

The Effects of Incorporating Indoor Green Spaces at Thompson Rivers University

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By
Randi Chandrasekara
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SUMMARY

During the winter season, people tend to stay indoors, which limits their exposure to the natural environment. Considering the importance of connecting with nature during colder climates, Thompson Rivers University (TRU) wants to elevate indoor green spaces to provide an exceptional way to interact with nature, which helps to provide plenty of mental and physical benefits for university occupants.

This report aims to provide information and recommendations on the mental and physical benefits of green spaces, demonstrating how green indoor spaces positively impact students' overall academic success and providing information about the most effective green wall types and their diversities.

GLOSSARY

ART	Attention Restoration Theory: The ability to concentrate may be restored by exposure to natural environments. (Ma et al., 2024)
green façades	Vertical framework structures that support the branch systems of the plants (Lundegren, 2019)
hydroponic system	Method of growing plants without soil (Smolova & Friedman, 2021)
Photosynthesis	Plants use sunlight, water, and carbon dioxide to create oxygen to the atmosphere (Liu et al., 2022)
Phytoremediation	The use of plants to remediate or clean up environmental pollutants (Liu et al., 2022)
Transpiration	The process of a plant's water loss or vapour mainly through the stomata of leaves (Liu et al., 2022)

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INTRODUCTION

Incorporating green spaces into the university surroundings provides numerous benefits for human health. Even though Thompson Rivers University (TRU) maintains a pleasing green outdoors, the cold winters and icy winds in the Canadian climate wreck the preserves of the lush greenery. However, TRU wants to enhance the indoor greenery experience with natural elements to improve the well-being of faculty, staff, and students. During the cold weather, people prefer to stay inside, which causes minimizing exposure to nature. The green walls are the standard method of representing bio-friendly indoor green visuals (Ma et al., 2024). It provides a sense of refreshment for everyone by allowing them to interact with greener surroundings.

This report emphasizes the importance of green indoor spaces for university occupants and explains why TRU should consider implementing green indoor projects. It will explain the benefits of implementing green indoor spaces, how the green environment affects mental health and human comfort, the effects of the green environment on students' well-being in academic settings, suitable living wall systems, and the types of indoor green walls for TRU indoor greenery settings.

IMPACT OF INDOOR GREEN SPACE ON UNIVERSITY STUDENT ACHIEVEMENTS

Green spaces are the areas that are often incorporated with the presence of vegetation and associated with natural elements. (Taylor & Hochuli, 2017). Indoor greenery systems are a popular architectural concept around the world. For instance, Thompson (2023) shows the green wall in

Singapore Changi Airport consisting of 10,000 plants and 25 species of vertical green design, and the nature-themed Singapore airport shopping mall *Jewel* as a great example of implementing indoor green spaces in Southeast Asia. Regarding indoor green spaces worldwide, McLaughlin (2022) discovered the United States Botanical Garden in Washington, DC, as famous as the *Living Planet Museum*, Gardens by the Bay in Singapore, Gaylord Opryland in Nashville, Yumenoshima Greenhouse Dome in Tokyo, Montreal Biodome in Montreal, Ford Foundation Atrium in New York City, and Sky Garden in London are the captivating green indoor creations in the world.

Advantages of Indoor Green Spaces

Reasons to transform indoor spaces with the greenery are:

- Purify and improve the air quality.
- Reduce the building heat impacts.
- Provide noise insulation.
- Maintain the Biodiversity
- Enhance the esthetic view.
- Improve mental and physical health.

(Data retrieved from Meral et al., 2018, <https://doi.org/10.3390/su10061995>; Smolova and Friedman, 2021, <https://doi.org/10.3390/j4020010>)

Maintaining indoor green spaces has been identified as an economical, environmentally friendly, and highly effective method of improving human health. Throughout the study, Liu et al. (2022) discovered the four fundamental roles of indoor plants that promote positive psychological effects on human health and comfort.

- Photosynthesis

In photosynthesis, indoor plants absorb Carbon dioxide (CO₂) and release Oxygen (O₂) when exposed to light. Plants have various photosynthesis rates, and plants with higher light intensity tend to undergo photosynthetic processes to produce more Oxygen. Additionally, photosynthesis produces negative air ions that are good for human health.

- Transpiration

Transpiration occurs when water travels from the plant root to the leaves as water vapour and releases into the air. This process helps to control indoor humidity. Light, air, temperature, and relative humidity are factors in the transpiration process of plants.

- Phytoremediation

In phytoremediation, indoor plants purify the air as a biological filter, absorbing chemicals, and gases like total volatile organic compounds (TVOC), Carbon monoxide (CO), Carbon dioxide, formaldehyde, and benzene.

- Psychological effect

The psychological effects of being around the greenery surroundings give emotional and physical stability by reducing stress.

Benefits of green indoor plants on human health

A natural green environment enriched with lush greenery provides a significant positive impact on human health:

- Help to reduce stress levels.
- Improve human attention.
- Provide Therapeutic benefits.
- Faster recovery from minor illnesses

- Increase the human productivity level.
- Enhance the job satisfaction and mitigate the anxiety.

(Stanborough, 2020)

Ma et al. (2024) researched 144 strong, physically, and emotionally stable university students on the effect of green walls on thermal perception and cognitive performance. The researchers found that designing biophilic indoor spaces enhances thermal comfort, cognitive performance, and physiological and psychological well-being. Throughout the study, they found that the increase in the amount of greenery environments impacts better cognitive performances and increased reading speed and memory capacity of university students. The Attention Restoration Theory (ART) emphasizes that occupying a single task requires constant deep focus and causes mental tiredness. However, being around plants and connected with nature helps improve the mind's deep focus and freshness (Ma et al., 2024).

McCullough et al. (2018) researched implementing green walls in schools. They identified how interior green walls affect students' academic achievements through applied pedagogical designs. Throughout the research, they found that indoor greenery settings help to reduce students' attention deficit behaviour, and the schools associated with the vegetation showed the student's improvement in test scores in reading, writing, math, science, and social studies. Also, McCullough et al. (2018) discovered that 101 public schools in Michigan identified the classrooms and cafeterias with green surroundings, increased their graduation rates and decreased criminal behaviours. In addition, integrating indoor green walls in academic environments offers a versatile positive impact on occupants through student well-being and community engagement.

Two types of indoor living wall systems

Indoor living walls are a good solution for implementing green space in buildings. Throughout the research, Smolova and Friedman (2021) discovered the two systems of indoor living wall systems: Soil-cell and hydroponic systems.

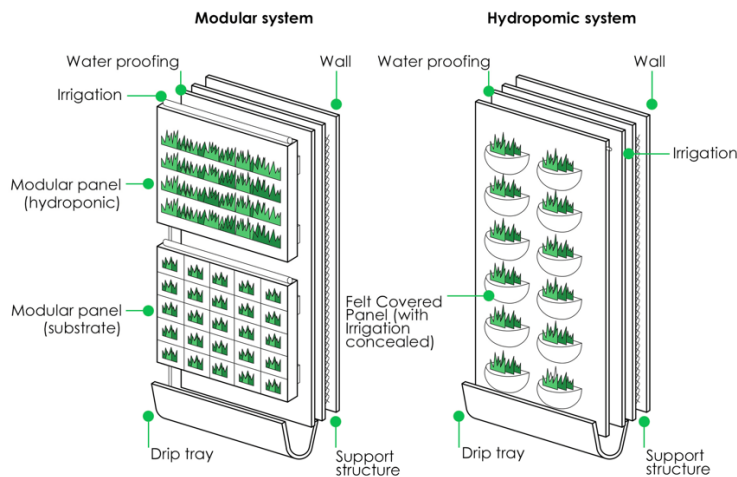


Figure 1: Types of living wall systems (Smolova & Friedman, 2021)

Comparison between Soil-cell Systems and Hydroponic Systems

Soil-cell Systems	Hydroponic Systems
Divide into individual compartments	Use a dense mat as a plant- growing media
Group the panels together	A lightweight system with rich nutrients
Grouped panels attached to the frame to control the plant growth	The living walls installs in separate modules or large panels fixed with brackets
Roots protect inside the cells	Roots are spreading across the layers
Due to the soil retaining the water capabilities, it requires minimum irrigation maintenance	Require consistent irrigation maintenance

Figure 2: Comparison between Soil-cell Systems and Hydroponic Systems

(Data retrieved from Smolova and Friedman, 2021, <https://doi.org/10.3390/j4020010>; Viritopia, 2022, <https://www.viritopia.com/blog/soil-vs-hydroponics-which-is-better-for-living-walls>; Chart created by Chandrasekara, 2024)

The researchers identified various adaptable styles in the study according to the space's layout and area. Proper lighting is necessary for plant survival, and ensuring the proper level of moisture for plant hydration and maintaining temperature for the plants' longevity are the key factors for installing living walls (Smolova & Friedman, 2021).

Diversity of Living Wall Typologies

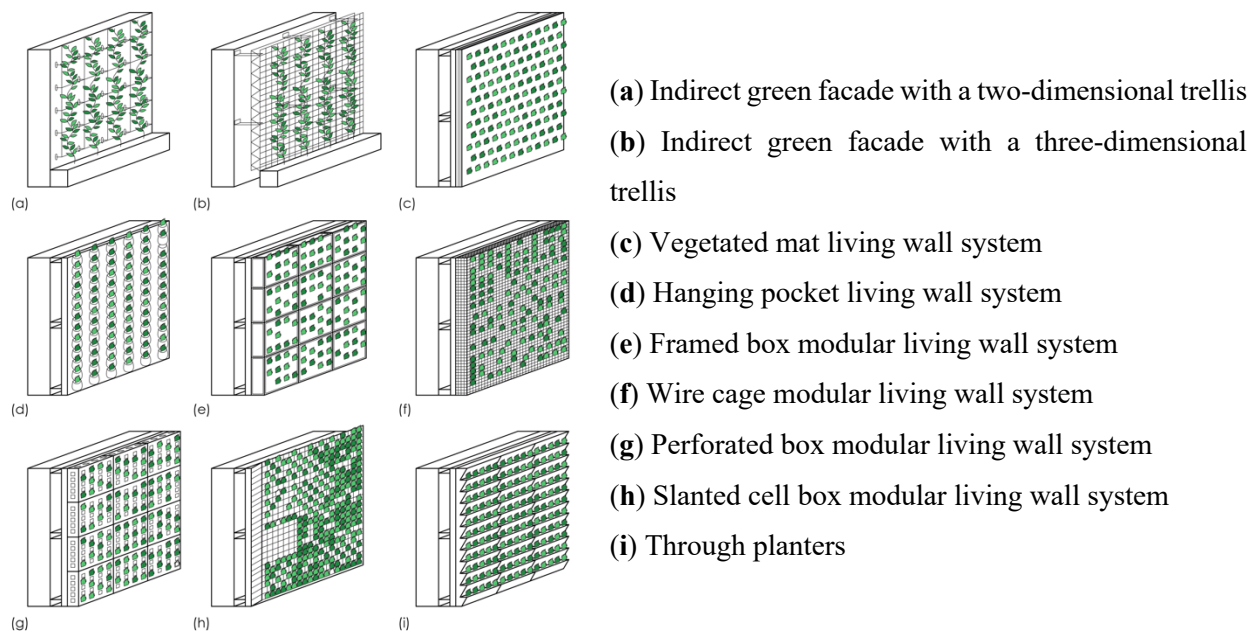


Figure 3: Diversity of living wall typologies (Smolova & Friedman, 2021)

People use indoor green walls (vertical gardens) to maintain ecological sustainability. Vertical gardens require a small and limited space to help keep the lush greenery inside the buildings. Meral et al. (2018) found that the three main types of green walls are green façades, bio-walls, and natural walls.

Green façades

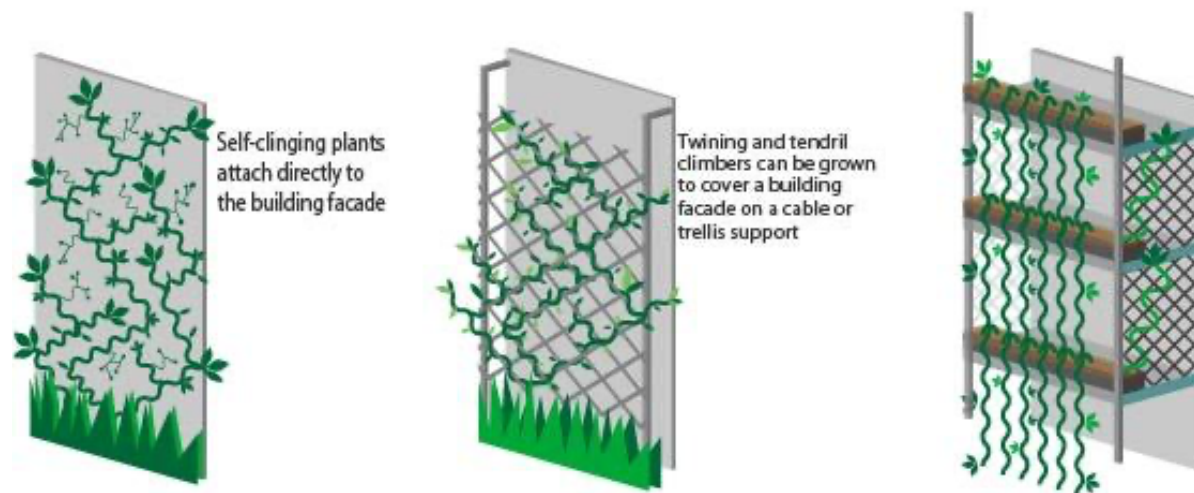


Figure 4: Designs of green façades (Lundegren, 2019)

Green façades are built as frames attached to the walls with plants instead of the soil bed. Meral et al. (2018) identified the green façade as an upfront green wall system that can be placed on surfaces such as metal, concrete, or brick and supported interior and exterior wall surfaces.

As Lundegren (2019) describes, the reasons green façades are a better choice for indoor spaces are:

- It is cheaper and easier to build than other green wall types.
- It is easier to add green facades to existing walls.

- Less control of plant growth patterns on the wall
- Require a simple irrigation system.
- A long-lasting system with a simple maintenance process to upkeep the structure and the plants.
- The higher sustainable system with less technology and resources

Bio-walls and Natural walls

The bio walls are installed in sunny, shady, and temperate climates. They are man-made plant-growing systems with special stainless-steel containers, geotextile, and irrigation systems. Natural green walls grow plants on the wall surface (Meral et al., 2018).

RECOMMENDATIONS

Reflecting on the findings of this report, my final recommendations are:

- Based on the research conducted by Smolova & Friedman (2021) and Meral et al. (2018), TRU should consider the overall benefits of developing an indoor green space for the well-being of the university occupants. As TRU has limited indoor areas, consider a hydroponic indoor living wall system that uses the maximum available space in the building by using vertical or stacked models.
- Compared to other types of green walls, TRU should focus on implementing green façades, as they provide substantial user advantages based on the facts explained by Lundegren (2019).
- TRU should consider the health and comfort benefits of incorporating green indoor spaces. Implementing green spaces helps improve the overall indoor environment for university occupants through the process of photosynthesis, transpiration, phytoremediation, and psychological effects, which significantly support a healthy indoor atmosphere.

- TRU should contemplate the research conducted by Ma et al. (2024) and McCullough et al. (2018) on university students' increase in cognitive performance while being around greenery. This research effectively proved that green indoor spaces significantly impact students' well-being. Other cities, like Michigan, have identified successful indoor green space project outcomes in the academic setting. Therefore, TRU should consider implementing green indoor spaces to achieve the same academic success and productivity for its university occupants.

CONCLUSION

According to the research findings, green indoor space is a convenient architectural concept used worldwide. In Canada, especially during the winter when exposure to nature is limited, having indoor green areas helps to interact with a tranquil natural environment, which supports fostering mental and physical wellness and enhances the productivity of faculty, staff, and students in a university setting. Therefore, I strongly recommend implementing green indoor spaces in TRU premises to provide healthy, comfortable, and conducive learning and engaging academic experiences for the success of all university occupants.

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