Feasibility and desirability of implementing a vertical garden on LSC Building of Dalhousie University's Studley Campus.

ENVS/SUST 3502: Environmental Problem Solving, Campus as a Living Lab
Dalhousie University
April 10, 2018

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Executive Summary

This study provides information regarding the feasibility and sustainability of a vertical garden in the study area on the eighth floor of the Life Sciences Center (LSC) at Dalhousie University. We hope to use this garden to benefit the university community through increased green space, volunteer opportunity and affecting food security on campus. Multiple studies have found that green space implemented in cities can decrease stress and increase productivity (Ibrahim, Kelly, Adams, & Glazebrook, 2013). Stress and productivity are two large aspects of student's lives, and important to regulate. Also, we hope to introduce volunteer opportunities for students with the upkeep of this garden, especially in their first year of study. Lastly, we hope that we can donate our produce to local initiatives such as the Loaded Ladle in the Dalhousie Student Union Building on Studely Campus.

The chosen methods were cost analysis of the vertical garden and surveys to determine interest in the project as well as determine interest in volunteering to sustain the project. The cost analysis showed that the vertical garden would cost around $852.99, but costs could be reduced by roughly $186.97 if materials were donated or recycled. Survey responses were collected via in-person and online surveys. In the responses there were no indications that people using the space would enjoy it less with a vertical garden, and 91.4% of all respondents said they would enjoy the space more or much more. Among this group 71% indicated interest in volunteering to sustain the garden after installation.

Results showed that there is a high level of interest in installing and maintaining a vertical garden. Knowing that the total cost of materials is between $666.03 and $852.99 is important because it could be used to help solicit funding. Also, since results were very pro-vertical garden installation and sustainability, these figures could be used to strengthen any pitches for funding that may be given in the future.

It is recommended that this project be followed up with further studies to engage real-time use of the space and opinions after installation. Also, this study should be used as a base for possible future projects installing small-scale vertical gardens in public locations. However, criteria should be changed based on location, people using the space, plant types that can grow in that environment, among other considerations.

Introduction

In an urbanized society, most human activities take place inside a built space. At the university level students, staff, and faculty use concrete buildings to teach, organize, and interact. In most of these buildings there is a significant lack of green representation. This research paper investigates perception of installing a vertical garden and gauges interest in sustaining it into the future.

Currently, the rate of depression among university students is higher than in the general public (Ibrahim, Kelly, Adams, & Glazebrook, 2013). Studies suggest that access to green spaces are linked with lower levels of depression (Cohen-Cline, Turkheimer, & Duncan, 2015). Green spaces on campus allow students, especially at stressful times, to regain a sense of control and achieve calmness (Lau & Yang. 2009). Not only therapeutic, several studies suggest that green spaces can also aid with concentration and productivity. (Xing, Jones & Donnison. 2017). Furthermore, in a study looking for a link between students' retention in school and campus design, Hajrasouliha et al. found that the existence of green spaces in an 'urban setting' can create social interaction, providing the value of 'social connectedness' (2016). Based on this information it is important to assess the current state of green spaces on campus and work toward introducing a higher level of green exposure.

Although the Studley Campus of Dalhousie University has a large proportion of green cover, most of the greenery is not interactive and underutilized during winter. For this reason the group decided to look into the implementation of an indoor interactive green space: a vertical garden.

In literature, the term 'vertical garden' is often interchangeable and is better defined as Zero-Acreage Farming (ZFarming). ZFarming is rooted in decreasing the use of resources through opportunistic planning and upcycling that is often used for food production (Specht et al. 2014). Vertical gardens hold a significant social value in the campus but also have shown to improve conditions through air filtration (Bass. 2000), sound-absorption (Davis et al. 2017), and temperature regulation (Bass et al. 2000). These characteristics are therefore beneficial in reducing energy consumption in buildings (Xing, Jones & Donnison. 2017).

Based on the literature on vertical gardens and the benefits of green space to students and university members, we wanted to see what an interactive vertical garden on Dalhousie University would look like. We were interested in what would be the initial benefits of a

vertical garden and the impact of the project on people who utilize the garden or the space it is built in. As a result, our research team decided to implement a small-size vertical garden as a pilot project.

For the implementation of the project, it was crucial to identify the following aspects of the project: (1) selection of space suited for plant growth (criteria outlined below); (2) response from university members to the proposed project; (3) determine design and materials required for the project. We believe that once these aspects are established the pilot project can be proposed and possibly implemented in the near future.

Methods

Selection of Location

The first step of the project was to select a location for the test-pilot of the vertical garden. Location was important because it determined the dimensions and design of the garden. To pick the location several criteria were listed as necessary when thinking about spots on campus where implementation would be effective and beneficial.

The criteria that were listed as necessary for the space were: high amount of light exposure year-round, consistently warm/humid temperatures, lacking green representation, moderate to high amount of student interaction, and small enough to employ a physical test pilot. After considering various locations on campus it was deemed that the eighth floor study space of the LSC Biology and Geology wing would be the best candidate.

The windows of the study space face south meaning high exposure to sunshine year-round and even during the winter months. Also, the space has floor to ceiling windows which means that there wouldn't be any loss of sunlight or sunless areas. Due to the high amount of sunlight the space is very warm/humid year-round and during the winter months. The year-round warmth will be important for plants to thrive throughout the year indoors.

The size of the study space wasn't very large and could host around 10 people sitting at a time, but it wasn't typically full and had a moderate number of people (2 - 6) at any given time. Given that the space was small and typically used by a moderate proportion of students it would be good to fair to occupy some space with a garden. After installation the proportion of students would hopefully increase from moderate to high use and show improvement of the space. Also, the space did have greenery but the small trees located there were in the way of

the ocean view which was an important feature of the space. Due to this obstacle, we noted that it was important for our garden design to not disrupt the view.

Garden Design

The next step was to create a design for the vertical garden which was then assessed with a cost-analysis. When creating the design for the chosen area several criteria had to be met. The focusses of the design were: monetarily feasible, easy to install/remove, safe, and easy to maintain over time (including watering and replacing plants over time). The overall design concepts were drawn on by various designs found on Pinterest and Google Images.

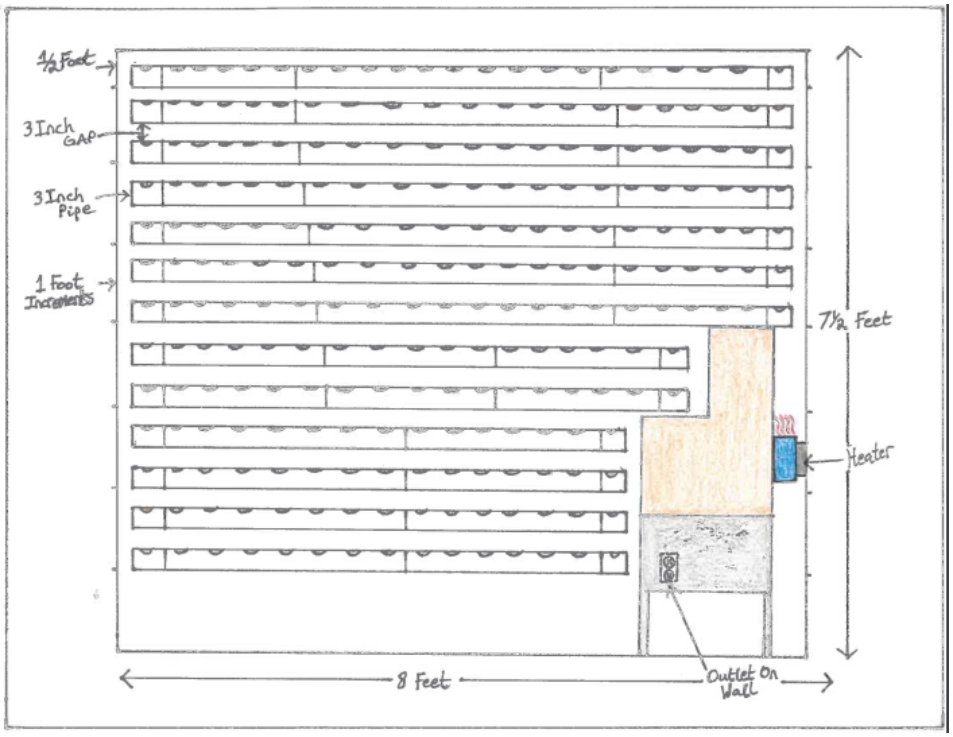

Figure 1 – Vertical garden design for the eighth floor study space of the LSC

Survey Methods

Questions on the survey were developed based on the need to gather information about: general opinion of the space, desirability of having a vertical garden, and availability of volunteers for maintenance. To gather this information surveys were printed out as physical copies and distributed in person by the research team. This proved beneficial because it allowed to see a representative sample of people who actually use the space. In an effort to reach more people with this research idea an online survey was created and distributed to colleagues as well as placed on posters in the study space. The online survey allowed for a larger pool of respondents when the team was not in the space to hand out physical surveys.

The online survey was also convenient for this study because it allowed for people to share it to colleagues who might also use the space and want to have a say in the project.

The research team spent several hours over the course of the week on different days and times to gather a sample that was representative of the people who used that space the most. Surveys were distributed in person Monday March 5th through Friday March 9th in the morning, noon and afternoon hours. In total the team dedicated roughly 20 hours of spending time in the study space and surveying people as they came into and left the study space.

Located in Appendix A is the full survey. Questions highlighted valuable information which needed to be gathered. “To what extent do you feel that you would enjoy the space if a vertical garden was implemented in this area?”, was an important Likert scale question posed to gauge student and faculty interest in having a vertical garden in the space. Another very important question for the sake of follow-up and sustainability of this project was, “If you are a student; would you be interested in volunteering to help maintain the vertical garden?”. This question was meant to determine whether there was enough availability of students to volunteer over the years to maintain the garden (watering, fertilizing, replacing plants, tending to sick plants, among other duties).

Results

Survey Response

The results from our survey performed on the 8th floor of the LSC showed evidence that people were in favor of the proposed vertical garden for the space. This survey was performed to gain data on whether our project would be valued or appreciated. We had 94 total responses on our survey, which was available online as well as paper copies that were circulated Monday March 5th to Friday March 9th (Figure 1). None of these respondents thought that the proposed vertical garden would not improve the proposed space. Of those responses, 82% were students (77/94) (figure 2).

Figure 2 Total survey response (N=94) when asked how much respondents thought proposed vertical garden would improve the 8th floor study area.

Figure 3 The association of survey respondents to Dalhousie University (N=94).

We also analyzed the faculty responses to our survey. We had seven total faculty responses (7.4%). Each of these responses said that they thought the study area would improve with the proposed vertical garden. Overall, none of the respondents from faculty thought the space would not improve with the proposed vertical garden.

We also asked the survey respondents if they would be interested in volunteering with the upkeep of the vertical garden (figure 3). Thirty-two students out of 84 were interested in volunteering with the project (38%). A large group of respondents also expressed interest in volunteering by answering “maybe” (33.33%).

Figure 4 Volunteer interest in maintaining the proposed vertical garden on the 8th floor of the LSC.

Garden Design Result

The finalized design for the vertical garden was a series of horizontal PVC pipes attached to three inch by six inch boards with ring clamps and and the wood boards anchored to the wall with masonry screws. Holes were drilled into the pipes to allow for the plants to grow and be watered. Also, one key aspect of the design was that a water-proof cover is accounted for so that any water spill would not harm the outlets in the corner of the space.

This design met the listed criteria because it only required basic equipment like drills for installation and maintenance. It was also safe because proper installation with masonry screws would prevent any failures or structural issues. One key feature of the design is that ring clamps could be loosened to allow easy removal and replacement of pipes when changing out soil. Another key to the design was that many materials could be repurposed to reduce costs. Many construction companies allow for scrap materials to be used in various projects to reduce waste and promote environmentally conscious practices.

Cost Analysis Results

Cost analysis was based on the design as mentioned in section **Garden Design** (see page 7).

Table 1 – Cost analysis of parts needed to build a vertical garden structure in the study area of the 8th floor in the LSC (8 foot by 7 foot wall space). Costs are based on materials found on the websites of Canadian Tire (Canadian n.d.) and Rona (Rona n.d.), Halifax locations.

Item	Amount	Cost	Sub Total	Total
PVC Pipe (3"X10')	13 lengths	13.99$/length	$181.87	$209.15
Masonry Screws (3/8”X4”, 12/box)	7 boxes	16.69$/box	$116.83	$134.35
Weatherproof Outlet Protector	1 unit	17.99$/unit	$17.99	$20.69
Wood(3”X6"X8')	13 lengths	8.29$/length	$107.77	$123.94
PVC Cement	1 tub	6.09$/tub	$6.90	$7.94
PVC End Caps	26 caps	2.29$/cap	$59.54	$68.47
Screws (3/4 inch, 100 screws/box)	1 box	10.99$/box	$10.99	$12.64
Paint	1 can	31.99$/can	$31.99	$36.79
Soil (107L bag)	6 bags	31.99$/bag	$191.94	$220.73
Seeds (by pouch)	8 pouches	1.99$/pouch	$15.92	$18.30
		Total	**$741.74**	**$852.99**

Discussion

Based off our survey response and cost-benefit analysis, we have determined that a vertical garden would be feasible to implement on the 8th floor of the LSC. A significant proportion of respondents to our survey were students who support the implementation of this project (Figure 2). They agree that the inclusion of a vertical garden into the study space will improve the area (Figure 1). Based off our results, we do feel that we have student interest in the proposed vertical garden. We also feel monetary need of the garden is reasonable and that we can gain funding based off of the interest our survey produced.

When doing analysis of these results in the future we will focus on Environmental Science students and Biology students. This is because the proposed area is on the Environmental Science floor of the LSC. We will focus on biology students because the greenhouse is property of the biology department. We feel it was important to have the biology students interest measured for when we take our data forward to maintenance and greenhouse management. Although only seven different faculty members responded to our survey, they all

agreed as well that the project would be beneficial and that they would like to see the garden installed. The response that students had to the prospect of volunteering with the project was another promising aspect of the survey. Strength in numbers in terms of student contribution to the project via volunteer work will benefit the scope of the project and allow for it to be monitored and maintained properly and effectively.

In terms of implications, our group recognizes the potential for the possibility of student investment into a project such as ours. Again, this is based off of the strong response we experienced in our interactions with students and faculty members. Allowing for this potential provides students with another way to contribute and get involved with volunteering. As students who started their degree in recent years, we recognize that first year students are interested in getting involved but that there is lacking opportunity at this level. Due to this, we would like to give lots of opportunity to first years to volunteer with the upkeep of this garden. To do this we will contact Susan Gass who teaches the first year environmental science class to get help spreading the opportunity. We plan to first give the opportunity to first year students. If they are not interested we feel that we have enough interest in upper year students based off our survey response to maintain the garden.

Monetary investments would also allow for us to improve upon the current project. If investments continued to grow, we could explore the potential to expand the project in order to implement similar designs in other spaces across Dalhousie's campus. When distributing surveys we were contacted by the co-chair of the Dalhousie Urban Garden Society. They were very interested in partnering with the project and were willing to donate funds to make this happen. We also have interest from the Environmental Program Students Society to donate funds as well as volunteer with the project. Based off of this interest, we feel that the $852.99 cost of the project is possible to meet.

As students who are aware of the mental health problems associated with being university students, we are excited to explore the potential benefits of vertical gardens. Green spaces have been shown to have a positive effect on well-being through restoration of stress and attentional fatigue (Groenewegen, 2006). With mental health problems being defined as a "university-crisis" it is necessary for institutions such as Dalhousie University to be a forward thinker and implementing design such as vertical gardens (Eisenburg, 2007).

Limitations

Limitations during the study were that a final garden design was not present in the form of artwork to demonstrate the design of the garden when the survey was distributed. This may have created a bias during sampling based on people's previous knowledge of vertical gardens because there are many different designs. Bias could have caused some people to tend to enjoy the idea of the garden more without an accurate representation or have a negative representation.

Something that was also limited was the amount of time that the team was able to dedicate to surveying during the week. Given more availability and resources the team would have preferred to spend roughly 40 hours during the sampling week to gather more information.

Conclusion

Initially, the aim of our research was to determine whether or not the possible implementation of a vertical garden project would be valued or appreciated by students and faculty. Based off of the results we gathered, there is significant evidence suggesting that majority of the target community want to see project come to life. Determining the interest around this project was important to our group as the findings will be useful when presenting the project for implementation. The next step for this project will be meeting with maintenance staff for the LSC Building to gain permission to move forward with this project. We will also contact Carmen Mills, LSC greenhouse director, to gain insight on the current student interactions with the greenhouse and consult her expertise for optimal plant species for the space.

When permission is granted, the next step will be sponsorship. Dalhousie Urban Garden Society, a levied student society on campus and EPSS, a student-managed society under the Faculty of Science both showed interest in participating by resource sharing (funding, volunteer base, knowledge-exchange). We aim to establish a volunteer base based on survey responses by reaching out to those who are interested in the project. We aim to have permission and funds set up at the beginning September, 2018 at the beginning of fall academic semester and have the garden installed by the December, 2018, in time for Dalhousie University's Winter Break.

Future research for this project should include an audit of how much produce there is from the garden, surveys gauging student response and looking for other potential spots for gardens if this one is successful. Once the garden is installed, we aim to measure how much produce there is on a monthly basis. The goal is to grow some produce to donate to the Loaded Ladle, a student-run food program at Dalhousie. If the garden is not successful at growing produce, efforts will be focused on creating an interactive, aesthetically appealing garden. We will also need to run surveys on student satisfaction with the garden's design and operation. Lastly, if this project is successful we will aim to help implement similar gardens across campus to increase green space.

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Acknowledgements

We would like to thank major contributors to the project for their dedication to giving us the appropriate tools for completing this kind of project. First we'd like to thank Professor Mui for teaching us throughout the semester in class and tutorials and giving us feedback/advice for the duration of the project. We would also like to thank Romeet Gonsalves for contributing feedback and advice over the duration of the project. Also, we would like to acknowledge the contributions of Rochelle Owen and Tarah Wright for taking the time to review our project and give feedback. Finally, we would like to say thanks to those who use the space and contributed to our project with their responses and contributing to what we consider as a strong proposal for the space.

Appendix 1.

Vertical Garden Survey

What is your association to Dalhousie University?
__ Student
__ Faculty
__ Staff member
__ Other: _____

What is your major (if student)
OR
What department do you work in (staff/faculty)?

_____

How often do you use this space per week?

__ Less than 1 hour a week
__ 1 - 3 hours a week
__ 4 - 6 hours a week
__ 7 or more hours a week

What do you like about this space? (Answer in a few words please)

_____

To what extent do you feel that you would enjoy the space more if a vertical garden was implemented in this area?

__ Much more
__ More
__ Neutral
__ Less
__ Much Less

If you are a student; would you be interested in volunteering to help maintain the vertical garden?

__ Yes
__ No
__ Maybe
__ Not sure

If you would like to follow this project or are interested in volunteering with the upkeep of this garden, please enter your email address here: _____