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# UNROLLING THE TRUTH ABOUT PAPER TOWEL

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Social, Financial and Environmental Incentives for Why Dalhousie University,  
Halifax, NS Should Install Electric Air Hand-Dryers in Future Buildings



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## **1.0 Executive summary** (1 page)

This paper aims to outline one way Dalhousie University can contribute to combating landfill waste. With the increasing global population and room for waste already becoming an issue, there is bound to be detrimental consequences in the near future. This study seeks to provide incentives for Dalhousie to implement a policy requiring integration of electric air hand-dryers in new buildings on campus. In doing so, there are many benefits: one benefit being annual financial savings associated with the switch. As the university advances their sustainable practices on campus, it sets an example and precedence for other institutions throughout the province. The study utilizes a mixed methods approach with qualitative and quantitative data to investigate the research question.

For the qualitative approach, we conducted a survey targeting Studley campus student preferences for methods of hand-drying that would ultimately inform decisions made in the quantitative analysis. Results showed the majority of Studley campus students supported divestment from paper towel in newly constructed Dalhousie buildings, despite paper towel being the most preferred practice and paper towel perceptions as the most sanitary option amongst students.

For the quantitative analysis, a cost-benefit analysis (CBA) was conducted demonstrating cost saving calculations in regards to paper towel versus Dyson Airblade hand-dryers, being implemented in newly constructed Dalhousie buildings. Two simulated scenarios (increase in student auxiliary fee of \$2.00 and \$0.50) using a fictional new building, similar in design to the Mona Campbell Building, calculated break-even costs for Dyson Airblades installation throughout the building. The CBA found Dalhousie would save roughly \$2,081.25 annually by switching to the Dyson V Airblade, and could support implementation in new buildings by increasing auxiliary fees.

Ultimately, the debate between paper towel and electric hand-dryers is controversial; however, there is an increase in literature concluding electric air hand-dryers have less of an environmental impact and have been enhanced to address sanitation concerns. By pledging to integrate electric air dryers in new buildings on campus, Dalhousie University can enhance overall sustainability practices on campus. Based on our study we recommend an intersectional approach by implementing electric air hand-dryers and keeping paper towel as an available option when constructing new buildings on Dalhousie campus.

## 2.0 Introduction

Global waste is set to drastically increase over the next 30 years (The World Bank, 2018). Canada is having to react to battling new challenges regarding waste, and the impact is now being felt provincially. Nova Scotia has done well in managing waste, such as the fact that it is illegal to dump plastic into landfills within the province (Hounsell, 2018). However, this is coming to an end, as Nova Scotian waste facilities have applied for special permitting to reverse the policy and other compromises that have been made (Hounsell, 2018). That being said, Dalhousie University has the opportunity to influence a change within Halifax. Due to Dalhousie being the largest university in Atlantic Canada, actions made by the University have profound impacts throughout the province and beyond (Zoledziowski, 2018). By targeting paper towel reduction through implementation of electric hand-dryers in new buildings on campus, the university would be contributing to the overall reduction of waste diversion from Nova Scotia landfills. When comparing impacts of paper towel versus electric hand-dryers, hand-dryers have less environmental, social, and economic impacts (Budisulistiorini, 2007; Chatelain & Reeves, 2017). There are also other benefits associated with electric hand-dryers, such as financial savings and lower maintenance costs (Budisulistiorini, 2007). Without constantly contributing new efforts towards combating waste, Nova Scotia will continue to see new challenges arise.

### *Research Question:*

What are the environmental (financial & social) costs and benefits of Dalhousie University campuses implementing policy stating all newly constructed Dalhousie facilities must install electric hand-dryers, ensuring future use of hand-dryers as a more sustainable hand-drying option?

## 3.0 Background

### *3.1 Nova Scotia and Global Waste Management*

Global waste is on the rise: last year the World Bank released a statement warning global waste will increase to 70% by the year 2050 (The World Bank, 2018). This drastic growth is largely driven by factors such as urbanization, growing populations, globalization, and consumerism (The World Bank, 2018; UNEP, 2015). If our current waste is not properly dealt with, further environmental degradation will progressively threaten public health (UNEP, 2015). As global

waste becomes unmanageable, people resort to noxious compromises such as throwing waste into the streets (UNEP, 2015). The statement made above by the World Bank suggests history could end up repeating itself.

Currently, Canada is having to deal with a new challenge imposed by globalization. On December 31<sup>st</sup>, 2017, China shocked the global arena by refusing to accept recycled plastic and scrap paper (The Economist, 2018). China was known to be one of the biggest global collectors of recycled materials, importing roughly \$24 billion-worth of scrap annually (The Economist, 2018). Halifax itself relied heavily on exporting waste to China, as the municipality sent approximately 80% of recyclable materials overseas (Hounsell, 2018). However, Nova Scotia is known to be a very active and successful player in managing waste. Consequently, if China made the ban more stringent, Canada and other countries could face a detrimental increase in the number of challenges related to waste. As of 2012, approximately 60,000 tonnes of waste was incorrectly processed and sent as solid waste to Nova Scotia landfills (Butts, 2014). Even with many small-scale Nova Scotian initiatives and government commitments attending to waste diversion, there has been an increase in the amount of waste being sent to hometown landfills (Butts, 2014).

When paper towel resides in a landfill it causes harmful environmental consequences. Studies show that during the break down process of paper towel, it releases excessive quantities of methane and other harmful toxins into the air (Wu, 2010). Paper towel has many lasting effects on the environment, as well as impacts on social and economic aspects of society (Budisulistiorini, 2007). The impact from paper towel begins at its cradle, where the manufacturing process demands large extraction of fossil fuels and heavy transportation (Budisulistiorini, 2007). In comparison, a large majority of studies found overall impacts are much less derived from electric hand-dryers. Joseph, Baah, Jahanfar, and Dubey's (2015) life cycle assessment showed results of electric hand-dryers having four times less of an environmental impact than paper towel. By switching to hand-dryers in new buildings on campus, Dalhousie would create precedence and encouragement for other institutions in the province and nation to find alternative ways to combat global waste issues.

### *3.2 Current Hand-drying at Dalhousie University*

Dalhousie University's research in regards to justifying the use of paper towel on campus is outdated. Correspondence with Dalhousie's Facility Management team on February 28<sup>th</sup>, 2019

revealed that the university is currently locked into a 10-year contract with a paper towel company which supplies 100% recycled fibre paper towel. However, the paper towel is unable to be diverted from landfills, due to issues of bodily fluid and chemical residues potentially contaminating paper towel and other forms of trash ending up in bathroom garbage bins (Wu, 2010). **Facilities Management justified sanitation issues regarding hand-dryers based on studies from 1995, 2008 and other vague material.** The 2008 study stated bacteria was found to increase while using electric hand-dryers; however, it is important to note, this study was focused on electric warm air hand-dryers. An electric warm air dryer or conventional hand-dryer, uses warm air to evaporate moisture when rubbing the hands together whereas, companies have now created air dryers (Dyson AirBlade for example) that use air to pull water from still hands (Snelling et al., 2010). Additionally, Dyson Canada, 2019 states the Dyson Airblade V model has a bacteria removal rate of 99.97%. More studies have emerged showcasing results that claim air dryers show little significant difference in the amount of bacteria produced in comparison to paper towel (Margas et al., 2013; Snelling et al., 2011). Ultimately, our study will provide newfound incentives and information regarding integration of electric hand-dryers at Dalhousie that also address issues such as sanitation.

### *3.3 Previous Research: Paper Towel versus Electric Hand-dryers*

There are many branches of research in relation to paper towel versus electric hand-dryers such as, life cycle assessments and psychological and biological analyses. Throughout relevant literature, bathrooms are considered “hotbeds” for resource waste (Renner, 2013). Renner’s study found that in 2014, over 13 billion pounds of paper towel was consumed, and that approximately 270 million trees were flushed down the toilet or thrown in the garbage each year (Renner, 2013). Moreover, results showed electric hand-dryers emit roughly 70% less carbon emissions compared to that of paper towel consumption (Renner, 2013). Chatelain and Reeve’s (2017) study showed similar results, highlighting paper towel emitted roughly 3,000 pounds of carbon emissions each year, and that electric hand-dryers are four times more environmentally friendly than paper towel. Their study went on to recommend that universities, specifically Skidmore college campus, NY, adopt and integrate electric hand-dryers within bathrooms (Chatelain & Reeves, 2017). A life cycle assessment conducted by Joseph et al. (2015) again found similar results showing high-efficiency electric hand-dryers, such as the Dyson Airblade, having less environmental impacts when compared to paper towel.

An important issue to bring to light is that of sanitation related to hand-drying methods. Snelling et al. (2011) compared warm air hand-dryers to ultra-rapid hand-dryers and found similar results to Dalhousie's Facilities Management reason for not adopting hand-dryers as warm air hand-dryers increased the abundance of bacteria on hands. The study also found that one reason for the increase of bacteria was not from the hand-dryer itself, but the rubbing of hands while drying (Snelling et al., 2011). Ultimately, this study resulted in the Dyson Airblade being superior to conventional warm air hand-dryers. Additionally, Taylor et al., (2001) focused on comparing sanitation between paper towel and electric warm air hand-dryers in their study. The findings suggested there was no significant difference between the level of airborne microorganisms when using either method, as well as stating both methods were sufficient and had acceptable sanitation results (Taylor et al., 2001). However, It is important to acknowledge there is contradicting research within the literature. For example, Margas et al., (2013) concluded air hand-dryers may still increase bacteria; however, the researchers did not find significant results to draw concrete conclusions. Additionally, Harrison et al. (2003), found there was a transfer of bacteria between 12.4% and 13.1% while using paper towel. Overall, the literature and previous research showcases either hand-drying methods have bacterial consequences and results rely heavily on bathroom conditions.

## **4.0 Methods**

For this study, we chose to utilize both qualitative and quantitative data to create a mixed methods approach in order to answer our research question.

### *4.1 Qualitative Data Methods: Student Survey*

In order to create a relevant and thorough report, we collected qualitative survey data to address four fundamental research goals that represented Dalhousie University Studley campus' student perspectives including: preferences of hand-drying methods, underlying explanation behind the preference, sanitation perceptions, and support for divestment from paper towel waste. The survey method was chosen due to its effectiveness in terms of feasibility of cost, ease of accessibility for respondents, ability to gather large datasets, and ease of creation and implementation for the researchers. Limited time frame of data collection (two weeks) increased the need of a simple and quick survey method.

Student perspectives are relevant to our study and the issue of paper towel waste, because the student population is the largest subset of the campus population in terms of abundance size; therefore, students contribute the most to resource consumption. Another aspect the survey explored was the reason behind preference of hand-drying methods and why one could potentially be better than another. Having this information is valuable because in order to change human behaviours, understanding the underlying psychology is paramount. Preferences and motivations of students are aspects of this study that were analyzed and used to demonstrate the importance of our research question. As hypothesized, sanitation would be an important underlying factor that persuaded student preferences. Ultimately, questions regarding hygiene and personal health receive the most controversy and attention; therefore, addressing the sanitation issue was a high priority goal in our study. Finally, student support for divesting from paper towel waste was the last topic we chose to address because students are the main consumers of this resource. Determining the degree of support from this population would demonstrate the importance of the research question and viable student concern on the subject.

#### *4.2 Participants and Sample Size*

We chose to focus our study on the Studley campus student population as it was the largest campus out of the four Dalhousie campuses, and its environmental impact was of most concern. The intended representative sample size to be surveyed included 370 students. This figure was calculated from the most current Dalhousie enrollment report from December 2017. Students from faculties of arts and social science, computer science, management, science, law, other graduates, and combined programs were summed together as those faculties made up the student population of the Studley campus. Specifically, this sum of approximately 10,373 students was then put through the Fluid Surveys Sampling Website (a sample size calculator), yielding a sample of 370 students needed in order to achieve a 95% confidence interval and 5% margin of error. Ultimately, the qualitative data obtained supplemented the cost benefit analysis research findings and demonstrated the importance of this research project. This in turn, strengthened the future recommendations that we intend on proposing to Facilities Management and The Office of Sustainability.

### *4.3 Survey Materials and Procedures*

Approximately 50 posters ([Appendix A](#)) were created and hung throughout high traffic buildings on the Dalhousie University Studley campus including: Life Science Centre, Wallace McCain Learning Centre, Mona Campbell Building, Killam Memorial Library, Student Union Building, Kenneth C. Rowe Management Building, Chemistry Building, Weldon Law Building & Law Library, Marion McCain Arts and Social Sciences Building, Henry Hicks Building, and the Goldberg Computer Science Building. Specifically, posters were hung in high traffic hallways, announcement boards, and in bathroom stalls. Alongside that, 200 quick response (QR) code handouts ([Appendix B](#)) were created for face-to-face distribution amongst the researchers to potential participants. The QR code method was implemented in order to improve user accessibility and ease while a web link was attached to the underside of the handout for those unable to use QR codes. Again, distribution of the QR codes occurred in the high traffic building as mentioned above. It is important to note incentives were used to help generate survey responses which included two \$25.00 Tim Hortons gift cards. Participants who filled out the survey were asked at the end of the survey form to leave contact information in order to be entered into a draw for the gift cards. Additionally, those participants who agreed to complete the survey during the face-to-face distribution were rewarded with an additional incentive of lollipops.

### *4.4 Survey Design and Rationale*

The survey titled “Hand-drying Methods Survey for Dalhousie University’s Studley Campus” ([Appendix C](#)) was created using the cloud storage service, Google Drive. With the Forms function, the survey was accessible to participants that opened it using the QR code or manually entering the provided survey link. In terms of the design of survey questions, all questions were consciously asked in order to maintain the aforementioned goals of the survey. No demographic questions regarding gender, sex, or age were posed other than which faculty the student associated with. This data was not relevant to the scope of the study or the research question as we were not interested in comparing perspectives based on student demographics; rather, we were solely interested in presenting a representative set of results demonstrating student perspectives.

An important question to highlight is the categorical preference question, “After washing your hands in a bathroom on Dalhousie University's Studley campus, which method of drying

your hands do you prefer?”, followed by a short response question inquiring about reasoning behind the preference. These questions are important to this study in regards to understanding underlying psychology of student preferences in order to educate and encourage change. Questions were also arranged in a manner to ensure respondent bias was avoided. For example, the rating questions regarding sanitation perceptions of hand-dryers and of paper towel were strategically placed two questions apart in order to avoid rating biases from either questions. These sanitation questions were important in terms of informing our goal of student sanitation perceptions. Sanitation is a subject that is of high concern amongst the population as it pertains to human health and well-being; therefore, we are able to address perceptions towards hand-drying methods in order to educate and instill change amongst the student population. Finally, the last questions posed pertained to the goal of demonstrating support (or lack thereof) to divest from paper towel waste and to what extent students are willing to contribute to the divestment. One single-response question asked students: “Would you support Dalhousie University in implementing a policy that requires the University to divert from the use of paper towel when establishing new buildings as of September 2019?”. This question is directly related to the research question at hand and demonstrates the importance of our research through student perspectives. Additionally, another supporting question asked: “Currently, the Sustainability Auxiliary fee that each student pays is \$18.15. Would you support a Dalhousie University initiative of increasing the sustainability auxiliary tuition fee by \$2.00 to facilitate the installation of electric hand-dryers in new buildings on the Studley campus?”. The figure of \$2.00 was used as it was the amount that could cover the costs of at least 18 electric air dryers based on the total Studley campus population. As this question involved the idea of an increase in tuition to fund new hand-dryers on campus, it demonstrated student support for divestment and also the support for assisting in an initiative that could potentially affect students financially.

Ultimately, all survey results were described with simple descriptive statistics. For the short answer preference rationale section, an *a posteriori* approach was used to retrieve common themes that cropped up amongst student answers. Further, statistical analysis was not necessary in keeping with our project goals and research question, as to not overly complicate results that should be simple and clear to the audience. Additionally, survey results informed decisions and choices made in the cost benefit analysis.

#### *4.5 Quantitative Data Methods: Cost-benefit Analysis*

For the quantitative portion of our study, we chose to conduct a cost-benefit analysis (CBA). This allowed us to determine savings Dalhousie could generate by switching from paper towel to electric air dryers for a simulated building model. The cost benefit analysis was conducted using information acquired from Dyson, Nova Scotia Power, Dalhousie University's 2017 enrollment report, and Michael Campbell (Senior Manager of Facilities at Dalhousie University). The Dyson V Airblade model was chosen based on its low energy requirements, hygienic design, and 12-second drying time, all of which were features informed based on common themes pulled from the survey preference results section. The Dyson V Airblade specifications were retrieved from Dyson directly and used to conduct the CBA. Additionally, specifications used for the calculations included time required per dry (0.0033 hours) and the energy requirement for the motor in watts (1 kW). Electricity costs were then calculated based on Nova Scotia Power's (NSP) large commercial building electricity rate of 9.526¢ per kilowatt hour (\$0.09526 per kWh). The annual cost of paper towel Dalhousie spends was supplied by Michael Campbell. Across Dalhousie's four campuses, 3000 paper towel dispensers are used. To determine the total cost of paper towel on the Studley campus, the Dalhousie enrollment report from 2017 was used. The ratio of students per campus was then calculated to determine the amount of annual paper towel costs for the Studley campus.

Our simulated model for the CBA was the creation of a building similar to the Mona Campbell Building in size, sustainable materials, Leadership in Energy and Environmental Design (LEED) certification, and cost. We assumed there were 10 washrooms total: 2 per floor and 2 gender-neutral washrooms on the bottom floor. The fictional building had 4 floors with 4 men's, 4 women's, and 2 gender neutral washrooms with 2 hand-dryers installed in each of the men's and women's washrooms, and one installed in each of the gender-neutral washrooms. In total, there were 18 hand-dryers in the fictional building. We assumed that the newly constructed building would be built to support electric air dryers, so wiring costs were exempt from the scenario. We directly corresponded with Dyson on the phone and email to obtain a quote for 18 of the Airblade V air dryers. Cost per use of the Dyson V Airblade including the cost per year was compared to the cost of paper towel per year for the same sized building. In order to conduct our CBA, the number of washrooms uses per day in a building the size of the Mona Campbell was estimated with 200 uses. It was also assumed the washrooms would be used 50% less for

summer months so total number of washrooms uses per year were based on these assumptions. Additionally, we did not account for the standby energy used from the Dyson V Airblades in our CBA as it was less than 0.5 W which was insignificant and omitted from our study. Wiring costs were not considered for the CBA as our proposed building model would be wired upon construction to allow the installation of electric air dryers.

Finally, two sets of scenario calculations were conducted for our CBA: scenario 1 determined the number of Dyson V Airblade dryers that could be purchased if the sustainability auxiliary fee was increased by \$0.50 while scenario 2 determined the number of dryers that could be purchased if the sustainability auxiliary fee was increased by \$2.00. A \$2.00 increase for this auxiliary fee was chosen for calculations as it was the amount that could cover the costs of at least 18 electric air dryers. A \$0.50 increase was then used to determine the amount of electric air dryers that could be purchased with a minimal increase in the sustainability auxiliary fee.

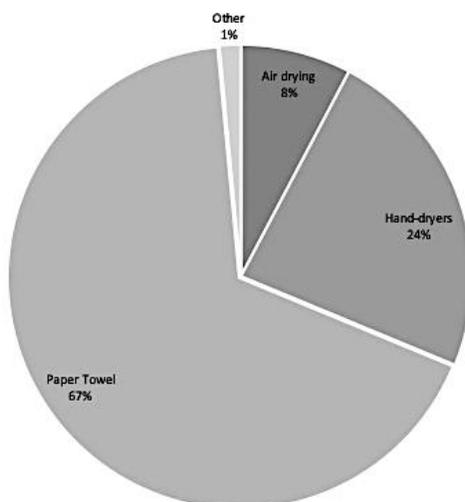
## **5.0 Results**

### *5.1 Survey Results*

The calculated sample size needed in order to achieve a 95% confidence interval and 5% margin of error based on the total Studley population of approximately 10,373 students was 370 responses; however, we did not reach the intended sample size. Instead, the actual sample size was 336 students thereby making the margin of error 5.26%.

### *5.2 Student Preferences*

Based on the sample size, it was determined the majority of students (67%) preferred paper towel over the combined methods of hand-drying, air-drying, and other possible methods (Figure 1).



**Figure 1** Pie Chart demonstrating hand-drying preferences given the categories of paper towel, hand-dryers, air drying, and other with a sample size of  $n=336$  Dalhousie University Studley campus students, Halifax NS. Adapted from “Hand-drying Methods Survey for Dalhousie University’s Studley Campus”. Created by T. Ngo, March 2019.

### 5.3 Hand-drying Preference Rationale

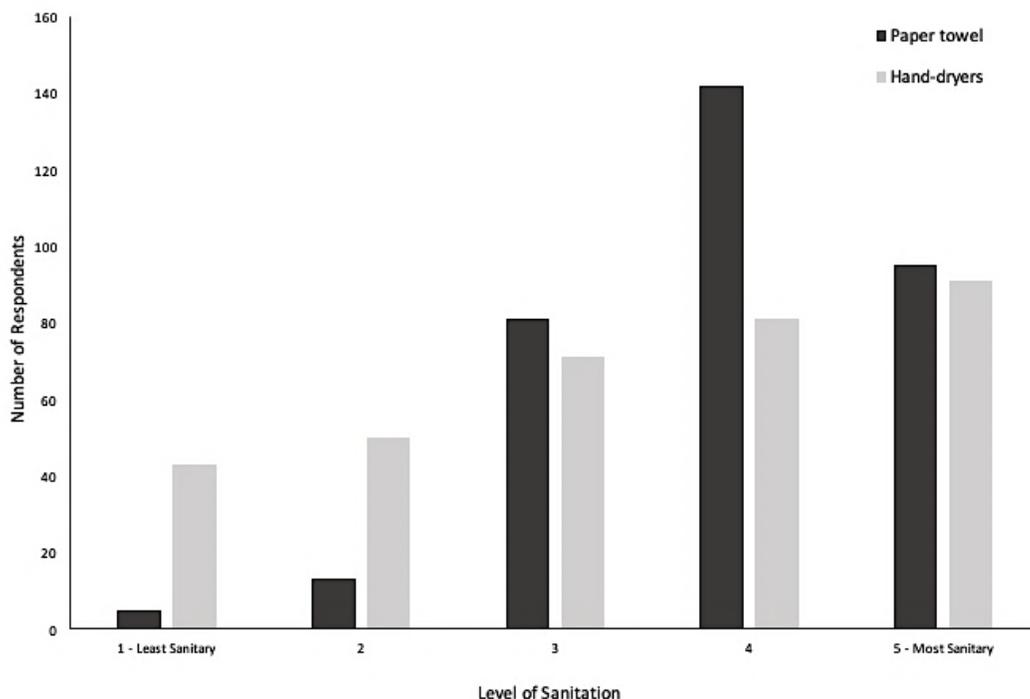
When students were asked to explain their rationale for their hand-drying practice of choice, many common themes came to light. Common themes behind paper towel preferences were mainly attributed to improved quality of the clean (effectiveness of drying), superior sanitation, and decreased time of drying (Table 1). For example, most students that chose paper towel stated that sanitation concerns, efficiency (speed and time), quality of the clean (physically wiping off dirt and bacteria), noise problems, and discomfort of hand-dryers contributed to their preference of paper towel over electric hand-dryers. On the other side, students stated awareness of environmental degradation and global waste issues as justification for choosing hand-dryers over paper towel. Additionally, most students quoted multiple themes as reasoning behind their choice. For example, one student stated: “There aren’t many hand-dryers in washrooms and the ones we do have are old, loud and ineffective” ([Appendix C](#)). Multiple themes attributed to the creation of various rows in Table 1 with more than one theme. Other students noted the lack of hand-dryers as an option to dry their hands and by default, chose paper towel as their preference: “Just because it’s [paper towel] right there. I don’t think I’ve seen hand-dryers at Dal” ([Appendix C](#)). One student even stated the economic potential and sustainability attributed to hand-dryers as well: “Can [be] more economically friendly if the electricity comes from the right source (such as plants that are not coal powered, or potentially from solar panels, etc.)” ([Appendix C](#)).

**Table 1** Hand-drying preferences rationale as demonstrated by common themes (Theme(s) column) devised from a posteriori method of the survey: “Hand-drying Methods Survey for Dalhousie University’s Studley Campus”. Student (%) column is the proportion of student who fall within theme categories given hand-drying preferences of paper towel, hand-dryers, air drying, and other from a sample size of n=336 Dalhousie University Studley campus, Halifax NS. Created by T. Ngo, April 2019.

Theme(s):	Students (%)
Environmental awareness	15.77
Quality of clean	15.48
Sanitation	12.50
Time	9.23
Waste awareness	6.85
Speed	5.95
Convenience	4.17
Accessibility	3.87
No reason	3.87
Sanitation and speed	2.98
Time and speed	2.38
Noise	2.08
Convenience and speed	2.08
Sanitation and Time	1.79
Quality and speed	1.49
Convenience and environment	1.49
Comfort	0.89
Speed and noise	0.89
Sanitation and quality	0.89
Environment and speed	0.89
Time and quality	0.60
Sanitation and noise	0.60
Environment and clean	0.60
Noise and speed	0.60
Quality, time, noise, accessibility	0.60
Economical	0.30
Comfort and sanitation	0.30
Comfort and time	0.30
Time, speed, sanitation	0.30
Noise, speed, sanitation	0.30

#### 5.4 Sanitation Perception

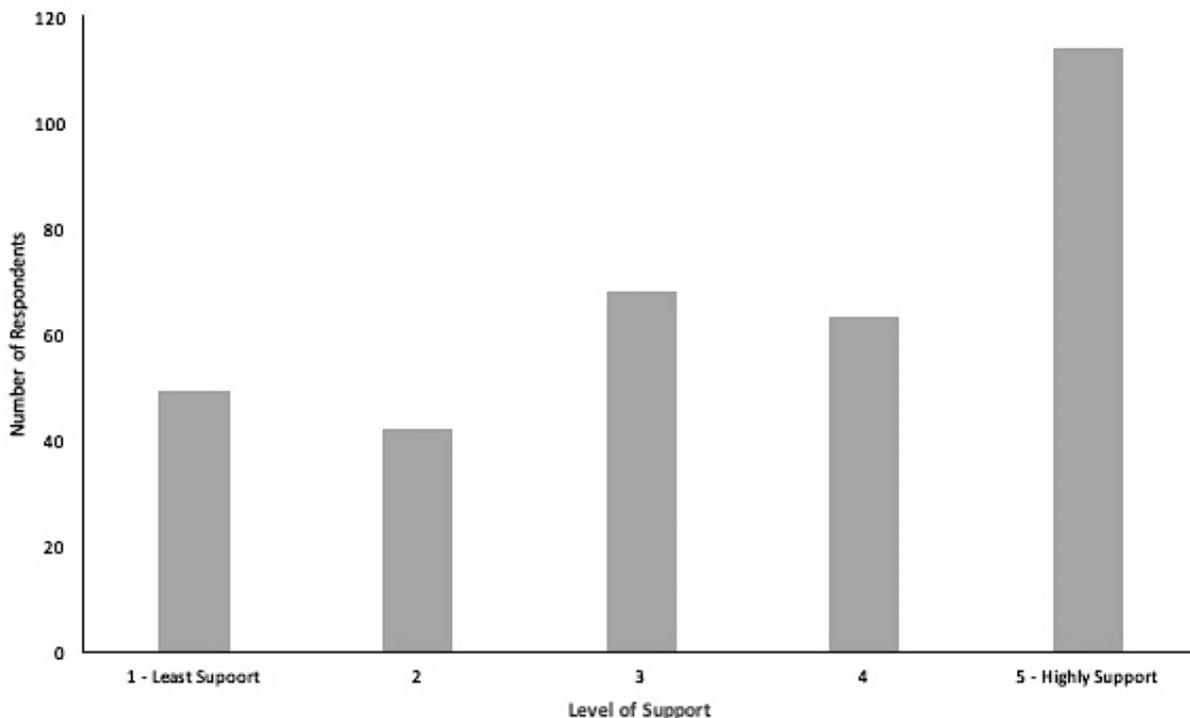
Sanitation was quantified on a scale of 1 to 5 with 1 being the least sanitary and 5 being the most sanitary (Figure 2). When asking students to rate the level of perceived sanitation in regards to paper towel and hand-dryers, it is apparent most students found paper towel as the cleaner option whereas, hand-dryers demonstrated mixed, lower results. The ordinal data obtained demonstrated a mean value of 3.92 and 3.38 for sanitation perception values of paper towel and hand-dryers respectively. The standard deviation related to paper towel sanitation was 0.90 while hand-dryers demonstrated a deviation of 1.36.



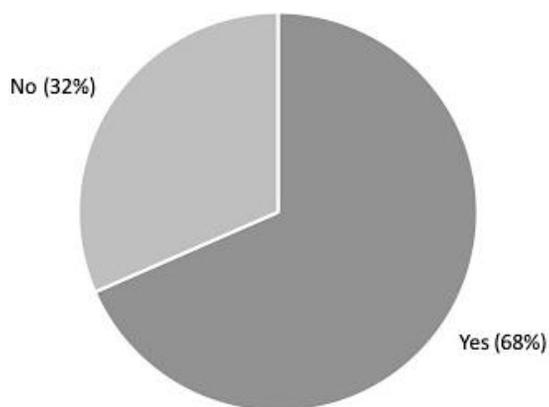
**Figure 2** Bar chart demonstrating rating scale response question of paper towel and hand-dryers perceptions of sanitation with 1 being the least sanitary and 5 being the most sanitary (mean paper towel = 3.92, standard deviation = 0.90, mean hand-dryers = 3.38, standard deviation = 1.36). The sample size was n=336 Dalhousie University Studley campus students, Halifax N.S. Adapted from "Hand-drying Methods Survey for Dalhousie University's Studley Campus". Created by T. Ngo, March 2019.

### 5.5 Support for Divesting From Paper Towel Waste

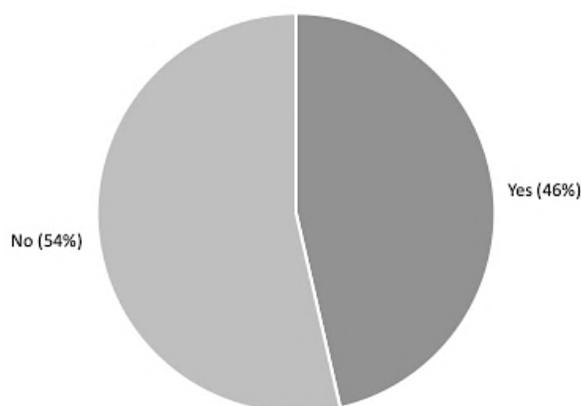
The first question that quantified the student support of divesting from paper towel demonstrated the degree of support amongst students that reinforced the initiative of replacing paper towel with hand-dryers on campus (Figure 4). The mean from the ordinal data collected was 3.45 while the standard deviation was 1.43. Next, Figure 5 demonstrates the single response question showing student support when implementing a policy that requires the University to divert from the use of paper towel when establishing new buildings as of September 2019. Most students (68%), stated yes they would support the initiative. Finally, figure 6 demonstrates the single response question showing student support of a fabricated Dalhousie University's initiative of increasing the sustainability auxiliary tuition fee by \$2 to facilitate the installation of electric hand-dryers in new buildings on the Studley campus.



**Figure 3** Bar chart (mean = 3.45, standard deviation = 1.43) demonstrating rating response question for student support of replacing paper towel with hand-dryers on Dalhousie's University Studley campus, Halifax NS. with a sample size of  $n=336$ . Adapted from "Hand-drying Methods Survey for Dalhousie University's Studley Campus". Created T. Ngo, March 2019.



**Figure 4** Pie chart demonstrating a single response question showing support of Dalhousie University, Halifax, NS. implementing a policy that requires the University to divert from the use of paper towel when establishing new buildings as of September 2019 with a sample size of  $n=336$  Dalhousie University Studley campus students. Adapted from "Hand-drying Methods Survey for Dalhousie University's Studley Campus".



**Figure 5** Pie chart demonstrating a single response question showing support of Dalhousie University, Halifax, NS. initiative of increasing the sustainability auxiliary tuition fee by \$2 to facilitate the installation of electric hand-dryers in new buildings on the Studley campus with a sample size of  $n=336$  Dalhousie University Studley campus students. Adapted by J.MacKee, March 2019.

## 6.0 Cost-benefit Analysis

### 6.1 Paper Towel

Dalhousie currently has 3000 paper towel dispensers across its four campuses, and spends \$350,000 annually on paper towel. Each paper towel dispenser costs \$116.70 to operate annually. For the Studley campus, we calculated that Dalhousie spends approximately \$199,500 on paper towel costs annually. This calculation was determined from the 2017 enrollment report. Dalhousie's Studley campus has a population of 10,373 students as of December 2017. Its total population was 18,846, therefore, 57% of its population was on the Studley campus. 57% of the \$350,000 total annual paper towel costs would be \$199,500. For our simulated model building, the cost to operate 18 paper towel dispensers annually was \$2100.60 ( $18 \times \$116.70 = \$2100.60$ ).

### 6.2 Dyson V Airblade Electric Air Dryer

From the quote obtained from Dyson, 18 Dyson V Airblade air dryers would cost \$873.75 per unit or \$15,727.5 total while NSP charges Dalhousie \$0.09526 per kWh. The Airblade requires 1kW of energy to operate and the dry time is approximately 0.0033 hours per use, therefore;  $0.0033 \text{ kWh} \times \$0.0953/\text{kWh} = \$0.00031$  per use. Based on the fictional building similar to the Mona Campbell Building, a cost of \$0.062 to operate all 18 electric air dryers per day, based on an average of 200 uses of the Mona Campbell washrooms per day ( $200 \text{ uses} \times \$0.00031 \text{ per use} = \$0.062$  per day) was calculated. For the annual cost, we assumed that during 8 months (Fall / Winter terms) the Mona Campbell washrooms were used 200 times per day, and during the 4

months of summer term, they were used 100 times per day. The calculations were as followed: 200 uses per day x 240 days = 48,000 uses during Fall / Winter terms; 100 uses per day x 125 days = 12,500 uses during Summer term which equates to 60,500 uses per year; 60,500 uses x \$0.00031 per use = \$18.75 to operate annually in electricity costs. Maintenance costs of electric air hand-dryers for this CBA were omitted.

In general, Dalhousie would save approximately \$2081.25 annually by switching to the Dyson V Airblade electric air dryer instead of using paper towel dispensers. Within 7 years, it was calculated that Dalhousie would recoup the cost of purchasing 18 electric air dryers from the money saved by removing paper towel expenses. In the subsequent 10 years, Dalhousie would save \$21,000 on paper towel costs and instead spend \$187.50 on electric air dryer electricity costs (based on stable NSP energy rates for this scenario). This is a net savings of \$20,812.50 over 10 years for only one proposed building model on the Studley campus.

### *6.3 Tuition Scenarios*

An increase of \$2.00 in the sustainability auxiliary fee for students on the Studley campus would generate \$21,474, allowing Dalhousie to purchase electric air dryers. An increase of \$0.50 in the sustainability auxiliary fee was then calculated thereby allowing Dalhousie to generate \$5,368.50 for electric hand-dryers. Based on these two scenarios, when \$2.00 was added to the sustainability auxiliary fee, Dalhousie could purchase 24 of the suggested Dyson V Airblade electric air dryers. When \$0.50 was added to the sustainability auxiliary fee, Dalhousie could purchase 6 of the Dyson V Airblade electric hand-dryers. Therefore, if students pay the \$0.50 fee increase, Dalhousie would have the air dryer costs recovered within 3 years of the auxiliary fee increase. For our scenario, we assumed students were willing to pay the \$2.00 increase in sustainability fees. The cost of 18 Dyson V Airblade air dryers would be recovered from 1 year of tuition fees from students on Studley campus. Please see [Appendix D](#) for complete and fully detailed cost benefit procedures, scenarios, and results.

## **7.0 Discussion**

This study offered two analyses that introduced new information regarding hand-drying methods at Dalhousie suggesting implementation of electric hand-dryers being more cost effective and feasible than continuing solely with paper towel initiatives in Dalhousie University buildings. Outside literature has concluded that universities should invest in electric hand-dryers, such as

Chatelain & Reeves (2017)'s study that found: due to excessive amounts of carbon emissions caused by paper towel, universities and institutions should integrate electric hand-dryers throughout washrooms.

Results of the survey showcased the student rationale regarding hand-drying preferences. Many students who preferred paper towel largely attributed their preference to their perception of paper towel being more sanitary, whereas students who opted for hand-dryers chose the option because of preconceived notions -- that they are more environmentally friendly. This relates to the Harrison et al. (2013) finding that when using paper towel, there can be a bacterial transfer between 12.4% and 13.1%. This demonstrated an increase in amount of bacteria during mainly attributed to the rubbing motion made while drying hands. Therefore, no matter the perception on sanitation in relation to hand-drying, studies show that there are many reasons for increases in bacteria with either method of hand-drying (Snelling et al., 2011). The mean value for sanitation perceptions of paper towel was 3.92 (rating scale of 5) with a standard deviation of 0.90, in comparison to sanitation perceptions of hand-dryers (mean of 3.38 with a deviation of 1.36) (Figure 2). These results illustrate a larger spread in the data; therefore, perceptions of sanitation relating to hand-dryers are more variable compared to that of paper towel. Divestment support for removal of paper towel from campus altogether, was highly accepted by students on the Studley campus (Figure 3). Additionally, support for a policy requiring integration of electric hand-dryers in newly constructed buildings on campus was also highly supported by students (Figure 4). However, this is contradictory in relation to preferences of hand-drying methods discussed above; even though students preferred paper towel, the majority of people went on to strongly support both the removal of paper towel from campus, as well as the integration of a policy making electric hand-dryers mandatory in new buildings. Lastly, the survey results highlight mixed emotions towards using the sustainability auxiliary fee to facilitate the transition to hand-dryers (Figure 5). The quote, "don't want to have to pay but care about sanitation and environment" ([Appendix D](#)), provided by a respondent that chose paper towel as their preference demonstrates the main reason behind refusal to support the initiative. It is important to recognize when people are presented with an increase in fees, similar to increasing tuition fees, there is a negative connotation. This is due to an increase in fees suggesting the person will lose capital, which in this case, creates reluctance towards supporting sustainable initiatives. Ultimately,

students recognized environmental impacts and supported integration of hand-dryers throughout campus.

Results from our CBA provided Dalhousie a general overview to answer why they should incorporate electric air dryers into future buildings. Dalhousie could save approximately \$2,081.25 annually on a building the size of the Mona Campbell if they installed electric hand-dryers upon construction of the building instead of paper towel dispensers. Paper towel was calculated to be six times more expensive to operate annually at Dalhousie than the Dyson Airblade electric air dryer ([Appendix D](#)).

Based on our survey, students supported sustainability initiatives at Dalhousie and saw benefit in the electric hand-dryer policy implementation. 69.3% of students said they would support the implementation of a new policy requiring future buildings to install electric hand-dryers (Figure 4). Additionally, 46% of students agreed they would be willing to pay a \$2.00 increase in the current sustainability auxiliary fee in order to support the implementation of our proposed electric hand-dryer policy (Figure 5). In conjunction with our survey results, the CBA demonstrated the Dyson V Airblade electric air dryer would be more cost-efficient in the long-term compared to paper towel. Based on our survey responses, hygiene was the main uncertainty participants had regarding the use of electric hand-dryers. For our CBA we chose the most hygienic electric air dryer on the market to determine financial feasibility of our proposed hand-dryer implementation policy. Our CBA demonstrates that it is not only feasible, but financially beneficial to switch to electric air dryers in all future buildings to mitigate the financial and environmental impact of paper towel waste in the long-term.

### *7.1 Limitations*

The greatest limitation to our study included the time constraint of having four months (duration of the course) to conduct the study based on the scope of the research question. More time could have amassed a more representative sample size that included all Dalhousie University campuses (not just the Studley campus), as well as to find more concrete and significant results for both the survey and CBA.

A limitation associated with the survey included a potential bias during distribution of the survey and our advertising material. Due to our group not having a male member, we were unable to advertise equally amongst male and female washrooms. However, a male was recruited to help advertise in some male washrooms around campus. Another limitation in regards to the

survey, was the issue of students not belonging to faculties that are found on the Studley campus completing the survey. As the sample size was calculated based on the sum of Studley campus faculties, the addition of the other students would ultimately change the require sample size.

Limitations for the CBA included omission of maintenance costs for Dyson V Airblade electric air dryers in our simulated building model. The cost of paper towel dispenser replacement parts and battery fees were also omitted. Moreso, the electricity rate used in the calculations was based on Nova Scotia Power's large commercial institution energy rates readily available on their website therefore, \$0.0953/kWh was the rate in which Dalhousie would be paying for electricity. For the CBA we further assumed the rate at which the washrooms in our simulated building would be used per day/per year in order to calculate a realistic value. Overall, due to lack of information available and time constraints to the study, assumptions and best estimates were made with caution and best judgement.

## **8.0 Conclusions**

Our study provides many incentives for why Dalhousie should integrate electric air hand-dryers in newly constructed buildings on campus. With paper towel being six times more expensive than hand-dryers and as studies lack concrete data on sanitation issues for either method of hand-drying, there is more incentive to install electric air hand-dryers in large institutions. Electric air hand-dryers, such as the Dyson airblade V, have four times less of an environmental impact, lesser need for maintenance attention, as well as both short-term and long-term cost benefits. By integrating electric air hand-dryers in newly constructed buildings, in the short-term Dalhousie would save \$2081.25 annually on a building the size of the Mona Campbell. In the long-term, after a period of 10 years, the university could expect roughly \$21,000 in cost savings. With this being said, there is no concrete reason why Dalhousie should not integrate electric air hand-dryers throughout campus since the environment is on the line.

### *8.1 Recommendations*

We have provided the following recommendations based on the analysis above:

1. Due to varying perspectives and contradictory findings found during the qualitative analysis, we recommend an intersectional approach by implementing air hand-dryers and keeping paper towel as an available option (to lesser extent) when constructing new buildings on campus;

2. We recommend utilizing either the sustainability auxiliary fee or another auxiliary fee to support the integration of air hand-dryers in newly constructed buildings as financial burden can easily be alleviated in this manner;
3. The low-voltage Dyson Airblade V is the recommended air hand-dryer to invest in because of its efficiency, sanitation, and cost feasibility as showcased in the CBA;
4. More research regarding the cost limitations as stated above should be investigated in a more thorough analysis if the Dalhousie University is serious about installing electric air hand-dryers.

## *8.2 Acknowledgements*

We would like to thank the College of Sustainability and Rochelle Owen for partnering with the ENVS 3502 course. This partnership facilitates the opportunity for these studies to influence sustainability on campus. We would like to thank DSUSO (Dalhousie Student Union Sustainability Office) for endorsing our study. Finally, we would like to thank Amy and Romeet for their constant support throughout this project. Our study would not have been possible without the connections, information, and guidance they supplied us with.

## References

- Budisulistiorini, S. H. (2007). Life Cycle Assessment of Paper Towel and Electric Dryer as Hand-drying Method in the University of Melbourne. *TEKNIK*, 28(2), 132-141. Retrieved from <https://ejournal.undip.ac.id/index.php/teknik/article/view/2139/1880>
- Butts, R. (2014). Integrated Solid-Waste Resource Management Strategy Review – Final Report. *Halifax Regional Municipality*. Retrieved from <http://legacycontent.halifax.ca/council/agendasc/documents/140114cow3report.pdf>
- Chatelain, L. & Reeves, M. (2017). Innovative Solutions for Reducing Waste at Skidmore College: Analyzing the Carbon Footprint & Economics of Paper Towels vs. Electric Hand-dryers. *AASHE: Purchasing/Procurement*. Retrieved from <https://hub.aashe.org/browse/publication/18920/Innovative-Solutions-for-Reducing-Waste-at-Skidmore-College-Analyzing-the-Carbon-Footprint-Economics-of-Paper-Towels-vs-Electric-Hand-Dryers>
- Dalhousie University. (2017). 2017/2018 Enrollment Statistics - Summary By Faculty. *Dalhousie University Office Of The Registrar*. Retrieved from [https://cdn.dal.ca/content/dam/dalhousie/pdf/dept/oiar/Public\\_Reports\\_and\\_Data/Enrollment/2017/Faculty\\_2017.pdf](https://cdn.dal.ca/content/dam/dalhousie/pdf/dept/oiar/Public_Reports_and_Data/Enrollment/2017/Faculty_2017.pdf)
- Dyson. (2019). “Dyson Airblade: Dyson Airblade V Hand-dryer. 30% Quieter”. *Dyson Canada*. Retrieved from <https://www.dysoncanada.ca/en/hand-dryers/dyson-airblade-v-nickel.html>
- Fluid Surveys University. (2019). “Survey Sample Size Calculator”. Retrieved from <https://fluidsurveys.com/university/survey-sample-size-calculator/>
- Harrison, W. A., Griffith, C. J., Ayers, T. & Michaels, B. (2003). Bacterial Transfer and Cross-Contamination Potential Associated With Paper-Towel Dispensing. *American Journal of Infection Control*, 31(7), 387-391. doi: <https://doi.org/10.1067/mic.2003.81>
- Hounsell, K. (2018, March 29). “Canadian Municipalities Struggling to Find Place for Recyclables After China Restricts Foreign Waste”. *CBC News: Technology & Science*. Retrieved from <https://www.cbc.ca/news/technology/garbage-recycling-china-plastics-canada-1.4586602>

- Joseph, T. Baah, K., Janafar, A. & Dubey, B. (2015). A Comparative Life Cycle Assessment of Conventional Hand-dryer and Roll Paper Towel as Hand-drying Methods. *Science of the Total Environment*, 515-516, p109-117. doi: 10.1016/j.scitotenv.2015.01.112. Retrieved from [http://apps.webofknowledge.com.ezproxy.library.dal.ca/full\\_record.do?product=WOS&search\\_mode=GeneralSearch&qid=1&SID=5AUIZITMjAgKeZBPPxv&page=1&doc=3](http://apps.webofknowledge.com.ezproxy.library.dal.ca/full_record.do?product=WOS&search_mode=GeneralSearch&qid=1&SID=5AUIZITMjAgKeZBPPxv&page=1&doc=3)
- Margas, E., Maguire, E., Berland, C. R., Welander, F. & Holah, J. T. (2013). Assessment of the Environmental Microbiological Cross Contamination Following Hand-drying With Paper Hand Towels or an Air Blade Dryer. *Journal of Applied Microbiology*, 115(2), 572-582. doi: <https://doi.org/10.1111/jam.12248>
- Nova Scotia Power. (2019). "Energy Rates". Retrieved from <https://www.nspower.ca/en/home/about-us/electricity-rates-and-regulations/rates/large-general-tariff.aspx>
- Renner, J. (2013). "The Importance of Reducing Restroom Resource Waste". *GreenFILE: Environmental Design and Construction*, 16(10), p 21-22. Retrieved from <http://web.b.ebscohost.com/ehost/detail/detail?vid=3&sid=5780e749-02a8-4ad1-b089-3e8a06f11216%40pdc-v-sessmgr02&bdata=JnNpdGU9ZWwhvc3QtG12ZQ%3d%3d#AN=91804646&db=8gh>
- Snelling, A. M., Saville, T., Stevens, D. & Beggs, C. B. (2010). Comparative Evaluation of the Hygienic Efficacy of an Ultra-Rapid Hand-dryer vs Conventional Warm Air Hand-dryers. *Journal of Applied Microbiology*, 110(1), 19-26. doi: <https://doi.org/10.1111/j.1365-2672.2010.04838.x>
- Taylor, J. H., Brown, K.L., Toivenen, J. & Holah, J.T. (2001). A Microbiological Evaluation of Warm Air Hand Driers With Respect to Hand Hygiene and the Washroom Environment. *Journal of Applied Microbiology*, 89(6), 910-919. doi: <https://doi.org/10.1046/j.1365-2672.2000.01122.x>
- The Economist. (2018, September 29). "A Chinese Ban on Rubbish Imports is Shaking up the Global Junk Trade. *The Economist Special Report: Waste*. Retrieved from <https://www.economist.com/special-report/2018/09/29/a-chinese-ban-on-rubbish-imports-is-shaking-up-the-global-junk-trade>

- The World Bank. (2018, September 20). “Global Waste to Grow by 70 Percent by 2050 Unless Urgent Action is Taken: World Bank Report” [Press Release]. Retrieved from <https://www.worldbank.org/en/news/press-release/2018/09/20/global-waste-to-grow-by-70-percent-by-2050-unless-urgent-action-is-taken-world-bank-report>
- UNEP. (2018). Global Waste Management Outlook. *United Nations Environment Programme; International Solid Waste Association*. Retrieved from [http://eprints.whiterose.ac.uk/99773/1/GWMO\\_report.pdf](http://eprints.whiterose.ac.uk/99773/1/GWMO_report.pdf)
- Wu, J. (2010, September/October). “Taking Paper Towels to the Compost Pile: An Essential Answer”. *Stanford Magazine: Online Exclusive*. Retrieved from <https://stanfordmag.org/contents/taking-paper-towels-to-the-compost-pile-essential-answer>
- Zoledziowski, A. (2018, October 18). “Atlantic Canada University Profiles to Help you Choose”. *The Globe and Mail: Canadian University Report – The Schools*. Retrieved from <https://www.theglobeandmail.com/news/national/education/canadian-university-report/atlantic-canada-university-profiles-to-help-you-choose/article36616098/>

Appendix A: Poster

**HAND DRYERS?  
PAPER TOWEL?  
WHAT'S YOUR  
PREFERENCE**

**ENTER TO WIN  
TIM HORTONS  
GIFT CARDS**



Fill out a quick survey to enter  
and win 1 of 4 \$25 Tim  
Hortons gift cards!!!



Scan me

Survey Link: <https://goo.gl/forms/n45eEA4qpyAEXRZx2>

SPONSORED BY DSUSO



Figure 6 Poster for advertisement, distributed throughout the Studley campus, Dalhousie University, Halifax, N.S. Created on Canva by J.Mackeen. March 2019.

### Appendix B: Handouts



Figure 7 Front of the handout, for distribution on the Studley campus, Dalhousie University, Halifax, N.S. Created by J.Mackeen. March 2019.

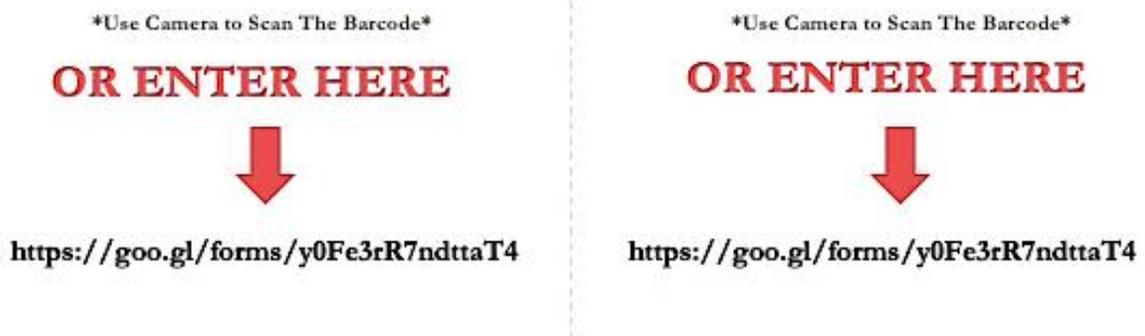


Figure 8 Back of the handout, for distribution on the Studley campus, Dalhousie University, Halifax, N.S. Created by J.Mackeen. March 2019.

## **Appendix C: Survey Results**

The survey has been attached to BrightSpace in PDF form, as well as the link to our survey is provided [here](#).

## Appendix D: Cost Benefit Analysis

*Specifications for our hand-dryer model chosen:*

- Model of hand-dryer for this calculation: Dyson V Airblade;
- Cost per unit = \$873.75 (called to get this quote);
- Takes 12 seconds to dry hands = 0.0033 hours;
- 1000 W motor = 1kW.

Our proposed scenario is the creation of a building like the Mona Campbell in size, sustainable materials, LEED certification, and cost. We assume there are 10 washrooms total: 2 per floor and 2 gender-neutral washrooms on the bottom floor, with our proposed building having 4 floors (4 men's, 4 women's, and 2 gender neutral). We assume there are 2 hand-dryers installed in each of the men's and women's washrooms, and then one installed in each of the gender-neutral washrooms, making a total of 18 hand-dryers in the building. We assume that the newly constructed building will be built to support hand-dryers so wiring costs are exempt from this scenario. We wish to implement a policy requiring all newly constructed buildings on Dalhousie campuses to use hand-dryers in washrooms instead of paper towel dispensers. Paper towel is not a sustainable option for the future. For our scenario we will use the Dyson V Airblade hand-dryer as it is the most energy efficient, hygienic, and has the fastest drying time of all other hand-dryers on the market. We called Dyson to obtain a quote for 18 of this model hand-dryers, it would cost \$873.75 per unit or \$15,727.5 total. Below we calculate a cost-benefit analysis for this model hand-dryer compared to paper towel costs for a Mona Campbell replica building.

*Basic Calculations:*

- Let's say NSP charges DAL \$0.09526 per kilowatt hour as they are considered a large size commercial business and therefore have lower electricity rates than a residential home;
- So,  $1\text{kW} \times 0.0033 \text{ hours per use} = 0.0033 \text{ kWh} \times \$0.0953/\text{kWh} = \$0.00031 \text{ per use}$ ;
- We will use the Mona Campbell building as our model for this calculation;
- $200 \text{ uses} \times \$0.00031 \text{ per use} = \$0.062 \text{ per day to operate hand-dryers}$ .
- For the annual cost, let's assume 8 months of the year during fall/winter terms the Mona Campbell washrooms are used 200 times per day and during 4 months of summer term they are used 100 times per day:

- 200 uses per day x 240 days = 48,000 uses during fall/winter term;
- 100 uses per day x 125 days = 12,500 uses during summer term;
- = 60,500 uses per year;
- 60,500 uses x \$0.00031 per use = \$18.75 to operate annually in electricity costs;
- (Standby mode uses less than 0.5W so it is exempt from this calculation as it would not be significant).

*Now let's compare this to paper towel costs:*

- Dalhousie spends \$350,000 on paper towel costs annually;
- Across its 4 campuses, Dalhousie has 3000 paper towel dispensers;
- Each cost \$116.7 to operate annually;
- Dalhousie's Studley campus has a population of 10,737 people as of December 2017;
- Its total population is 18,846, so 57% of its population is on the Studley campus;
- 57% of total annual paper towel costs would be \$199,500.

*Let's use the Mona Campbell example again:*

- We require 18 hand-dryers for a building like the Mona Campbell;
- 18 hand-dryers x \$116.70 annual cost per electric hand-dryer = \$2100.6 in paper towel costs for this building annually;
- Dalhousie would save approximately \$2081.25 annually by switching to this model of electric hand-dryers instead of using paper towel dispensers. Within 7 years Dalhousie would make recoup the cost of purchasing 18 electric hand-dryers from the money saved by removing paper towel costs. Reminder: these savings are based on a potential building the size of the Mona Campbell with 18 electric hand-dryers installed without wiring costs required.

If this building were to be implemented into Dalhousie's future building plans, they potential savings from switching to electric hand-dryers instead of continuing the use of paper towel would be substantial. For 10 years, Dalhousie would save \$21,000 on paper towel costs and instead spend \$187.50 on hand-dryer electricity costs within those 10 years (assuming Nova Scotia Power rates stay stable for this scenario). This is a net savings of \$20,812.5 over 10 years for only one proposed building. Keep in mind the scenario for this building is using approximately 2% of the total Studley campus population (10,737) and it is a relatively small calculation, but can be expanded to encompass all of the Studley campus buildings if Dalhousie

implements our suggested policy to divest from paper towels and use electric hand-dryers in all future buildings.

If we consider the cost of our Dyson hand-dryers in their first year, we would need \$15,727.5 to purchase them. To compare, the paper towel dispensers are provided for free from the paper towel company, with batteries and parts replacement also free of charge. For this scenario we will not be considering the cost of electric hand-dryer maintenance. So, for the Dyson hand-dryers \$15,727.5 upfront, with an annual electrical cost of \$18.75 to operate. For the paper towel dispensers, \$2100 annually.

If the sustainability auxiliary fee for students on the Studley campus was increased by \$2 for the purpose of electric hand-dryer costs, Dalhousie would have \$21,474 to purchase hand-dryers with. If students were only willing to pay \$0.50 more in sustainability auxiliary fees, then alternately Dalhousie would have \$5368.5 for electric hand-dryers. Based on these two calculations, if \$2 was added to the sustainability auxiliary fees then Dalhousie could purchase 24 of the suggested Dyson V Airblade electric hand-dryers. If \$0.50 was added to the sustainability auxiliary fee, then 6 of the Dyson V Airblade electric hand-dryers could be purchased. If students were more willing to pay the \$2 increase Dalhousie would be able to readily purchase hand-dryers for any new buildings. If students were only willing to pay the \$0.50 increase, Dalhousie would have the hand-dryer costs covered within 3 years of this auxiliary fee increase being implemented. For our scenario we will assume students are willing to pay the \$2 increase in sustainability fees. The cost of the 18 Dyson Airblade hand-dryers would be recovered from 1 year of tuition fees from students on Studley campus.

*Summary of findings:*

- Dalhousie would save \$2081.25 annually in a building the size of the Mona Campbell if they installed electric hand-dryers upon construction of the building instead of paper towel dispensers;
- Dalhousie currently spends \$350,000 on paper towel for its four campuses annually;
- Dalhousie does not see the environmental benefit in switching to electric hand-dryers;
- To operate, paper towel dispensers cost \$116.7 annually compared to \$18.75 for electricity costs to operate electric hand-dryers annually, paper towel is approximately 6 times more expensive to operate annually;
- Paper towel is wasteful and ends up in landfills;

- Electric hand-dryers produce no waste, can be serviced by a technician if any issue occur, come with 5-year warranty from Dyson;
- If Dalhousie wishes to be viewed as a sustainable university, they must make the switch to electric hand-dryers for all future buildings;
- Based on our survey conducted for this project, we sampled 339 students on the Studley campus regarding their thoughts on paper towel vs. electric hand-dryers in campus washrooms;
- Of those 339 respondents 233 or 68.7% said they yes, they would support implementation of a new policy that requires new buildings to have electric hand-dryers instead of paper towel dispensers;
- 181 of those 339 or 53.4% agreed they would be willing to pay a \$2 increase in the current sustainability auxiliary fee in order to support this implementation of electric hand-dryers into new buildings;
- Overall the Studley campus student population cares about sustainability at Dalhousie and would see benefit in electric hand-dryers being installed into all future buildings.