UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An Investigation into Heated Seat Cushions as a Substitute for Propane Patio Heaters for the Perch Restaurant

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EXECUTIVE SUMMARY

This report investigates alternatives to propane patio heaters to keep patrons warm with the goal of extending the Perch's patio hours. The Perch which is located in the new Student Union Building wishes to find a more sustainable option to heat its patio to align itself with LEED and acquire a platinum certification for the building. A triple bottom line analysis was conducted on heated seat cushions, propane, and electric table top heaters in order to compare their economic, environmental, and social viability.

For the triple bottom line assessment the following were compared: Vesture's microwaveable Microcore™ heat pad as the heated seat cushion, a 48,000 BTU standing propane heater, and AZ's electric tabletop heater. Carbon dioxide emissions were used to compare the environmental impact of each product. It was found that the heated seat cushions produced only 9.6 kilograms (kg) of CO_2 per hour whereas the propane patio heaters and electric table top heaters produced 30 kg per hour and 27.6 kg of CO_2 per hour respectively. CO_2 emissions were calculated based on the combustion of propane for a 48,000 BTU propane heater and electricity used by the electric table top heaters and to heat the seat cushions. In addition, the Microcore™ heat packs are composed of a glycerin-based liquid, whereas the propane and electric table top heaters are made of steel. Glycerin is an organic compound naturally found in abundance (Robinson, 2014), whereas steel is a metal which needs to be mined and processed. Based on CO_2 emissions and product materials, it was concluded that the heated seat cushions were the most environmentally sustainable of the three heating options.

The three products were compared economically based on their upfront product cost and their running costs. The initial cost for the 80 Microcore™ packs needed to heat a patio of 80 customers is $2344.00 after shipping and taxes. The electricity needed to heat all of the Microcore™ pads would cost $0.325 per hour. In comparison, the cost to buy ten standing propane heaters and their propane tanks is $2217.50, with a running cost of $6.00 per hour. To buy 23 table top heaters for each table on the Perch's patio, it would cost $3565.00 with a running cost of $9.72 per hour. These figures resulted in the purchase of 80 Microcore™ heat packs having the shortest cost recovery period in comparison to the electric table top heaters and propane heaters, thus making them the most economic option.

Propane heaters are the industry standard for heating outdoor patios at restaurant and are commonly used throughout Vancouver and UBC. In order to gather primary data regarding the social success of the Microcore™ microwaveable heat pads, a survey was conducted. Overall, participants responded very positively to the heated seat cushions, showing a 100% preference to the Microcore™ technology over propane heaters. Social assessment of electric table top heaters was compromised by the fact that the heaters must be plugged into a power source to operate. Due to the limited availability of electrical outlets on the patio, many electrical cables would be required creating an unsafe environment. There is also risks involved with propane heaters. In addition to the hassle of physically replacing the propane tanks, there is

also potential for leaks and their associated risks. While propane heaters have been the staple heating method for outdoor seating at restaurants, survey results indicate that people are willing to use the Microcore^{TM} heat pads as it would be a step in a more sustainable direction.

Overall, we recommend the purchase and use of the Microcore^{TM} heat pads to keep customers warm on the Perch restaurant's patio based on the environmental, economic, and social viability of the product. Student involvement may also be increased by using a UBC manufactured outer covering potentially made by the UBC Sewing Club or another student group. By using the heated seat cushions, the Perch's patio season may be extended to the end of October. This creative approach to keeping customer's warm can be harnessed by the Perch restaurant and potentially spread to other outdoor restaurants on campus, leading UBC towards a more sustainable future.

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GLOSSARY

Radiant heat:	Heat transferred by electromagnetic waves rather than conduction or convection, for example, heat from the sun.
Triple bottom line:	A way of assessing if an idea or implementation is sustainable by considering its environmental, financial, and social impacts.
Glycerin:	An odorless, colourless, thick, sweet liquid that is usually a by-product of soap manufacturing.
Thermoplastic:	A substance that becomes hard when cooled and soft after heating.

LIST OF ABBREVIATIONS

UBC	the University of British Columbia
BTU	British thermal unit
CO_2	Carbon dioxide
kg	Kilogram
hr	Hour
GHG	Greenhouse Gas
kWh	Kilowatt Hour
sq. ft.	Square feet

1.0 INTRODUCTION

From a sustainability standpoint, the major issue with conventional patio heaters are their use of gasoline – usually propane – to heat the people and objects around them. Since most patio heaters are radiant heaters, little heat is lost directly to the air as the whole point of patio heaters is to heat the people around them (Roth, Dieckmann, and Brodrick, 2007). However, when no humans that require heating are present, the heaters are effectively heating their surrounding objects, which will then release the heat because of the colder air surrounding them. In consideration of this loss of energy, it is more efficient for people sitting outside to be warmed by direct contact with a heat source in order to minimize energy and heat loss. Sitting on top of a heated seat cushion best fits this constraint.

The environmental impact heated seat cushions have in terms of energy consumption versus heat output over time will be compared to the energy consumption of a typical patio heater. To compare the two, the carbon dioxide (CO_2) emissions produced by propane patio heaters, electric table top heaters, and in the heating of the seat cushions will be compared with each other. Since a heated seat cushion will only be heated up when a customer needs it, it is speculated that the heated seat cushions will consume less energy and have a smaller environmental impact in comparison to the propane and electrical heaters which will be operating most of the time.

Implementing the heated seat cushions will also depend on their running cost. The running cost will be calculated by the electricity used to heat up a seat cushion, the time it takes for the restaurant server to heat it up, and its initial cost. It will also be compared to the running cost of the traditional heating methods.

Alongside economic and environmental impacts, social aspects also need to be accounted for. Normally, the customers in a restaurant do not sit on a heated seat while eating their meal, however many people sit on similar heated seats in their vehicles while they drive. Safety and health factors of those both sitting on the heat pads and those operating them must also be considered. The opinions of potential customers need to be taken into consideration before implementing heated seat cushions in order to stay warm on the patio outside.

This triple bottom line assessment* is detailed in the following sections. According to the layout plan for The Perch’s patio, the floor space is about 2100 square feet (sq. ft.), and there are eighty seats available. When comparing between propane heaters and heated seat cushions the case where the patio is completely full will be considered... The findings will be considered as a whole to find a sustainable, practical, and portable option to keep customers warm while enjoying the Perch restaurant's patio.

2.0 METHODOLOGY

2.1 PRIMARY SOURCES

A survey was conducted in order to obtain feedback on the customer satisfaction of people who used the Microcore^{TM} cushions. The survey included a variety of age groups and asked questions relating to the user's comfort and warmth before and after using the cushion. The survey also included questions about the effect of the cushion's appearance on user experience, how long the cushion stayed warm, and whether users preferred the cushion over propane heat.

2.2 SECONDARY SOURCES

In order to find information on a majority of the topics discussed in this report, sources such as websites and scholarly articles were consulted. These sources were used to find information on: things that are not easily measurable; such as CO_2 emissions, the cost of products, materials, and energy costs for the different methods of heating.

2.3 CALCULATIONS

The following calculations have been made: the amount of CO_2 emissions produced by each heating method was to compare environmental impacts, the cost of purchasing each method and its accompanying running costs was calculated, and the approximate time it will take to recover the cost of each heating method for financial impacts.

3.0 ENVIRONMENTAL IMPACT

3.1 HEATED SEAT CUSHION

The heated seat cushion used for this investigation was "Lava Buns" by Vesture. Lava Buns contains two parts: a cushion covering made in China and a liquid heat pack, referred to as the Microcore™, which is made in the USA.

3.1.1 Microcore™ Heat Pad and External Cover

The covering is comprised of a 100% polyester cover shell, and a 100% polyester cover filler. The Microcore™ element contains a proprietary heatable liquid comprised mostly of glycerin*, which is encapsulated by a thermoplastic* envelope (U.S. Patent No. 5,545,198, 1996). The glycerin liquid is a fairly sustainable as glycerin is a natural component in all living organisms and is not considered toxic. In addition, glycerin is safe to dispose in small amounts in water sources since it decomposes relatively fast into unreactive organic molecules (BenchMark Energy Corporation, 2012).The cushion covering on the other hand is not sustainable due to its use of polyester which is inherently a petroleum based product.

Due to the harsh negative effects of polyester production, it is suggested to use another more sustainable external material, such as organic cotton or recycled polyester. Organic cotton production uses natural fertilizers and pesticides which ensure that the fertility of soil is maintained or improved and groundwater and water bodies are kept free of synthetic chemicals (Organic cotton, 2014). Recycled polyester is another sustainable fabric choice as it is made from recycled plastic bottles and other plastic materials; this diverts bottles and other plastics from ending up in landfills (O Ecotextiles, 2009).

The electricity provided by BC Hydro results in 0.8 kilograms (kg) of CO_2 emissions per kilowatt hour (kWh) (BC Sustainable Energy Association, 2014). The Lava buns require heating in a 1000 watt microwave for six minutes to produce the required heat to keep a customer warm for a meal, which is approximately an hour. A microwave running on high temperature for 6 minutes uses approximately 0.14 kWh. The CO_2 produced by heating one Lava bun is 0.12 kg. Since there will be 80 seats, and in the case they are all full, 80 Lava buns will be required which results in 9.6 kg of CO_2 to be produced per hour (BC Sustainable Energy Association, 2014).

3.2 PROPANE HEATERS

The combustion process of propane reacts with oxygen (Tang et al, 2008) in the presence of an energy source; either a spark or flame. This reaction produces CO_2, a greenhouse gas (GHG) alongside carbon monoxide, and water. A typical patio heater can heat an area of about 210 sq. ft. with a heat output of 48,000 British Thermal Units (BTU) (Walmart Canada, 2014). Considering if the entire patio seating was full, the propane heaters would need to cover an area of approximately 2100 sq. ft. This would mean there would have to be 10 heaters to cover the entire floor, with some cold spots because the heat covers a circular shape.

Since the heat output is 48,000 BTU, it would produce that much heat per hour at its maximum setting. At full patio capacity there are ten heaters turned on which would result in 480,000 BTU of heat per hour, and since 62.3 kg of CO_2 is released per million BTU, about 30 kg CO_2 will be released per hour (Energetics, 2009).

In the case there aren't many guests and in consideration of the goals UBC has, the GHG produced by the propane could be minimized by seating guests closer together. Instead of having for example, three heaters on, one for each group, one heater could keep those three groups warm.

3.3 ELECTRIC TABLE TOP HEATERS

Since electricity provided by BC Hydro produces 0.8 kg of CO_2 emissions per kWh (BC Sustainable Energy Association, 2014), a single electric table top patio heater operating at 1.5 kWh would create 1.2 kg of CO_2 emissions for an hour of operation. According to The Perch's patio seating plan, there will be twenty-three tables on the patio. Therefore, if each table has an electric heater, this will create ~27.6 kg of CO_2 emissions for each hour if all twenty-three heaters are operating.

3.4 COMPARISON

Table 1. CO_2 emissions comparison.

	Microcore Heat Cushion	Propane Heater	Electric Heater
CO_2 Emissions	9.6 kg/hr	30 kg/hr	27.6 kg/hr

The electric table top heaters and propane heaters produce approximately the same amount of CO_2 emissions per hour. In comparison, the heated seat cushions indirectly produce about a third of CO_2 emissions of the other two options. Environmentally, the heated seat cushions are the best choice.

4.0 FINANCIAL IMPACT

4.1 HEATED SEAT CUSHION

In order to achieve optimal temperatures, the Microcore^{TM} pack needs to be heated for three minutes on each side. A microwave running on high temperature for 6 minutes uses approximately 0.144 kWh (BChydro, 2014). Electricity costs 11.27 cents per kilo watt hour, which equates to 1.62 cents to microwave one Microcore^{TM} pack for six minutes (BC Hydro, 2014b). Assuming a heat pack only needs to be heated up once for the duration of a meal which roughly lasts one hour, it would cost the Perch $1.30 to keep a full patio of eighty customers warm per hour. Each Microcore^{TM} heating pack costs $11.00 before tax and shipping, therefore it will cost the Perch $880.00 to buy eighty heat packs before tax and shipping. In addition, the Perch will need to purchase microwaves to increase heating efficiency. Two 1000 Watt microwaves should also be purchased that could be plugged into outlets either in the kitchen or another area out of the customer's sight (BChydro, 2014).

4.1.1 UBC Manufactured Outer Covering

Rather than using the polyester covering that came with the "Lava Buns" product, which is made from an unsustainable material, outer coverings should be manufactured for the Microcore^{TM} heating pad. This outer padded covering would be made out of a sustainable material like recycled polyester or organic cotton. By manufacturing their own fabric covering for the heat pad, UBC and the Perch restaurant can also put their own branding on them.

Assuming each seat cushion requires 1 m^2 of fabric, the price of recycled polyester required to manufacture 80 seat cushions would range from $400 to $1600 (Alibaba, 2014a). The price of organic cotton required to manufacture 80 seat cushion would range from $80 to $240 (Alibaba, 2014b).

4.2 PROPANE HEATERS

The cost of the propane heater referred to under 'Environmental Impact' is $158 plus 12% tax, which totals to $176.96. An empty 20 lb. propane tank costs $39.99 (Canadian Tire, 2014) plus tax which is $44.79. Since ten patio heaters are required, the total upfront cost of both the heaters and propane cylinders will be $2217.50. One gallon of propane can produce 91,600 BTUs of heat (Pierce, 1998), which means every hour each patio heater would use about half a gallon of propane per heater per heater. This would result in five gallons of propane used per hour for all ten heaters. A 20 lb. tank can safely hold 4.7 gallons of propane (Nale, 2014) therefore, collectively, one propane tank of gas is used per hour of service for a full capacity patio. It costs $24 including taxes to refill a propane tank Gas station attendant (personal communication, November, 2014), therefore the maximum running cost of propane patio heaters is $24 per hour.

4.3 ELECTRIC TABLE TOP HEATERS

Each electric table top patio heater needs to be plugged into an outlet to provide heat. For a single electric table top patio heater that operates at 1.5 kWh it would cost $1.69 to be plugged in and turned on for an hour (BC Hydro, 2014b). If each of the twenty-three tables on the patio requires an electric table top patio heater, it will cost the Perch $38.87 each hour to heat its guests. In addition to energy costs, the upfront cost of a single electric tabletop heater is approximately $155.00 (Global Industrial, 2014a; Global Industrial, 2014b). Therefore, the cheapest upfront cost to purchase twenty-three electric table top patio heaters would be approximately $3565 before taxes.

4.4 COMPARISON

The running cost per hour is calculated assuming heating for 20 people.
The cost recovery period is calculated assuming a profit of $2 per customer and 20 customers per hour.

Table 2. Cost recovery comparison.

	Running cost per hour	Initial cost	Cost recovery period
Heated seat cushions	$0.325	$2344.00	59 hours
Propane heaters	$6.00	$2217.50	65 hours
Electric heaters	$9.72	$3565.00	118 hours

The cost recovery period of the heated seat cushions is the lowest. After the cost has been recovered, the heated seat cushions also provide the greatest profit at $39.67 per hour.

5.0 SOCIAL IMPACT

5.1 HEATED SEAT CUSHION

In order to gather primary information about the public's response to using heated seat cushions an experiment and survey was conducted on ten participants, 5 males and 5 females, who ranged from 19 to 66 years of age. While sitting on the seat cushion at a temperature ranging from 10°C to 15°C, the participants completed a series of questions which asked them to: rank the external appearance of the cushion, their initial and final temperature response to the cushion, and their initial and final comport levels. Results of the survey are summarized in the charts below:

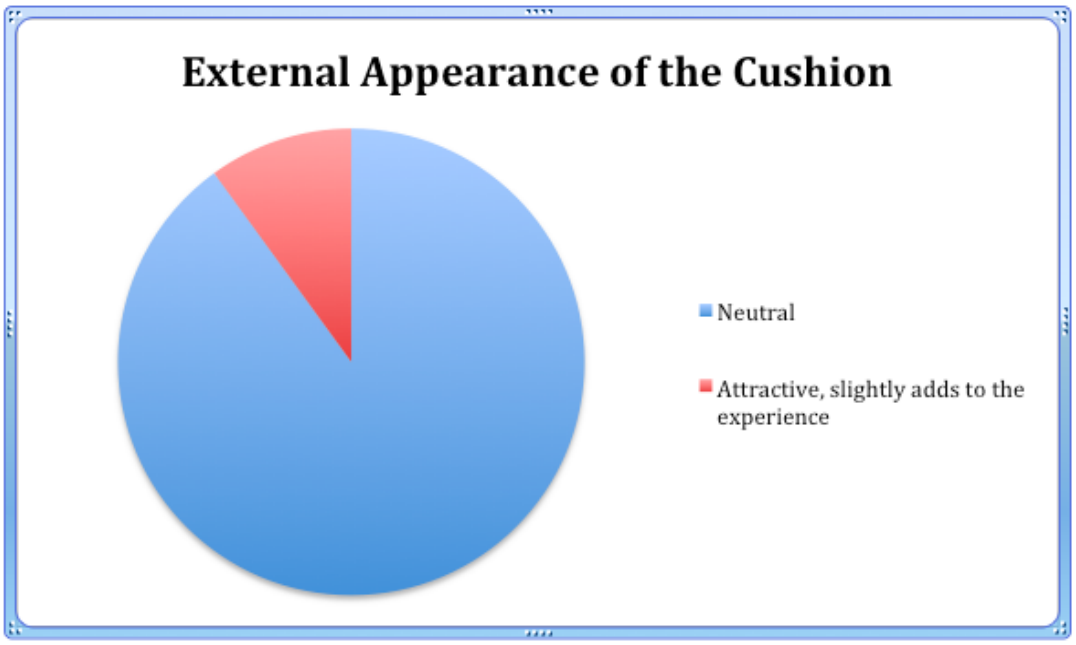

Figure 1. External appearance assessment

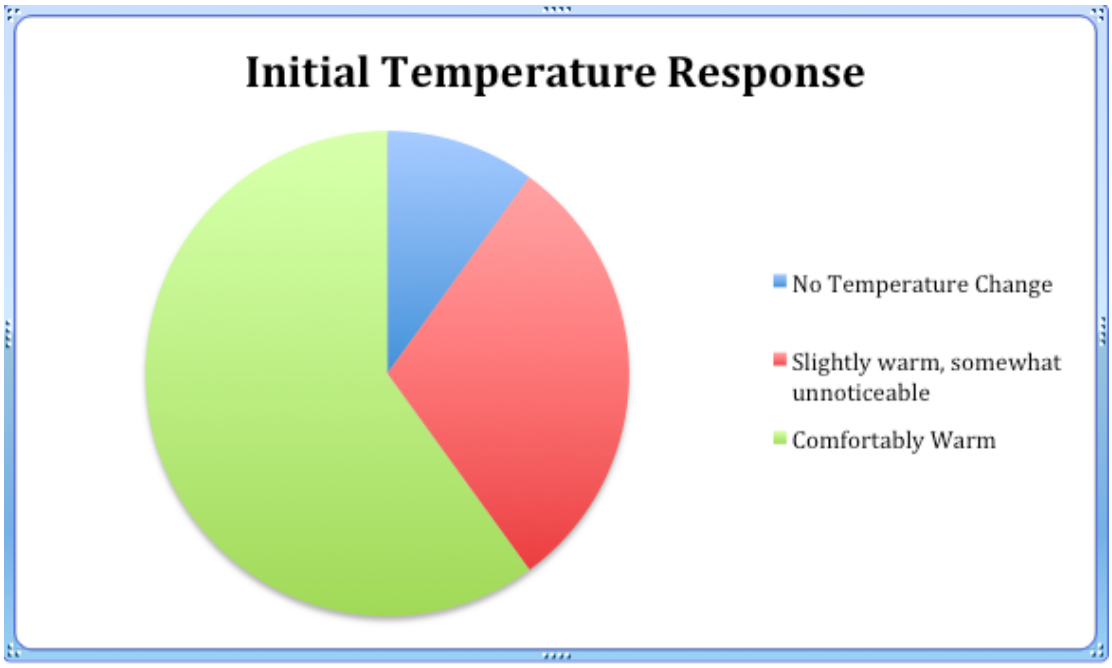

Figure 2. Initial temperature level of survey participants

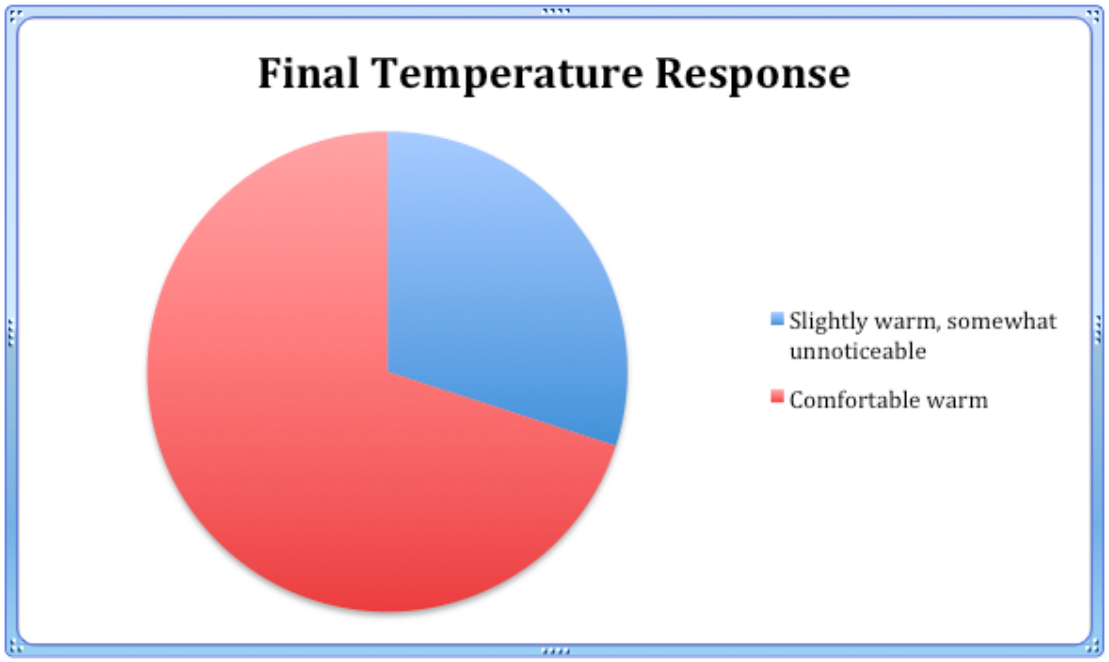

Figure 3. Final temperature level of survey participants

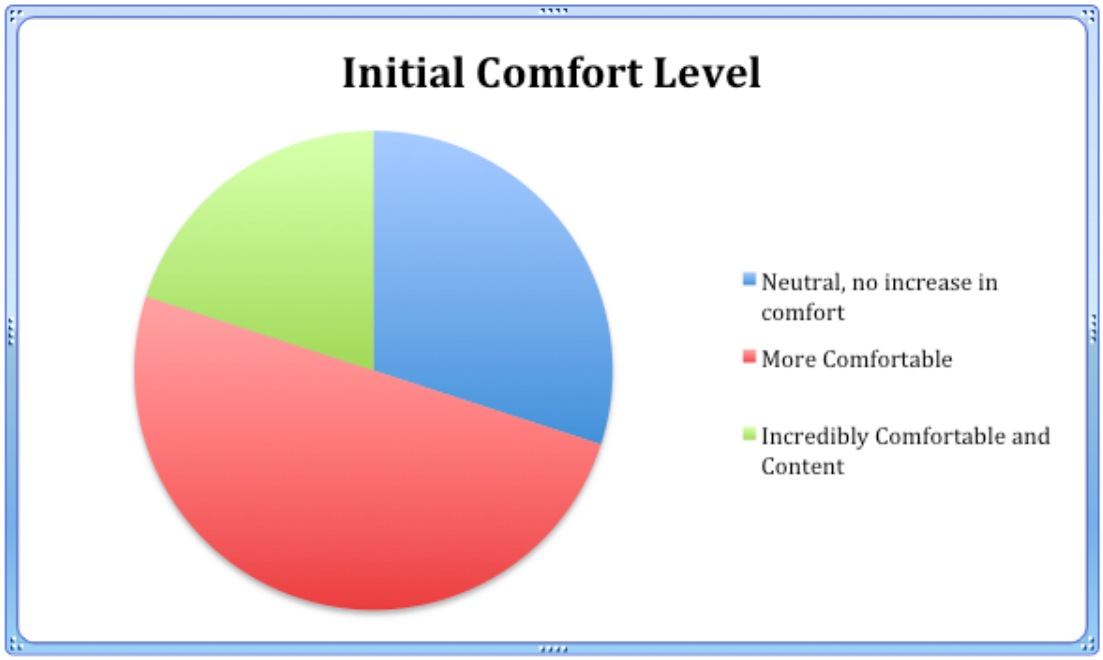

Figure 4. Initial comfort levels of survey participants

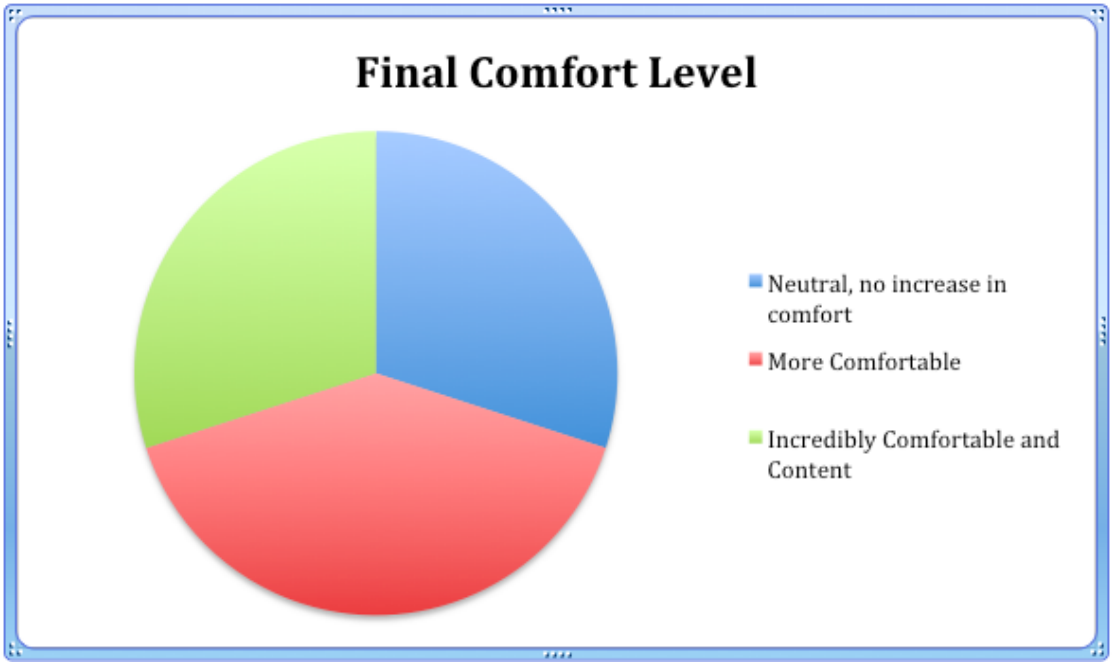

Figure 5. Final comfort levels of survey participants

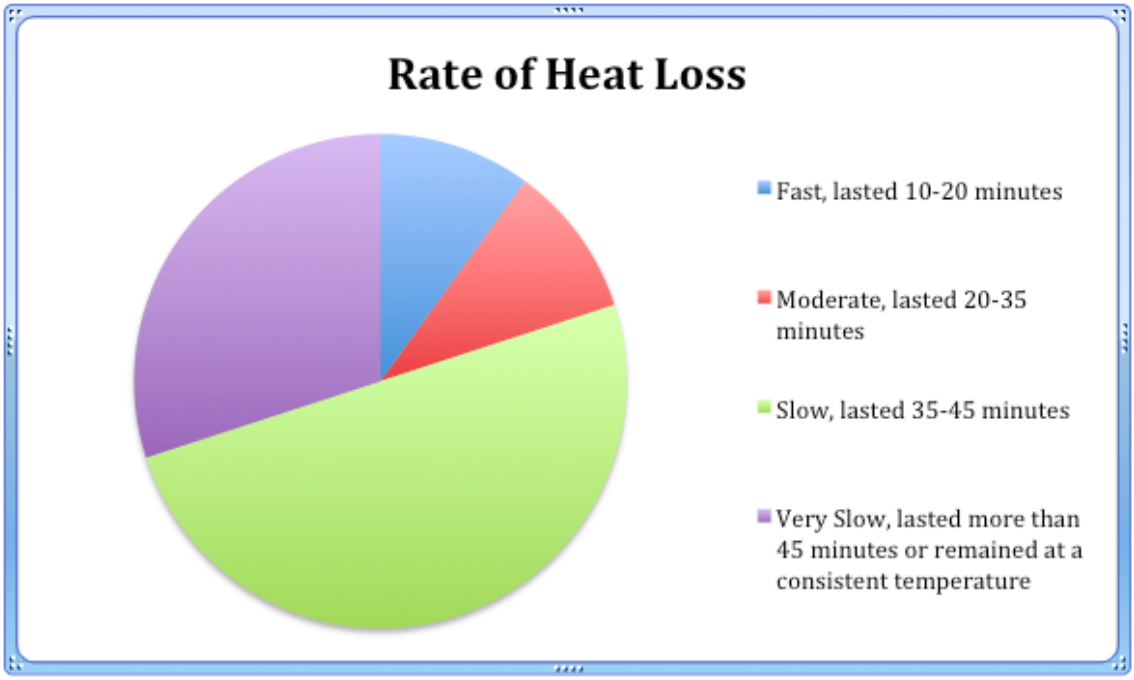

Figure 6. Estimated rate of heat loss by survey participants

The following comments were also provided by survey participants:

- "Direct contact with the heat source makes the heated seat more efficient. It is also more comfortable!"
- "After it has already been heated by another user, I only needed to heat it up in the microwave for 1.5 minutes to reach a comfortable temperature."
- "Great idea, but will be difficult to compete with patio heaters. Think of in a vehicle. When people use seat heaters in a car they don't stop using the regular heating system because the heat doesn't travel to your extremities."

From the data above, one can gather that the Microcore™ heating pad maintains a constant temperature for roughly 45 minutes. Participants were also told that the heated seat cushions were a more sustainable option compared to propane heaters. After being informed of this fact, participants were then asked whether they preferred propane patio heaters or the heated seat cushion. The results of this question was that they all preferred the heated seat cushion. Overall, the survey results indicate that the heated seat cushion provides sufficient heat and customer satisfaction.

5.1.1 Heated Seat Cushion Safety

The heated seat cushions have a very low operational risk. Potential for harm only arises in microwave operation. Waiters and other individuals who take the Microcore™ pad in and out of the microwave should wear heat protecting gloves, as the pad can become quite hot after it has been completely heated. The Microcore™ pad also has a built in sponge that is compressed to 40% of its size (U.S. Patent No. 5,545,198, 1996). The sponge ensures that if the pad ruptures, external leakage will be minimized. In addition, the Microcore™ pad contains a proprietary liquid solution composed of glycerin and other non-toxic chemicals. Therefore, if the pad were to rupture creating an external leak, there would be a very low risk in negative health effects.

5.2 PROPANE HEATERS

Since propane heaters are the industry standard for pubs and restaurant (Hitchings, R.2007), staff may already know how to use and maintain the propane heaters. Additionally, customers will not have any qualms against their use in terms of comfort, because they would know what to expect from these heaters.

One of the issues that could arise is the restaurant staff may find it tedious to have to swap and refill the propane tanks and some of them may find them too heavy to carry.

5.3 ELECTRIC TABLE TOP HEATERS

Electric table top heaters are similar to propane heaters because they are also radiant heaters so the overall comfort level would be good. However, they will also create some drawbacks in comparison to propane heaters and heated seat cushions. One drawback is that a table top heater will take up space on the dining table, creating less space for guests which could be awkward and cause discomfort. In addition, the restaurant would require extension cords and cables to plug the heaters into as there are minimal electrical outlets on the patio. Having cords running along the floor of the patio to multiple tables would create a tripping hazard for guests and servers. In terms of being able to clear the patio for different functions, table top heaters would require a lot more work to setup the tables again due to having to tape or pin the wires down again.

5.4 COMPARISON

The electric table top heaters present the greatest inconvenience in use because it minimizes table space, requires a lot of time to set up, and creates a tripping hazard because of the required extension cords. They would also put a strain on the perch's limited number of electric outlets. The propane heaters on the other hand are independent structures and can easily be moved around. In addition, the propane patio heaters are the industry standard for patio heating in Vancouver and are commonly used in many restaurants. However, the results of the survey indicate that the heated seat cushions increased the comfort and temperature of users. In addition, all survey participants indicated that they preferred the heated seat cushions over propane heaters, especially since they are more environmentally sustainable. It can be gathered that the heated seat cushions can compete with the comfort and heating capabilities of propane patio heaters.

6.0 RECOMMENDATIONS

Based on the preceding sections it is recommended that the Microcore™ heated seat pack be used to keep customers warm on the Perch restaurant patio as it is the most sustainable option. It is suggested that the Perch purchases a minimum of 80 Microcore™ pads and two microwaves to be prepared for the situation where the patio is completely full. When the patio is not completely full, the extra heated seat cushions can be used as a heated backrest.

Using a sustainable material to manufacture a covering for the Microcore™ also provides a potential opportunity for increased student engagement. Instead of paying for manufacturing of the Microcore™ covering, the Perch restaurant could request the UBC Sewing Club to help with the design and actual construction of the padded covers.

Since the heated seat cushions are in direct contact with the body of the customer, this is a very efficient way to keep guests warm compared to a radiant heater placed further away from them, as minimal heat is lost to surrounding air and objects. As a result, the use of heated seat cushions could potentially extend the patio season to the end of October.

7.0 CONCLUSION

Based on the previous evaluations of heated seat cushions, propane patio heaters, and electric table top heaters, it is concluded that heated seat cushions are the most economically, socially and environmentally viable heating option. Environmentally, the heated seat cushion is a much more sustainable choice in comparison to propane patio heaters as they create about a third of the amount of CO_2 emissions as a propane heater does per hour. In addition, the upfront cost of Microcore™ heat packs for the entire patio is a slight $126.50 more than that for propane heaters. However, the running cost of the heated seat cushions is substantially less expensive compared to propane patio heaters. This results in the total cost recovery period for the heated seat cushions to be shorter than that of propane heaters. Through a survey conducted on individuals aged 19-66, it was found that the overall response to the heated seat cushions was very positive. According to the survey, the majority of participants experienced enhanced comfort by the heated seat cushion, which maintained a comfortably warm temperature for about an average of 45 minutes. Although patio heaters are the industry standard for heating and commonly used in many popular restaurants throughout Vancouver, the survey results indicate that heated seat cushions can compete with the comfort and temperature level that propane heaters provide. Overall, using the Microcore™ heating packs with a UBC manufactured outer covering is the most sustainable heating choice for the Perch restaurant patio according to the triple bottom line assessment.

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