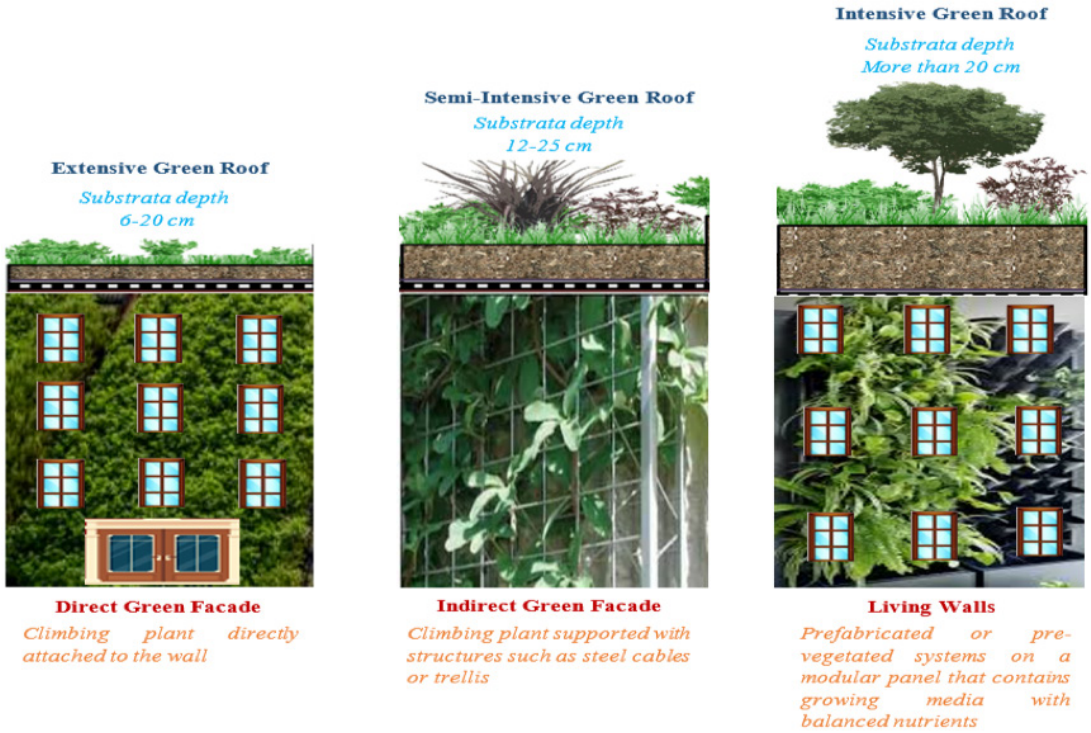

Figure 1: Green Wall and Green Roof Classification

forms of natural vegetation such as rain gardens, street trees, urban drainage systems, green roofs, and green walls, etc., Due to the limited availability of land and the multiple advantages that it offers in terms of three sustainability pillars, green walls and roofs represent the most technologically sound solutions.

Green walls, the kind of vertical structures with various plant species are available in two main types: green facades and living walls based on the support structure used. Green roofs represent adopting any green technology such as growing plants, energy efficiency or insulating panels, or green construction materials in rooftop gardens. They are available in different types based on substrate depth. The main classification of green walls and green roofs is presented in Figure 1.

Technology Involved in Green Walls and Green Roofs Constructions

Table 1 shows the main characteristics that distinguish the types of green walls and roofs.

Table 1: Characteristics of Green Walls and Green Roofs [1, 2, 3]

Characteristics	Green Walls			Green Roofs		
	Direct green facade	Indirect green facade	Living wall	Extensive	Semi-intensive	Intensive
Vegetation layer (Type of plant used)	Climbing plants (Evergreen and deciduous)	Climbing plants (Evergreen and deciduous)	Grasses, shrubs, and herbaceous plants (Evergreen)	Turf/ Grass, Sedum	Shrubs, Herbaceous, Coppices, turf	Trees, herbaceous plants, shrubs, coppices, grass
Support structure	No	Yes	Yes	N/A	N/A	N/A
Irrigation system	Yes / No	Yes / No	Yes / No	Yes / No	Yes	Yes
	Depends on the plant species used and the climatic condition					
Drainage system	Yes / No	Yes / No	Yes / No	No	Yes / No	Yes
Waterproofing layer	No	Yes / No	Yes / No	Yes	Yes	Yes
Speed of surface coverage	Slow	Average	Rapid	Slow	Average	Rapid
Surface deterioration	Yes	No	No	No	No	No
Maintenance	Low	Average	High	Low	Average	High
Environmental burden	Low	Average / High	Average / High	Less	Average / High	Average / High
		Depends on the amount of material used			Depends on the amount of material used	

Benefits of Green Walls and Green Roofs

Figure 2 presents the benefits which can be achieved with the use of green walls and green roofs in terms of environmental, economic and social aspects.

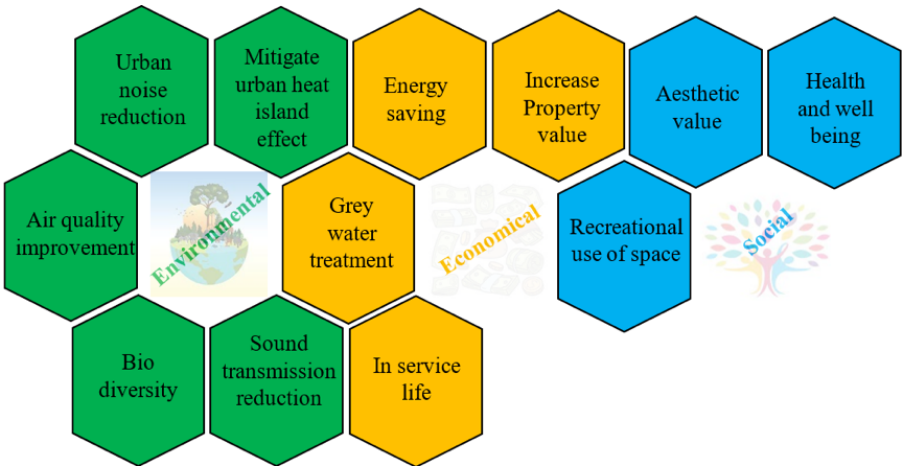

Figure 2: Benefits of green walls and green roofs
Source: [3]

Cost of Green Walls and Green Roofs Constructions

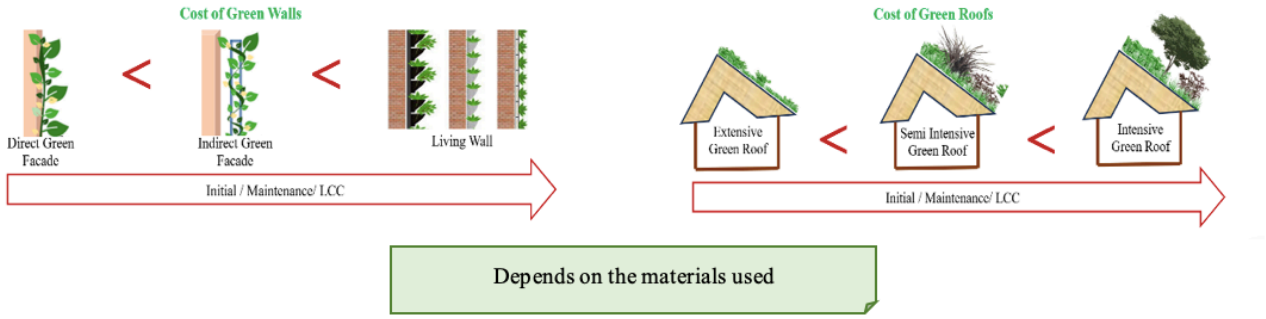

Figure 3: Cost of Green Walls and Green Roofs Constructions

Both these concepts of green walls and green roofs address most of the pressing challenges in the current society. Since Sri Lanka is a tropical-climactic country, adopting these greenery concepts is not much challenging. The green wall and green roof concepts are rapidly spreading in the global context. However, those greenery applications are in their infancy in Sri Lanka.

In the case of the application of both green walls and green roofs, the preliminary survey recorded that there are limited applications but used in all types of buildings irrespective of type of function. Amongst the samples, extensive green roof type is the most commonly available while in terms of green walls, direct green façade type is applied in boundary walls to serve the purpose of aesthetic appearance. Further, the living wall type was seen on internal walls while the indirect green façade type was on to exterior wall surfaces of the building.

A detailed case study analysis carried out with indirect green facades and similar-natured conventional wall buildings of Residential, confirmed that the indirect green façade responsible for an average of 1 - 2 ^{0}C of temperature reduction compared to the conventional wall which results in saving a minimum of 75% of energy cost for cooling purposes in the tropical climate [4]. In addition, when compared to the conventional wall, indirect green façade profiles can save on average 27% of maintenance costs due to minimum external redecoration time interval as green walls act as a protective layer to the building's external wall from natural phenomena including solar intensity, wind, rain, etc. Life Cycle Cost (LCC) contribution and the savings are summarised in Table 2. It is required to highlight that according to the equation mentioned in the last column of the table, positive values are savings to the conventional wall whereas negative values are actual savings to the building that has the green wall.

Table 2: Cost distribution of green walls

Cost	LKR/ m^2 (PV)		Green wall cost impact
	Green wall (GW)	Conventional wall (CW)	$\frac{\text{PV of GW} - \text{PV of CW}}{\text{PV of CW}} \times 100\%$
Initial	12,842.17	10,776.95	19%
Maintenance	3,254.35	4,566.92	-29%
NPV without energy	**16,096.52**	**15,343.87**	**5%**
Energy	34,550.19	97,676.02	-65%
NPV with energy	**50,646.72**	**113,019.89**	**-55%**
NPV – Net Present Value, PV – Present Value, GW – Green Wall, CW – Conventional Wall			

Recommendations

It is noteworthy that integrating green building practices into educational buildings might benefit students' learning potential as well as their physical, psychological, social, and cognitive growth. For example, Almeida et al. [5] have identified some benefits of green walls and green roofs that can influence the consequences for students in different ways as shown in Table 3.

Table 3: Benefits of green walls and consequences for students [5]

Benefits \ Consequences for Children	Cognitive development improvement	Increased school performance	Decrease in school absenteeism	Self-discipline	Concentration improvement	Increased working memory	Decreased blood pressure	Decreased heart rate	Decreased diseases
Sound transmission reduction		x	x				x	x	
Temperature regulation		x	x		x				x
Air quality improvement	x	x	x		x	x			x
Improvement of health and well-being	x	x		x	x	x			x

To this end, it is significant to introduce green walls and green roof concepts to the educational buildings to make the learning environment very conducive.

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