

AN INVESTIGATION INTO OPTIMAL PERSONAL HEATER - HEATED SEAT CUSHION

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APSC 262

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UBC Social Ecological Economic Development Studies (SEEDS) Student Report

**AN INVESTIGATION INTO OPTIMAL PERSONAL HEATER -
HEATED SEAT CUSHION**

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ABSTRACT

This report discusses the investigative procedure involved in the selection of an optimal personal space heater: heated seat cushion, and an in depth analysis of our choice. The purpose of this project was to use the Triple Bottom Line approach to identify the most economically and environmentally viable personal space heater that could be used at the workstations at UBC. All the available models in greater Vancouver were thoroughly investigated using the Triple Bottom Line analysis, and one specific personal space heater model was identified. Data for this project has been collected from both primary and secondary sources. This project is a component of a trade-in program conducted by UBC's Social Ecological Economic Development Studies program (SEEDS) where employees can trade in their heaters for a more environmentally friendly and energy efficient model at no cost. The cost of the new heater can be recouped from the money saved from the electricity, preferably over a span of two years. The Triple Bottom Line assessment of the cost of purchase, and energy cost savings was evaluated based on the assumption that the heater will be used for 600 hours per year as per our stakeholder, Ms. Kara McDougall. The results of our analysis, helped us narrow down upon the TheraPad Cush Seat Warmer, as the best model for use. The environmental aspect compared the energy cost and the CO_2 emissions. The social aspect as well as the survey results confirm that the most important factors in heater selection were safety, low noise, size, material and comfort. The TheraPad Cush Seat Warmer is safe, comfortable, and affordable and has absolutely no noise.

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GLOSSARY

TBL: Triple Bottom Line (TBL) is a framework with three parts: social, environmental and financial.

SEEDS: Social Ecological Economic Development Studies

1.0 INTRODUCTION

Offices spaces, or institutions with large number of employees require good insulation during severe winters to provide a comfortable working environment to its staff and faculties. Thermal comfort varies from person to person, based on age, body metabolic rates, culture and many other factors. Hence, choosing a design that provides thermal comfort best can be quite challenging. Personal heaters are mostly used in offices to address this problem. A typical convection heater would require at least 1500 W to operate, which is equal to fifteen 100 W light bulbs operating at the same time in a single room. This can lead to overloading of the power grid and cause the circuit breaker to trip. It can potentially disrupt the building's internal HVAC sensors which instead trigger the cooling system, causing more discomfort. As per the results of our survey and personal observation, ceramic space heaters are commonly used among the UBC staff, which has its own set of problems. These heaters increase the overall energy consumption and demand of the whole building, and may overload the electrical circuit. Therefore, investigation for an alternate more energy efficient model is required, and this project explores all the different options available and narrows down to the use of heated seat cushions for workspaces.

2.0 BACKGROUND

Personal heaters are one of the popular choices to keep one self warm in office spaces. Based on the method of heating, personal heaters can be categorized into convection heaters, radiation heaters, and heated accessories such as heated seat cushions or blankets.

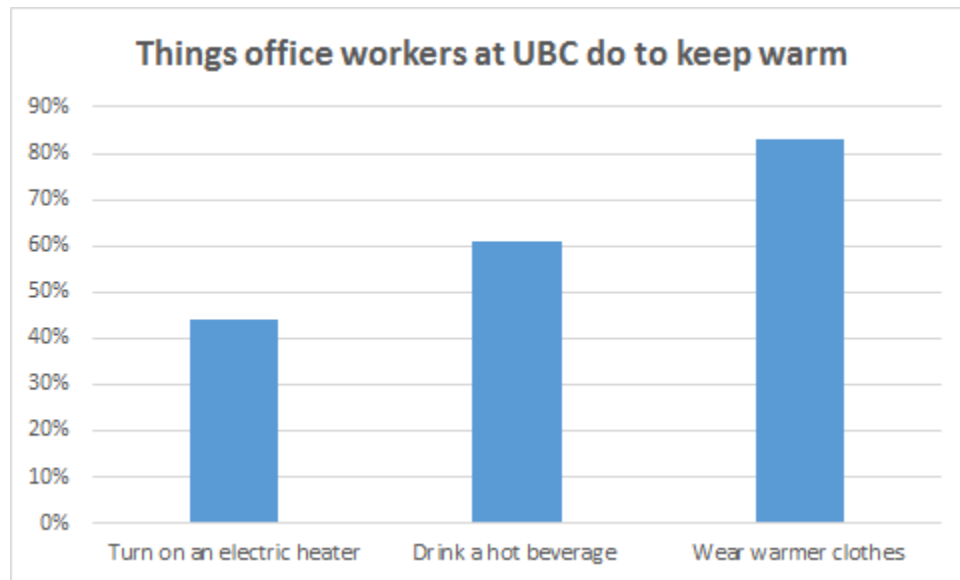


Figure 1: Things office workers at UBC do to keep warm

2.1 CONVECTION HEATER

Convection heater works on the principle of air convection currents through the body of the appliance. The heat generated is usually by the heating element, which is usually a high resistance coils, to surrounding air through a fan. Most oil based heaters also follow a similar principle. They are available in both wall-mounted and portable stand-alone types. Most convection heater models available are not very expensive, such as this 1500W model illustrated below, which only costs \$16.99. The Impress 1500 Watt is well equipped with variable thermostat, inner windshield, and auto-safety shut-off feature.



Figure 2: Impress 1500 Watt 2 Speed Fan Heater (Amazon, 2015)

However, it also has numerous problems and hence, is not the most reliable choice.

- Buildings in UBC are installed with HVAC system to maintain a certain temperature. When the air is heated up by the personal heater, the HVAC system will try to reduce the room temperature.
- It has very high power consumption
- The ambient noise created the fan can be unpleasant to some people.

2.2 RADIATION HEATER

Radiation heater is designed to replace the traditional convection heater. Instead of heating up the air to transfer the heat, radiation energy is released from the heater to heat up the object directly. As a result, it will not interfere with the HVAC system and have no fan noise.



Figure 3: Comfort Zone® Oscillating Parabolic Dish Radiant Heater (Amazon, 2015)

However, it is not cheap as a 1000W model illustrated below which cost \$129.95. Even though it is more efficient than the convection heater, it still a lot energy to keep the user warm.

2.3. HEATED SEAT CUSHION

Heated seat cushion and heated blanket heat by conduction. It is very similar to the heated blanket in principle but is a better option for the office environment. It can be used as an additional layer on the seat on which the user can sit on. Heat generated by the cushion can be transferred directly to the user, hence it requires much less energy to keep the user warm. Therefore, since heated seat cushion has all the benefits of the heated blanket and also fits the office environment better. Also according to our stakeholder Ms. Kara McDougall, heated blankets are more suited to private use instead of use in a professional environment. Hence, heated seat cushion is perfectly suited to the needs of the UBC staff. The rest of the report will investigate three models of heated seat cushion in detail through TBL.



Figure 4: Lumbar Cushion (thewarmingstore, 2015)



Figure 5: TheraPad (Amazon, 2015)



Figure 6: Ergo Comfort (Amazon, 2015)

3.0 METHOD OF INVESTIGATION

3.1 PRIMARY INVESTIGATION

Besides conversations with the stakeholder, a survey was conducted at the Mary Bollert Hall and Woodward Instructional Resources Centre and 20 UBC staffs answered the survey. Seven people from the Woodward Instructional Resources Centre and thirteen people from Mary Bollert Hall participated in providing us valuable feedback. Offices in these buildings are shared between two to five people per room and the temperature cannot be set by an office worker. The survey itself is modified from a previous SEEDS project report. Refer to Appendix – A for a sample survey.

3.2 SECONDARY INVESTIGATION

Major secondary sources of information for this investigation are peer reviewed journals, online newspaper articles and published research papers on our topic of interest. Most of the information gained on the commercially available heater models was obtained from online catalogs of the leading suppliers such as Amazon, Walmart and Canadian Tire. These online catalogues were also a source of customer feedbacks and reviews that helped us assess the user experience of the heaters.

4.0 SOCIAL ANALYSIS

The social analysis of the three models was performed through a survey on the UBC staff, customer reviews, and product specifications of those models. The survey showed that Comfort and Safety are the most important factors when choosing a personal heater. The factors ranked after these two are related to how practical the personal heater is.

Table 1: Average Ranking of Top 4 Factors When Choosing a Personal Heater

Rank	Factors	Average Ranking
1	Comfort	1
2	Safety	1.75
3	Temperature control	2.33
4	Noise	2.38

4.1 COMFORT

Thermal comfort can be different from person to person, so no thermostat setting can make everybody happy. All of these three models can provide thermal comfort to the user without annoying their co-workers with warm air or fan noise. According to customer reviews, the cushions look like and feel like regular cushions and are very comfortable to sit on. However, people who never used heated cushions before may need some time to get used it (Amazon, 2015). People who have lower back pain prefer the Lumbar Cushion model and Ergo Comfort model (Amazon, 2015). They both have good lumbar support and also includes the massage function. The Ergo Comfort model has 8 strategically placed power magnets that promotes blood circulation and provide comfort for neck, back and lumbar areas to relieve stress and stiffness (Amazon, 2015). It turns a regular office chair to a heated massage chair. However, as Jun Yan, a staff member at the Woodward Instructional Resources Centre said, he would prefer to use the

massage seat cushion at home instead of at the office. According to him, it will not feel comfortable anymore when you sit on it all day long.

4.2 PRACTICALITY

All three models do not make any noise when used as heater, but they do make motor noise when in the “massage” mode. All three models are portable especially the TheraPad. It weighs less than half kilogram, and only 2 inches thick (the warming store, 2015). The small size also means they are great for small or crowded office since they do not use any ground space. One problem as Jun’s co-workers mentioned was that it was only her hands and feet which were cold. In that case, she can put the Lumbar Cushion model on the ground to warm up her feet. As the survey showed, 95% of the office worker only use personal heater for two months during the winter, but these seat cushions can be used throughout the year just as regular seat cushions when winter is over.

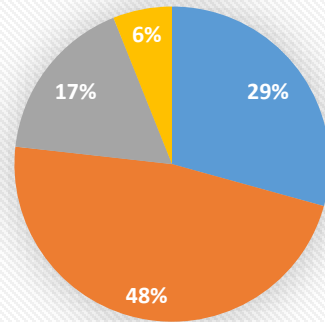
4.3 SAFETY

Compare with convection heater, the heating element of heated cushion operate at a much lower temperature and lower power level. It reduces the chance of power overload. The TheraPad model has auto-shutoff function which has a 10-hour shut off period (the warming store, 2015).

4.4 CONCLUSION OF SOCIAL ANALYSIS

The TheraPad model is the top recommended choice considering comfort, practicality, and safety. It feels and looks like a regular seat cushion which makes it an ideal choice for the office environment. It also has an auto-shutoff function which is the fifth ranked factor for choosing personal heater. The survey also showed that UBC office workers are willing to try this model.

How likely UBC Staff Would Use the TheraPad Model



■ Definitely ■ Maybe ■ Probably not ■ Definitely no

Figure 7: How likely UBC Staff Would Use the TheraPad Model

5.0 ECONOMIC ANALYSIS

5.1 PRODUCT COST

The cost of the three shortlisted heated seat cushion products is summarized below in Table 2 below.

Table 2: Product Cost Summary of Heated Seat Cushions

Model	Product Cost (CAD)	Product Cost/Watt (CAD)
Lumbar Cushion	\$ 27.40	\$1.83 / W
TheraPad	\$133.20	\$8.88 / W
Ergo Comfort	\$ 57.76	\$1.44 / W

The Lumbar Cushion heated seat cushion is has the lowest product cost of the three heaters. However, the Ergo Comfort heated seat cushion has a power rating of 40 W of heat in comparison to the other two products which have a power rating of 15 W. As a result, the product cost analysis took into account the heating capacities and determined a new metric which looks at product cost per Watt of heating capacity. The Ergo Comfort heated seat cushion has the lowest product cost per Watt of heating capacity.

5.2 OPERATIONAL COST

The cost of energy consumption is a major consideration in economic analysis. In traditional convection and radiation based heaters, there is considerable amount of energy consumption for heating up ambient air and objects. This distribution of heat is not only unwanted, but it also results in unnecessary utility bill charges. In comparison, the energy consumption of all three heated seat cushions is significantly lower than conventional convection and radiation based heater. The power consumption for all three heaters is summarized in Table 3 below:

Table 3: Power Consumption of Heated Seat Cushions

Model	Power Consumption (W)
Lumbar Cushion	15
TheraPad	15
Ergo Comfort	40
Dual TheraPad	30

The power consumption of a typical convection based personal space heater is 1500W. The power consumption of all three models of heated seat cushions is less than 3% of the 1500 W baseline. At first glance, the TheraPad and Lumbar Cushion models appear to have the lowest power consumption. However the economic metric must consider the power consumption in terms of heat delivered. All three models utilize electric resistance in the heating elements and deliver heat that is nearly proportional to the electric power consumption. Furthermore, the Ergo Comfort heat seat cushion model provides a heater backrest. In case, the user finds the heat or coverage of the TheraPad or Lumbar Cushion to be insufficient, he/she may wish to add supplementary sources of heating. The Lumbar Cushion product is designed for use in the lumbar region and cannot double up as a seat bottom. However, an additional instance of TheraPad may be used as a backrest for supplementary heating, consuming a total of 30W. The TheraPad, with its modular design, offers the advantage of being an expandable heating solution at very low operational cost.

5.3 DISPOSAL COST

Table 4 below summarizes the dimensional and weight data of the three heated seat cushion products.

Table 4: Dimensional and Weight Data of Heated Seat Cushions

Model	Product Dimensions (cm)	Product Weight (g)
Lumbar Cushion	12.7 x 38.1 x 30.5	450
TheraPad	43.2 x 43.2 x 5.1	1000
Ergo Comfort	48.5 x 47.0 x 8.9	1000

The Lumbar Cushion model is the lightest product with the smallest footprint. The Ergo Comfort model has the largest footprint. All three products are light enough to be handled with ease. However, the presence of vibrational motor components for massage in the Lumbar Cushion and Ergo Comfort models requires additional consideration to safely dispose electrical components. Based on complexity of disposal, TheraPad has the advantage of having fewer electrical components and is likely to have a cheaper cost of disposal.

5.4 MISCELLANEOUS COSTS

A key criterion for evaluating the shortlisted heater models from an economic standpoint is the impact it has on the building HVAC system. A typical convection heater raises the temperature of ambient air which may in turn trigger the cooling mode of large building HVAC system. This sequence of operation is not only counterintuitive but results in extravagant energy expenditure due to the large power requirements of central HVAC equipment. All three heated seat cushion models do not rely on heating the ambient air and hence, prevent the highly wasteful sequence of operation involving the cooling mode of central HVAC systems. However, the TheraPad model has an auto-shutoff feature that turns off the heater after 10 hours of use. This is a useful feature in preventing unnecessary energy wastage in the event that the user forgets to turn off the heater.

5.5 CONCLUSION OF ECONOMIC ANALYSIS

The results of the Economic Analysis described above reveal that the TheraPad heated seat cushion has a significant advantage over the Lumbar Cushion and ErgoComfort Heated Seat Cushions in operation, disposal and miscellaneous costs but have a very high initial product cost. As indicated by the stakeholders, the personal heater is expected to run 600 hours per year. As a

result, lower operational costs have the ability to provide a payback towards high initial product purchase costs. While the Lumbar Cushion and heated seat cushion does not stand as a clear winner in individual portions of the economic analysis, it strikes a reasonable balance between upfront purchase cost, operational cost, disposal cost and miscellaneous costs.

6.0 ENVIRONMENTAL ANALYSIS

6.1 ENERGY CONSUMPTION AND CARBON FOOTPRINT

As described in Section 5.2, the energy consumption of all three shortlisted heater products is less than 3% of the energy consumption of a typical 1500W convection heater. Energy consumption is a metric that is just as important to environmental analysis as it is to economic analysis. Whether or not the source of electricity is fossil fuel, wasteful dissipation of heat is still a negative contribution to the environment. The key consideration in this segment of environmental analysis is to provide thermal comfort thru minimal energy expenditure. While all three heated seat cushion models minimize wasteful dissipation of heat to raise the temperature of ambient air, the TheraPad heat seat cushion has an additional feature that automatically shuts off the device after ten hours of use to minimize energy wastage. None of the shortlisted heating products utilize combustion of carbon fuels to deliver heat.

6.2 MANUFACTURING LOCATION

The Lumbar Cushion and Ergo Comfort products are manufactured by Wagan Tech in USA. While a number of power accessories sold by Wagan Tech are made in China, the heated seat cushion products are assembled in the USA. However, the individual components of Wagan Tech's heated seat cushion products are not necessarily made in the USA or North America. In comparison, the TheraPad model is handcrafted by Shield Life in Korea.

6.3 CONCLUSION OF ENVIRONMENTAL ANALYSIS

Environmental analysis of the shortlisted heated seat cushion products revealed that all three products offer thermal comfort with low energy wastage. The TheraPad heated seat cushion model stood out with its auto-shutoff feature that ensures safety as well as prevents energy wastage. The environmental analysis took into consideration the location of manufacturing to determine the impact of product transportation on the environment. While two of the shortlisted models are assembled in the USA, Asia is a major source of electronic components in all three models. Additionally, import of heated seat cushion products from China and Asian countries only adds a marginal increase in the massive trade links with North America. As a result, conservation of energy takes precedence over location of manufacturing. With such consideration, the TheraPad heated seat cushion model is superior to the Ergo Comfort and Lumbar Cushion in minimizing damage to the environment during end-use.

7.0 CONCLUSION AND RECOMMENDATIONS

After a thorough investigation into the available convection, radiation and conduction heaters, the heated seat cushions were what was unanimously agreed on as the best recommendation for use at UBC's workstations. Furthermore, narrowing down to one specific heated seat cover model from all the three models that we investigated, was a great challenge. Keeping in mind several factors, including safety, comfort, requirement and most importantly aesthetics, a decision was taken that the Therapad would be the best option. According to the results of the research of customer reviews and user end experience, the TheraPad model is very highly recommended considering comfort, practicality, and safety. Results of Economic Analysis described above, the TheraPad heated seat cushion has a significant advantage over the Lumbar Cushion and Ergo Comfort Heated Seat Cushions in operation, disposal and miscellaneous costs but have a very high initial product cost. The TheraPad clearly has an advantage over Lumbar Cushion and heated seat cushion in terms of economic analysis, upfront purchase cost, operational cost, disposal cost and miscellaneous costs. All the three shortlisted heated seat cover models have similar wattage ratings and minimal energy wastage due to dissipation. Hence, as a conclusion the heated seat covers were a wise choice environmentally. However, what makes the Therapad unique is its advanced features, including the "auto-shutoff", which keeps the user's mind free of worry about turning the heater off! Hence, we created a better work environment with the introduction of TheraPad to work spaces. However, it could be challenging to get a clear picture of what would be comfortable for every single staff member. Our survey results only reflect what is comfortable for a majority. Hence, a recommendation would be that UBC allows some individuals to use the other two models described above in the report in case they found TheraPad uncomfortable. The Thermapad operates on DC current and hence a DC adaptor would be required to be able to be used

through the power supply on the walls. A final recommendation would be to ensure that a DC adaptor is also purchased along with the heater in case it is not already included.

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APPENDIX A – SAMPLE SURVEY

Thank you for taking the time to fill out this survey. This survey is being conducted as part of an APSC 262 class project to learn more about workplace attitudes toward thermal comfort and use of electrical heater. The results have the potential to contribute to energy efficiency and conservation in UBC buildings.

Please circle your choice of answer for each question below:

1. I care about energy conservation in my workplace.

I care very much – 1 2 3 4 5 – I do not care at all

2. I would guess that a portable heater uses as much electricity as:

- A) One 100 W light bulb B) Fifteen 100 W light bulbs C) fifty 100 W light bulbs
D) I don't know

3. To keep warm in my workplace, I currently do the following: (select all that apply)

- A) Drink a hot beverage G) Close window(s)
B) Wear warmer clothes H) Close blinds or curtains
C) Put on additional layers I) Get up and walk around
D) Use a blanket on my lap J) Turn on an electric heater
E) Use a shawl/throw around my shoulders K) Turn up the thermostat
F) Close door(s) L) Call UBC Building Operations
M) Other _____

If you answered J, please answer the following two questions

3.1 I typically need to use my personal heater in these months: (circle all that apply)
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

3.2 When I use my personal heater, I typically turn it on for (approx.) _____ hours per day

4. Please rank the top three factors in terms of importance when choosing a personal heater, 1 being most important

Appearance ___ Comfort ___ Ease of use ___ Price ___ Quality ___ Safety ___
Auto-shutoff ___ Noise ___ Max. heat output ___ Temperature control ___

5. If a replacement product were provided free of charge, I would be willing to use the following heated seat cushions instead of my current personal heater :

- A) Definitely
- B) Maybe
- C) Probably not
- D) Definitely no



Feature:

- lumbar support
- massage lower back

comment:

- A) Definitely
- B) Maybe
- C) Probably not
- D) Definitely no



Feature:

- easy to carry
- Hand Crafted

comment:

- A) Definitely
- B) Maybe
- C) Probably not
- D) Definitely no



Feature:

- lumbar support
- 8 massage motors

comment:

APPENDIX B – 3 X 3 VISUAL PRESENTATION

The 3 X 3 Visual Presentation is available at the following location for viewing:

http://prezi.com/uzsjxnek1m7o/?utm_campaign=share&utm_medium=copy

