

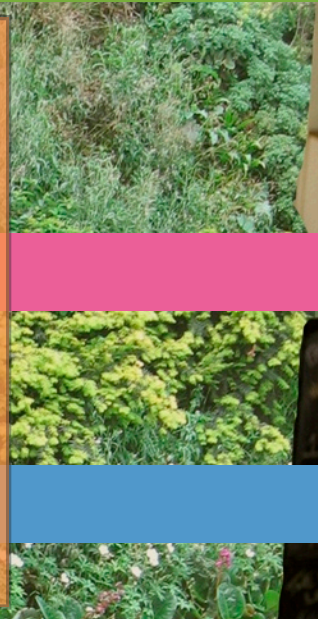


Green Wall

(abridged)

The feasibility of a green wall in
the Student Union Building

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Executive Summary

Green infrastructure is the concept of using plants in urban and indoor areas in order to receive the benefits of their natural biological processes and improve the overall living environment. One facet of green infrastructure is the “green wall”, created by integrating plants into vertical structural supports to form a living system. The following report will look at the feasibility of constructing a green wall in the Student Union Building of Dalhousie University.

Humans possess an intrinsic connection with nature. This connection has been lost through the development of urban structures. Plants have been used for centuries to increase the well being of the community. Incorporating a green wall within the SUB will provide these benefits to the occupants and provide this space with a more welcoming atmosphere that is more user friendly.

A values and opinions Interviews with industry leaders, literature review of previous studies and a survey were utilized in the development of this report.

The space available in the student union building is a west facing wall that only receives moderate daylight. The green wall has the potential to be 6’ or 21’ tall, since it is located in an atrium area, the chosen height will greatly affect the scope, scale and cost of the green wall and its long term maintenance. The Student Union Building is funded by the students for the students, making their opinion an essential component of our analysis. The overwhelming response was in favour of a green wall but there were questions over expected costs.

The primary design objective when creating a green wall is aesthetics. But lots of research has been conducted on both the quantifiable and qualitative benefits of incorporating a green wall into an indoor space. These included increased energy efficiency of the building, noise reduction, improved air quality and improved human well being. The expected benefits of a green wall will vary depending on leaf area, leaf density, site conditions and scale. Type of plants, scale of project and location of the wall can be manipulated depending on which green wall benefits are needed in the building.

Three green wall companies and one expert were approached to provide estimates on the proposed green wall project; they were NedLaw, Easy Living Technologies, Green Over Grey and Sue Sirrs respectively. Information from each of these manufacturers was included in recommendations to SUB facilities management but are not included in this report, for reasons of confidentiality.

Sue Sirrs, a local landscape architect provided her knowledge and past experience. She stated that the highest cost associated with the project would be the ongoing maintenance of these types of systems, which need to be factored into the business plan before going forward.

Modern green wall technologies are still evolving and as such their costs and benefits are not well-documented. This technology also poses the distinct problem of transparency within the companies as each company uses different techniques in the manufacturing and process of the system. Out of the green walls that have been investigated the main problem has been with faulty irrigation systems, however with the systems continually evolving this should not be a problem. As it stands the most important aspect of implementing a green wall in the atrium of the SUB is that it may attract more community members to utilize this space providing more revenue in the SUB while making the space warm and welcoming.

A list of seven recommendations has been compiled due to the findings of this report. This list includes, working with the companies that were investigated as well as keeping the options open for new business partners, acquiring a lift as well as certified horticulturalist for maintenance, using this report as a baseline for future research, live tracking and visible reminders of what the wall is doing, the installation of rainwater cisterns, the installation of photovoltaic solar panels, and to consider incorporating this into the proposed addition.

To move forward on this project the DSU will need to conduct broader student surveys to assess public opinion in regards to the addition of a green wall, get more in depth estimates from the companies that were looked at in this report as well as look into more and varied green wall providers and finally look at all of the potential stakeholders on campus that might want to collaborate on this initiative.

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Introduction

In ancient Babylon, King Nebuchadnezzar II built the Hanging Gardens of Babylon: a wonder of the ancient world, and ancestor of the modern green wall (Green roofs for healthy cities, 2008). The hanging gardens are one of the many examples of functional or decorative uses of plants in architecture; Greek and Roman builders used hanging vines on trellises and walls to decorate stone houses; Scandinavians planted grass on their roofs to keep their houses warm in the winter and cool in the summer (Trepener et al, 2009). Modern descendants of Babylon's hanging gardens, green walls, are as technologically diverse as they are advanced. The green wall industry is rapidly growing, as is the science around the environmental effects of green walls.

The intention of this report is to look into what the ancients already knew about the benefits of implementing foliage into public spaces. This report will assess the feasibility of installing a green wall in the Student Union Building (SUB) at Dalhousie University by investigating the costs and benefits of similar walls and assessing the building's existing infrastructure. This report will also show if the Dalhousie community would support this type of project, and investigate the impacts of a green wall on Dalhousie's reputation.

The wall being examined for a potential green wall installation is located in the atrium of the first and second floor of the Student Union Building. It is the east wall of the foyer, opposite the information desk. The wall is 23 feet wide and 21 feet high. The second floor of the Student Union Building opens up into the atrium. This report examines the costs and benefits of two sizes of walls. A large wall, from floor to ceiling of the east wall of the atrium, would be 21 feet tall and 23 feet wide. A small wall would be only 6 feet tall and 21 feet wide. The small wall was explored because a significant cost of the large wall is the vertical maintenance, as a mechanical lift is required for maintenance on the higher sections of the wall (see appendix, figure 1, for schematic).

The Student Union is currently planning for major renovations over the coming years (personal communication, Pat Martin, February 1 2012). Assessing the feasibility and desirability of a green wall in this space will inform the Student Union and the board of operations as to whether this is a worthwhile feature to incorporate in the Student Union Building. Furthermore, if the board deems that this space is undesirable for a green wall, there is a strong baseline of information for constructing a green wall in other sections of the SUB. Green wall technology is a rapidly advancing field; if the board deems that a green wall is not appropriate at all, there are many suggestions in this report regarding what to look for in green wall innovations that would make green walls more feasible and desirable in this space.

Methods

Opinions and Values Survey

A cross-sectional survey was used to gather information on the population of the Dalhousie community at a specific point in time: March of 2012. The survey attempted to determine the community's opinions towards a green wall in the Student Union Building.

To begin, the survey asked questions to establish demographics and usage of the SUB. Next, it inquired about environmental awareness, fondness of plants, awareness of foliage in the SUB and opinions about plants. The survey then asked about awareness of green walls, interest in involvement in a green wall project, and concern about the cost and maintenance of a green wall.

Because of the large sample size, multiple-choice and multiple-select questions were more appropriate than interview style or open-ended questions. The survey obtained values and opinions that can be directly linked to specific aspects of the green wall feasibility analysis.

The survey software proved to be a useful tool, as many of the participants were directed to the survey through links on twitter and facebook. However, this means that there may be a selection bias in the results, as many of the participants were connected to the researchers through social networks. This means that the results may be biased towards a younger demographic of like-minded participants. To mitigate this bias, the survey was posted in as many distinct networks as possible, to garner attention from as diverse a group of individuals as possible.

The service was free, but it was limited to 10 questions and 100 participants. The sample is not as large as would be ideal at Dalhousie, a community of at least 17000 individuals. The results, no less, offer a valid impression of the opinions and attitudes of the Dalhousie community.

Literature Review

To gain an understanding of the benefits of a green wall within the Dalhousie Community, a literature review was performed. The literature review investigated the improvements to the psychological health, physical health, and well-being of people exposed to indoor plants in general and green walls more specifically. The literature review was used to find out what information existed on the subject matter, as it is more efficient to review previous studies rather than to do primary research. All of the

sources were either academic or published, so it is safe to say this method was reliable. The main limitation in our literature review was finding concrete information on the qualitative impacts of green walls. This is likely a result of the modern green wall being a relatively new technology that has strong patents limiting potential third party research.

Interviews

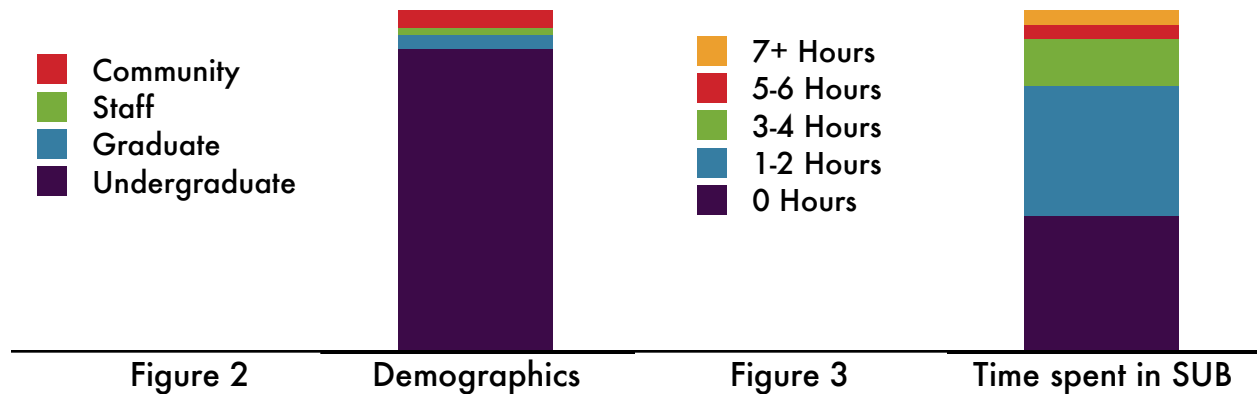
Interviews with industry representatives were essential to gain an understanding of green wall construction, maintenance and overall cost. These interviews were conducted both in person and through conference calls. The interviewees were provided with a schematic sketch of the east wall of the SUB atrium. During these interviews questions were asked to gauge the feasibility of installing a wall into this space. With these specifications, representatives from NedLaw, Green Over Gray, Easy Living Technologies and a horticulturalist and green wall expert Sue Sirrs were able to provide cost estimates and information on the technology that will need to be included. These interviews provided essential information, as these experts could give approximations on what the costs and benefits of green walls would be. By doing interviews with multiple sources, the results that came from this study became more reliable as they could be compared and contrasted for biases as well as spectrum of different types of green walls was explored. Interviewing the maintenance staff of both the Nova Scotia Community College and Saint Mary's University provided insights into future maintenance considerations and possible long term challenges associated with green wall. The delimitations of this report were that it was infeasible to have all of the participants come to see the actual space as it would have been far too expensive.



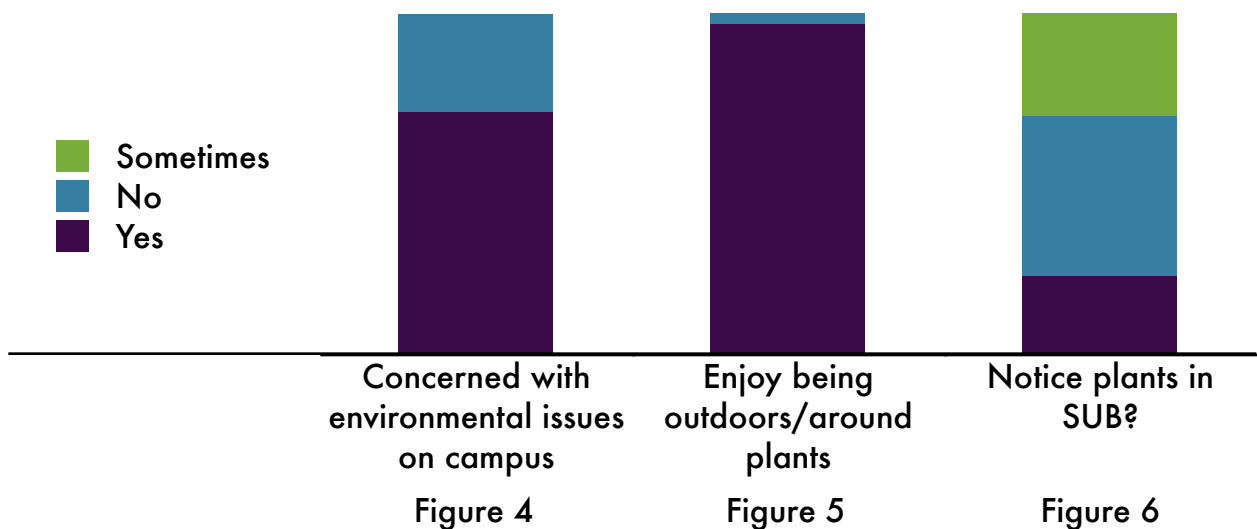
Results

Opinions and Values Survey

The first question of the survey established demographics, found that 89% of participants were undergraduate students, 4% were graduate students, 2% were staff members, and 6% were community members (Figure 2). The second question determined that 40% of the participants don't spend time in the Student Union Building, while 38% spend between 1 and 2 hours, 14% spend between 3 and 4 hours, 4 spend between 5 and 6 hours, and 5 spend more than 7 hours (Figure 3).



Question three inquired as to whether participants were concerned with environmental issues on campus; 71% of participants answered "yes" and 29% answered "no" (Figure 4). Question four asked the participant if they enjoy being outdoors or around plants; 97% answered "yes" (Figure 5) Question five asked the participant if they notice the plants currently in the Student Union Building; 23% answered "yes," 47% answered "no," and 30% answered "sometimes" (Figure 6).



Question six was a multiple-select question, asking students what they believe plants add to a space; 40% said decor and esthetics; 30% said better air quality; 26% said psychological benefits; 2% said mess; and 2% said nothing (Figure 7).

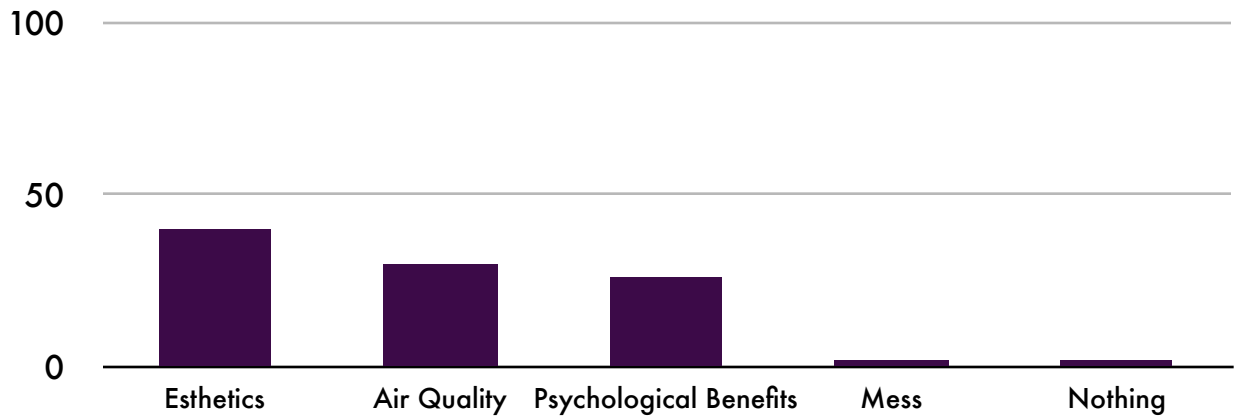


Figure 7

In response to question seven, 43% of participants said that they knew what a green wall was; 12% said that they had heard of them, but don't know what they were; 21% said that they had seen one in the city; and 24% said that they don't know what a green wall was.

Question 8 asked participants if there should be a green wall in the Dalhousie Student Union Building; 65% of participants answered "yes"; 9% answered "no"; and 26% answered that they do not care.

Question 9 asked participants if they would be concerned with the cost and maintenance of a green wall; 64% answered yes and 36% said no. In response to question 10, 47% of participants said that they would be interested in being involved with the project while 53% said that they would not be interested (Figure 8).

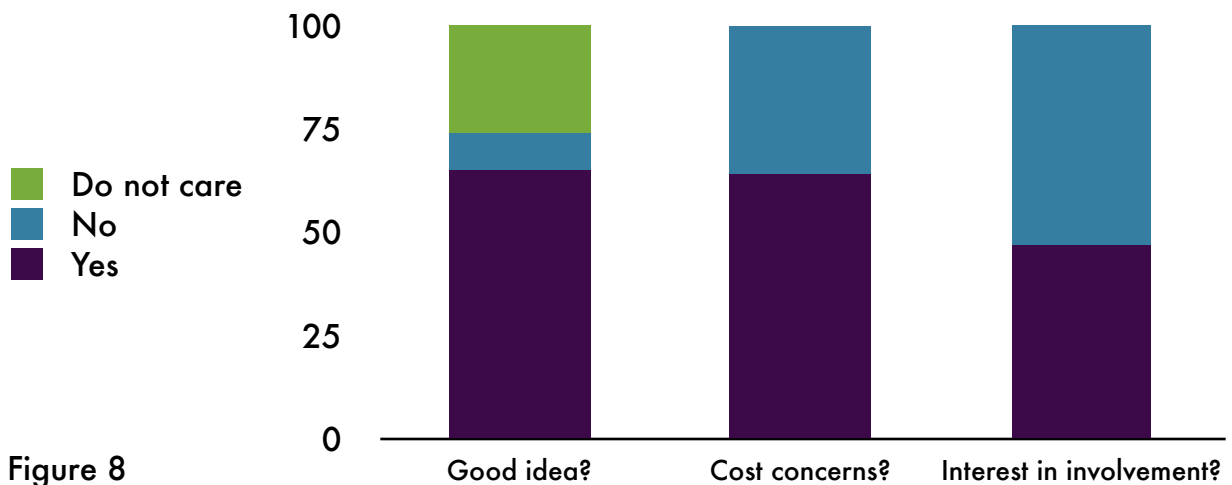


Figure 8

Literature Review

Green infrastructure is the concept of using plants in urban and indoor areas in order to receive the benefits of their natural biological processes and improve the overall living environment (Green roofs for healthy cities, 2008). Green walls, integrating plants into vertical structural supports, are one facet of green infrastructure (Green roofs for healthy cities, 2008).

The term “green wall” is often considered to include all living vertical garden systems (Green roofs for healthy cities, 2008), but they can be divided into two major categories: green façades and living walls. Green façades are typically used outdoors and can be anchored to the wall surface or grown on trellises or other freestanding structures. A common example of a green façade is English Ivy, which grows on the sides of buildings. Living walls are more complex biological systems that require a higher degree of maintenance. These walls must be fixed to an existing structure and consist of vertical panels that the plant root systems grow into. Because these walls are controlled systems, they can support a high diversity of plant life. Irrigation mechanisms are integrated into the wall’s infrastructure and the application of nutrients through fertilizer is usually necessary to ensure optimal plant health (Green roofs for healthy cities, 2008). There are numerous different types of living walls suited for both indoor and outdoor structures. The wall most suited for Dalhousie’s SUB would be an indoor living wall design.

Indoor living walls offer many benefits as well as decorative value (Table 1). The benefits vary with differences in the design features of the wall and with factors such as leaf area, leaf density, site conditions and scale.

Interior living walls can improve the air quality of the indoor environment. Both the plants living on the wall and microbes within the medium act as biofilters to improve indoor air quality by filtering out toxins such as carbon dioxide, volatile organic compounds, nitrous oxides and sulphur oxides. Studies have shown that there are significantly lower concentrations of toxins in the area surrounding a living wall (Loh, 2008). The wall will also remove particulate matter and pollen from the air by deposition on the leaf surface of the plant (Ottele et al, 2010). This air quality improvement from plants has been shown to reduce coughs by thirty percent and dry throat and irritation by twenty-four percent (Fjeld, Veiersted, Sandvik, Riise & Levy, 1998, p. 204). The improved air quality of a building's interior can reduce the necessity of bringing in outdoor air; this can reduce the energy costs associated with heating and cooling outdoor air for inside use (Green roofs for healthy cities, 2008).

Benefit	Description
Improved energy efficiency	<ul style="list-style-type: none"> • Reduction in energy used to heat and cool air brought in from outside for indoor use
Improved indoor air quality	<ul style="list-style-type: none"> • Filter contaminants usually removed using the HVAC system of the building • Remove dust and pollen from air (deposition on leaves) • Filter toxic gases (nitrous oxides, sulphur oxides, VOCs, carbon monoxide) & sequestration of carbon
Noise reduction	<ul style="list-style-type: none"> • Reduction of sound transmitted through and reflected off of wall surface
Improved aesthetics	<ul style="list-style-type: none"> • Plants in indoor environments
Improved health	<ul style="list-style-type: none"> • Improved air quality • Reduced toxins • Other links between plants and improved health
Improved well being	<ul style="list-style-type: none"> • Link between presence of plants and improved mental well-being

The plants and plant medium can reduce noise levels in the indoor space. This is because the green wall acts as a barrier reducing both the amount of sound transferred through and reflected off the wall surface (Wong et al, 2010).

The main purpose for implementing a green wall is for the expected esthetic benefits that improve the indoor building environment. Studies have shown a link between plants and improved human wellbeing. Plants in office buildings have been shown to improve job satisfaction. In an institutional setting, like an office or a school, people who spend time around plants have reported a decrease in fatigue by 30% (Fjeld et al., 1998, p. 204). Patients have also shown faster recovery when in the presence of nature (Loh, 2008). Humans have an intrinsic connection to nature, but residents of urban environments are losing their connection to the natural environment. A green wall is an effective way to incorporate plants into an urban setting.

The indoor environment recreates a tropical climate with constant warm temperatures and controlled irrigation. Due to the microclimate of the indoor space, only tropical plants can be used. Ideally the plants are ones that would typically grow vertically on

tree surfaces, such as epiphytes (personal communication, John Gallant, April 1). The plants are selected based on their expected benefits and performance for the given wall design. The criteria given by NedLaw for the selection of their plants is biofiltering capabilities, growing capability on vertical medium, suitability for microclimate (temperature and light), growth with hydroponic irrigation system and water quality. The plants that they have pinpointed at being optimal for use on a green wall are *Hedera algeriensism*, *Ficus benjamina*, *Ficus elastica*, *Dracaena* spp. *Shefflera arboricola* and *Philodendron selluom* (personal communications, Alan Darlington, April 12). The plants used for replacements on the SMU wall are imported from Florida and purchased through a Halifax company (personal communication, John Gallant, April 1).

Maintenance is a key aspect of a living wall and should be considered during the design process, as it will have large influence on the long-term costs of the project. The wall will require constant pruning in order to ensure healthy growth of the plants and to deter detritus-eating pests. There is also some annual replacement of plants needed on the wall, around 10% per year. The maintenance of proper chemistry is an important issue in Halifax as the regular tap water has a high concentration of salts. Plants grow optimally in slightly acidic soil, but a build up of salts in the irrigation system can make the water more basic leading to unhealthy plants and even death. Since this is a controlled system there is no competition between plants for access to water or nutrients, therefore an adequate amount of both must be supplied to the wall. Fertilizer can be applied via the irrigation system if necessary, the primary nutrients needed for plant growth are potassium, phosphorous and nitrogen (personal communication, John Gallant, April 1).

Chemical pollutant	Plants effective at removing it
Benzene (C ₆ H ₆) / Toluene (C ₇ H ₈) / Xylene (C ₈ H ₁₀)	-Kimberly Queen Fern (<i>Nephrolepis obliterated</i>) -Orchid sp. (<i>Phalenopsis</i> sp.) -Dieffenbachia sp.
Carbon Monoxide (CO)	-Spider plant (<i>Chlorophytum comosum</i>) -Janet Craig <i>Dracaena</i> (<i>Dracaena deremensis</i> <i>Ficus</i> sp.)
Volatile Organic Compounds (VOCs)	-Golden Pothos (<i>Scindapsus aures</i>) -Devil's ivy (<i>Epipremnum aureum</i>) -Philodendron sp.
Formaldehyde	-Peace lily (<i>Spathiphyllum</i> sp.) -Boston fern (<i>Nephrolepis exaltata</i>) -English ivy (<i>Hedera helix</i>)
Trichloroethylene (TCE)	-Mother-in-law's tongue (<i>Sansevieria trifasciata</i> 'Laurentii') -Chrysanthemum (<i>Chrysanthemum morifolium</i>) - <i>Dracaena</i> sp.

Interviews

Interviews were conducted with representatives from three green wall manufacturing firms, but are not included in this version of the report.



Sue Sirrs is a Landscape Architect and head of Outside Planning. She is the only local businessperson building green walls. She designed and built the outdoor wall at NSCC, has done many smaller outdoor walls, and has experimented with indoor walls. She provided valuable expertise throughout the research process and showed a legitimate interest to working on this project. Sue provided her past experiences with this type of technology by recommending leading companies who work in the field and also enlightened this project by stating that the highest cost would be the ongoing maintenance of these types of systems.

Sue believed that tropical plants were the only option for an indoor wall, as local plants require the cold weather that the Nova Scotian winter provides. These tropicals on most walls do not include edible plants however if Dalhousie University decides to build an outdoor wall certain invasive species such as strawberries may invade the wall. The tropical nature of the wall also provides a problem with moisture within the wall, meaning that it may develop mold within the medium creating a musty smell.

Although Sue liked the idea of student involvement in the project and ongoing maintenance she, explicitly stated the need for an on site horticulturalist with expertise in the field of tropical plants. This would be vital for the long term health of the wall as students will only be working on it during certain semester and may not be as involved if they knew that they would not be working on it in the future.

Four interviews were conducted with maintenance people that work on walls in Halifax. These interviews illuminated the importance of good maintenance on the walls, and indicated some important variables to scrutinize in considering green walls.

Saint Mary's University (SMU) has a three-story green wall with biofiltration, built by NedLaw. John Gallant, the maintenance technician for this wall said that the plants on

the wall were unhealthy before he was hired to perform regular maintenance on the wall. He does one day of maintenance work per month.

The SMU green wall boasts the most technologically advanced wall; however, one of the managers of the wall said that the university has not been able to quantify the benefits, and that the wall may even increase environmental and monetary costs. He speculated that the increased humidity from the wall increases the load on the building's air conditioning system in the summertime. Nonetheless, his general attitude towards the wall was very positive, and he said that the school received significant positive feedback about the wall. Professors and students have also integrated the wall into lessons, doing experiments, studies and lectures based on it.

The Seaport Farmers' Market (SFM) green wall was built by Green Living Technologies, who did not return requests for quotes for this project. This wall demonstrates the reputational and esthetic impacts of a wall that is not properly cared for. Because of warranty issues, the green wall at the SFM is not currently receiving any plant maintenance. The result is many dead plants, soil erosion, invasive insects and fungus, and bare areas. Sue Sirrs pointed out that a wall with unhealthy plants has a hugely detrimental impact on a space, and is far worse than no wall at all. The SFM green wall uses a system similar to ELT, with vertically mounted individual plant cells, and a trickle-down water system. The main issue with the SFM green wall is that the trickle-down water system has been clogged, so the plants closer to the bottom of the wall are dying. The manager for this wall was very adamant that any wall receive adequate professional maintenance.

Plant Care is the plantscaping company that is currently contracted to maintain the plants in the Student Union Building. Though they have not had contracts to maintain any prior green walls, they have the capacity to do maintenance on a potential green wall in the SUB. They offered preliminary approximate price quotes of \$1296 and \$495 for the large and small walls, respectively, plus HST. The representative from Plant Care noted that the required maintenance is often under-represented by firms who build the green wall. He noted that the wall at SMU is maintained according to manufacturer's guidelines, and he believes that it is not receiving sufficient maintenance. If a wall was installed in the Student Union Building, the cost of maintenance may be covered for the first one or two years, depending on the manufacturer.

Discussion

Through this study it was found that there are a number of considerations that must be taken into account when looking at whether or not a green wall is a feasible, or even desirable, option for the SUB. The three different companies that were explored had three different variations on green walls that could all be supported by the infrastructural and utilities capacity of the SUB. The question that then remains is whether or not the costs of having a green wall outweigh the benefits. Through this analysis there were a number of different factors that were identified that should be considered. That being said, this report does not give a concrete recommendation for whether or not a green wall should be put in but rather outlines the merits, shortcomings and challenges of green walls in general as well as that of the individual green wall companies and the variation they provide.

Costs

Green wall technology is an emerging field. Many of the quantifiable costs of a green wall are still only described qualitatively. This is a significant barrier when trying to assess the environmental impact of a green wall. All indoor walls require some sort of pest control; this ranges from soapy water (personal communication, Leslie Savoie, April 4, 2012) to chemical pesticides (personal communication, Sue Sirrs, Feb 27, 2012). Irrigation technology is vastly diverse, and can range from grey-water irrigation that is recycled through the system to heavy irrigation of drinking-quality water in a flow-through system. Any green wall in the Student Union Building will also require artificial lighting. Finally, the purported energy saving benefits of green walls are vague, and the facilities manager at SMU said that the green wall may actually increase cooling costs in the summer, as it makes the air more humid (personal communication, Mike McCann, March 22, 2012). Though most of these costs are not quantified, they should still be considered when considering the green wall.

There has been a problem with the green wall at Saint Mary's University where a pipe was leaking for an extended period of time. Irrigation problems become especially concerning with hydroponic models as a constant flow of water is required to keep the nutrient and evapotranspiration levels high enough for the plants to survive.

The greatest pitfall of a green wall is the risk of its failure. Sue Sirrs pointed out that an unhealthy green wall is far worse than no green wall at all. She noted that, while healthy plants have positive psychological and esthetic benefits, unhealthy ones have negative psychological and esthetic impacts (personal communication, Sue Sirrs, Feb

27, 2012). Indeed, if the green wall were not adequately planted and cared for, it would be better to have no wall at all.

Benefits

Many of the benefits of green walls are either difficult to quantify, or difficult to compare between different manufacturers. The benefits change with options such as different buildings, green wall technologies, plant selections and plant coverage. The three manufacturers included in this report could not provide precise quantities for most of the benefits of their walls. Instead, most benefits are describe qualitatively.

One quantifiable benefit that would likely make an impact on the SUB is the improvement of air quality that the green wall would have on the internal environment of the building. There are many studies that speak to the benefit that plants have on reducing VOCs and dust particulates (Loh, 2008). These benefits are drastically increased through increased airflow across the plant wall as harmful particulates are brought to the plants for processing.

Other benefits that are less quantifiable are the psychological benefits associated with plants in general as well as the aesthetic aspect that a green wall would add to the space. This is where real opportunities lie for a green wall in the SUB. Through the survey and the empirical evidence found in the literature review, it was determined that the Dalhousie community likes being surrounded by plants and that the student population is supportive of a green wall in the SUB. By increasing the appeal of the space, the SUB could see an increase in people using the building, and has a unique opportunity to set itself apart from other spaces on campus. Appendix BLANK shows a variety of different green walls that enhance the space they are in. If one of the goals of the SUB is to provide a space for students to meet, eat and relax in a welcoming environment, putting a green wall in the atrium is a potential option.

Other possible benefits of the wall involve learning opportunities for staff and students in terms of how natural systems work and some of the biology behind the biofiltration system. Other possible benefits of the wall involve learning opportunities for staff and students in terms of how natural systems work and some of the biology behind the biofiltration system. Information plaques could be placed next to the wall to educate the public on these subjects. Online information tools could also be implemented for monitoring purposes as well as providing the community with information of the benefits of the green wall.

Public Opinion

From the information gathered in the opinion survey, it is clear that people in the Dalhousie community believe that plants provide aesthetic appeal, and increased air quality within a space as well as psychological benefits for its occupants. This shows us that the Dalhousie community is in favor of a green wall as it can contribute to their overall well-being. The majority of survey respondents use the SUB for at least an hour per week, and would benefit from the positive effects of a green wall in the SUB. The green wall may also attract more community involvement.

According to the data collected, a high percentage of the respondents stated they enjoyed being around plants and the outdoors; however, less than a quarter of the students surveyed noticed the potted plants in the SUB. This demonstrates that there is significant room for improvement in the plantscape of the SUB.

Overall, a large majority of survey respondents believe a green wall is something the SUB should have, and almost half of these respondents displayed an interest in learning more about the green wall. At SMU, students have used their green wall as a learning tool, and the results from the survey of the Dalhousie community demonstrates that there is significant interest in similar engagement in a green wall in the SUB.

The survey respondents demonstrated significant concern for the upfront and long-run costs of a green wall, echoing the common concern that a green wall should only proceed as an economically sound venture, with long-run integrity.

Despite the concern for the price of the green wall and the question of who will be paying for it, the opinions derived from the public survey demonstrate intrigue and support in the community for a green wall to be built in the SUB.

Conclusion

The public opinion survey that was conducted showed strong support for a green wall. However, if the student union decides to move forward on this project, a broader student survey should be conducted. Were the student union to move forward with this project, there are many avenues of collaboration on campus. Student groups such as the Loaded Ladle may be interested in growing edible food products on the wall. Faculties such as Biology, Sustainability, Environmental Science and Architecture could incorporate the wall into labs, lesson plans and projects. Collaboration with others on campus will be important if the student union wishes to reach as many people as possible.

It would also be beneficial to consider more companies and green wall variations as well as look at other areas of the SUB as a prospective location. This will ensure that all options are explored before moving forward with a project. Even the companies that were contacted for this project have a lot more information to provide.

One of the areas that will need to be explored in more detail will be the true cost for construction and maintenance. Because some of the companies were not able to come in person to give estimates, many of the estimates were quite rough. The price of demolition of the chalk boards and electrical, plumbing and contracting fees were also not assessed. Maintenance can be done by a variety of different third parties or in house so a maintenance plan would need to be established by the DSU.

Finally, when considering the addition of a green wall for the student union it will be useful to think of the construction of a green wall in terms of how it can compliment, enhance or interfere with other renovations that will be happening in the coming years.

Throughout this report there have been three primary companies sourced, Dalhousie University should take these estimates and decide which company would be the best to work with or even to work with another provider. The SUB needs to acquire a lift to maintain this wall and hire a horticulturalist to maintain it. The main recommendation is to use this report as a jumping point and for the student union to build upon making sure that prices are consistent with the findings and that a broader community would enjoy this installation.

There should be plaques to explain the wall to occupants of the SUB and a live tracking system that can be accessed online to show what the system is doing to benefit the occupants.

Another recommendation would be to install a rainwater cistern to the SUB to provide ample gray water for the wall so that the water bill will not be greatly increased.

The highest cost recommendation for this report would be to install photovoltaic solar panels on the roof of the SUB so that the sun can power the artificial lighting.

As the cost and design of a green wall is greatly reduced if it is incorporated into the original design of the building it would be more cost effective if the green wall is incorporated into the addition that will be built onto the SUB.

Acknowledgments

We would like to thank the many people who have helped us gather information on green walls throughout this project. We are grateful to the companies NedLaw, Green over Grey and ELT who provided us with estimates and information, and Saint Mary's University, Seaport Farmers Market and Nova Scotia Community College for allowing us to view their green walls and speak to their employees. We also acknowledge Sue Sirrs who provided us with a vast amount of information on the construction and implementation process, Pat Martin who is facilities manager in the SUB and our advisor, and of course Rochelle Owen and Rebecca MacNeil.

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Appendices

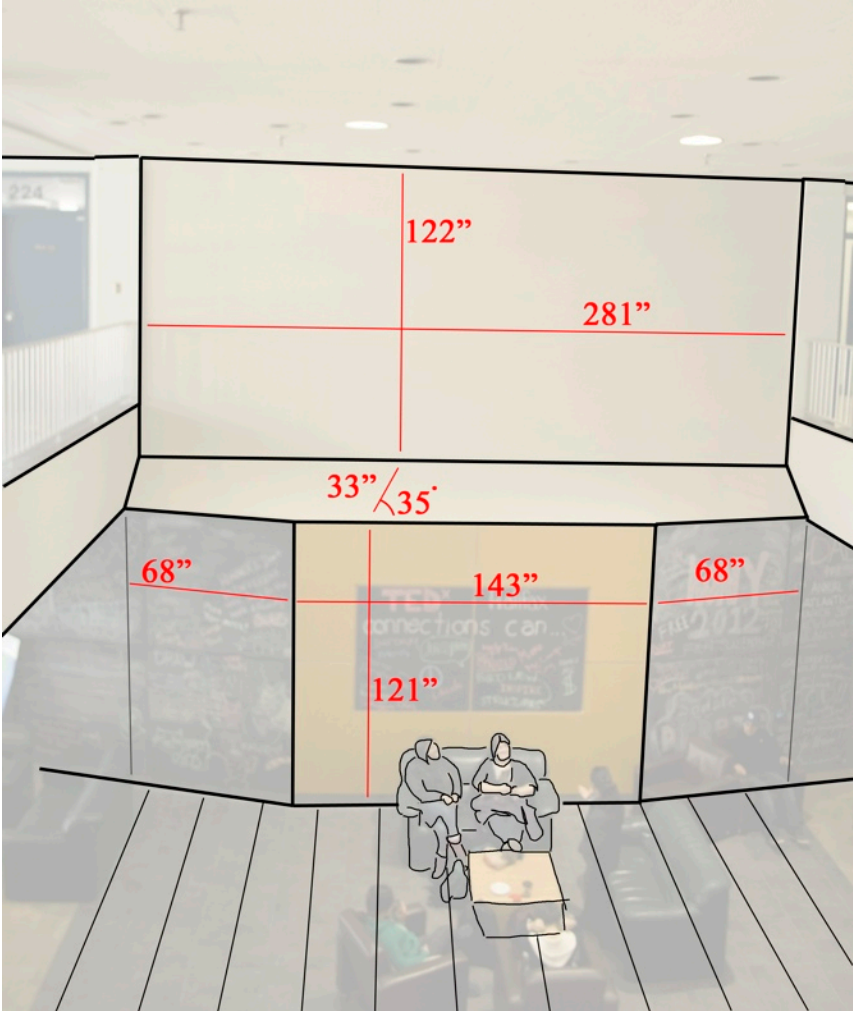


Figure 1: Schematic of east wall of SUB atrium.

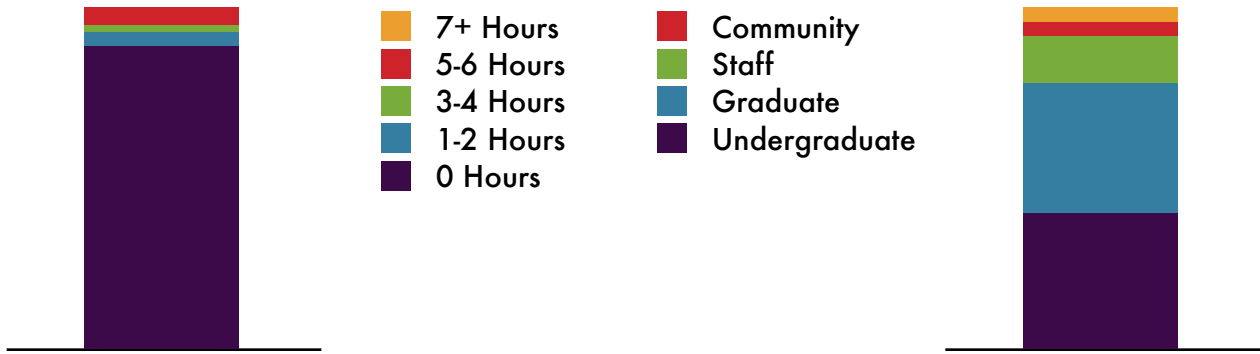


Figure 2: Survey results, time spent in SUB per week.

Figure 3: Survey results; demographic of survey participants.

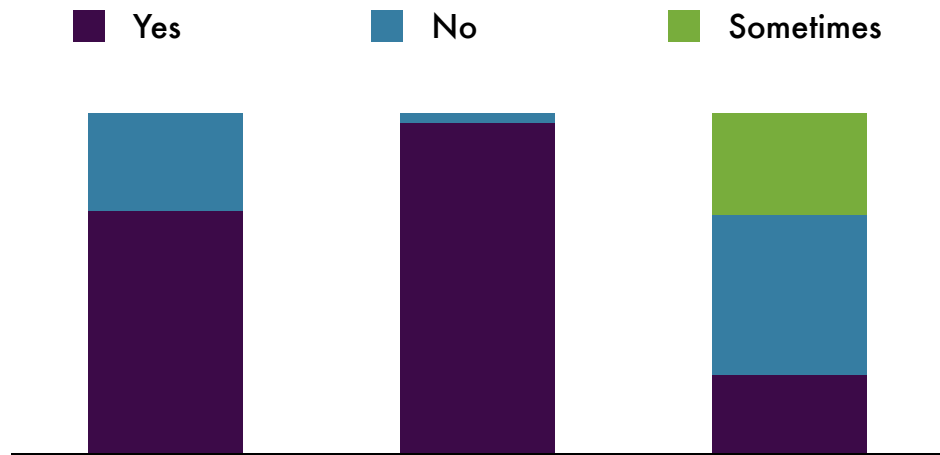


Figure 4: Survey question, are you concerned with environmental issues on campus?

Figure 5: Survey question, do you enjoy being outdoors/around plants?

Figure 6: Survey question, do you notice the plants in the SUB?

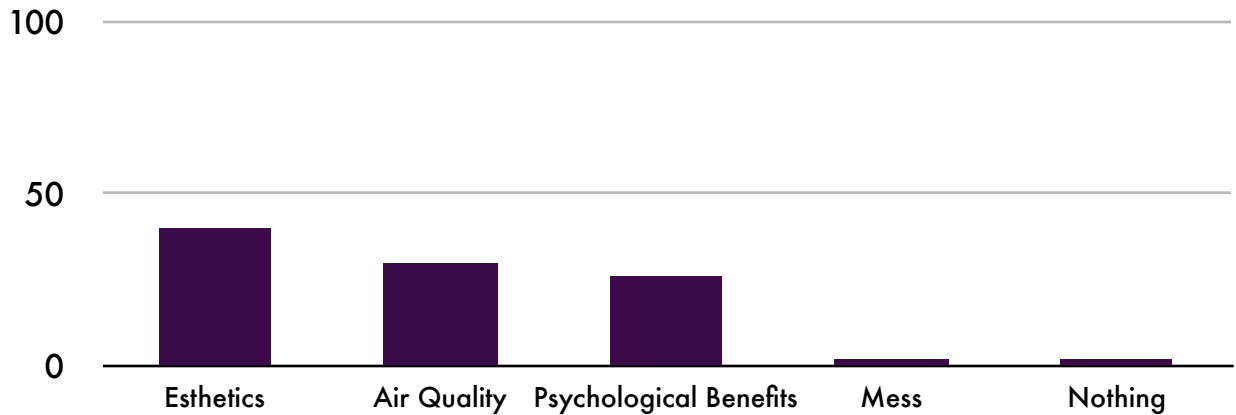


Figure 7: Survey question, what of the following do you think plants add to a space?

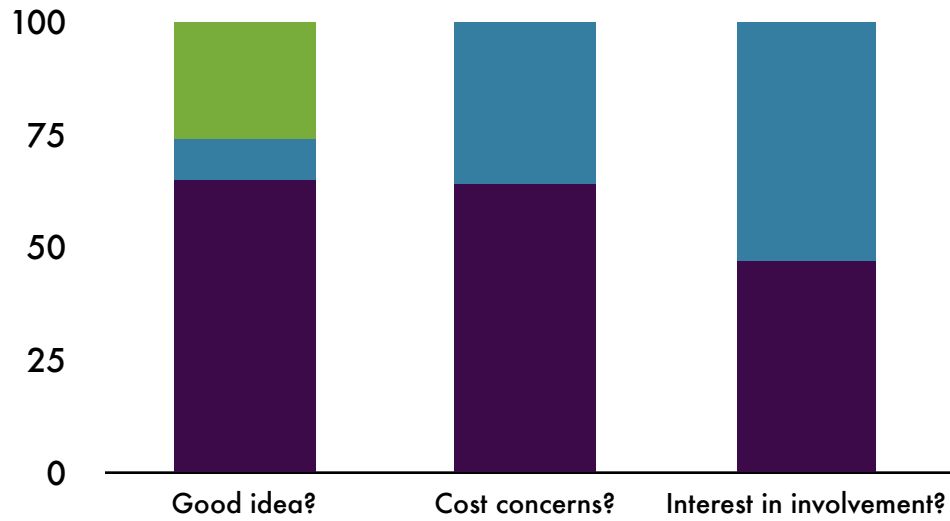


Figure 8: Survey questions; do you think a green wall is a good idea?; would you be concerned about costs and maintenance?; would you be interested in being involved?

- Do not care
- No
- Yes

