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WASTE REDUCTION AND SUSTAINABILITY AT SKIDMORE COLLEGE

Abstract:

The purpose of this capstone project is to create the most culminating analysis of all of the available hand drying methodologies, and utilize this research in order to integrate the most environmentally sustainable and economically stable hand drying installation within Skidmore's establishments and specifically the new Center for Integrating Science building. The new 200,000 square foot CIS building will encompass 23 teaching and 46 research labs, 22 instrumentation rooms, 41 project and preparation spaces, five technology suites, 15 classrooms and meeting rooms, as well as social, display, and other public areas. We analyze the integration potential for this new building as well as Skidmore College entirely within this investigation. Throughout this analysis, the criteria that will be examined with be the structural acoustics of the allotted space, noise in decibels, backlight photography, cradle to cradle analysis, and a waste audit.

Introduction:

Humans are beginning to reach a point in civilization where we do not fully consider the cradle-to-cradle reactions and consequences of our actions. This research addresses the paper waste and energy consumption while hand washing in restrooms. The current debate that is ongoing on college campuses is about whether or not paper towels are the most environmentally friendly, economically sound, and efficient at eliminating harmful germs and bacteria. This research investigates whether or not electric hand dryers are recognized as a viable alternative to paper towels currently utilized at Skidmore College. This is an extremely pertinent issue because Skidmore is landfilling on average 17,800 lbs. of paper towels from restrooms across the campus. In order to eliminate this source of waste, the potential negative effects of using hand

dryers must also be addressed. The main concerns about electric hand dryers that we plan to investigate are in regard to their material costs, maintenance costs, installation, overall energy consumption, noise pollution as well as their ability to eliminate germs and bacteria**.** In order to properly analyze this situation, we must understand the sanitary and environmental efficiency of both paper towels and electric hand dryers. Within this study, we also explore the existing literature of the situation which is well balanced between both sides of the argument; paper towels and electric hand dryers.

immense amount of waste created within restrooms on college campuses. On a more local scale, Skidmore college is currently very interested in bolstering campus sustainability, and has purchased the energy permits for the local solar facility for the next 22 years, as well as made commitments to reduce emissions through many other innovations such as micro-hydro, passive solar, geothermal, and building retrofits (bulbs and building materials). This is why we find a long term economic analysis reasonable. We're also interested in influencing the bathroom components of the soon to be build Center on Integrative Sciences (CIS building) on Skidmore Campus within the near future.

Figure 1: Analysis of Paper Towels (PT's) vs. Electric Hand Dryers (EHD's)

The figure above describes the factors that we plan to consider throughout our economic analysis. It is important to recognize the overall cradle-to-cradle inputs that occur throughout these hand drying mechanisms. The economic analysis investigated the process of making paper towels, what are paper towels made of (fiber contents -- Virgin vs. post-consumer recycled materials), cost of paper towels, how many rolls/boxes of paper towels does Skidmore College use per semester/year, how far away is the landfill that the paper waste is being transported to, what kind of vehicle is transporting the waste, transportation costs of PT's, packaging costs of paper towels, how long will they take to degrade in a landfill, will they compost in a landfill, is

there an economic benefit of having less noise pollution (surveys). In order to properly investigate this issue, we must consider all facets of the paper towels, creation to destruction.

These inputs for paper towels are going to be directly compared to the cradle to cradle use of electric hand dryers. In specific regard to our economic analysis, our research considered questions like what materials are the EHD made from, what are the initial purchasing and installation costs of EHDs, how much energy do EHDs use, what kind of energy would Skidmore College supply the EHDs with, what is the overall cost of maintenance, what are people's willingness to pay for less noise pollution, how many places on campus are actually feasible locations to place EHDs.

The purpose of this research is to better understand if EHD's are more efficient both economically and environmentally. Without economic incentives, this will never gain enough support to be recognized on a large scale by institutions such as Skidmore College and other Colleges or Universities. After we have created this economic comparison, the secondary motive of the study will be analyzing germ accumulation and restroom sanitation.

Sanitary safety is the most important aspect of our research. We need to analyze how effective these two hand drying methodologies are. In order to answer this question, we must conduct experimental studies on campus in order to compare PT's and EHD's individual sanitation efficiencies. We plan to recruit Skidmore College students to participate within our study where they are told to use one of these two hand drying mechanisms. We want to examine common bathroom behaviors and actually determine how effective hand dryers are and what kind of positive change can be made. Bacterial prevention is the most important factor and many literature sources say that electric hand dryers spread more germs that PT's. We also plan to analyze the overall sanitary conditions of Skidmore's restrooms by using a UV light to detect

germs and bacteria. We believe that this facet of our investigation will lead to insightful realization towards the improvement of the overall sanitary condition of our restrooms.

Research Questions:

1.

Figure 2: (Mendez & Lynch, 1976)

Many stakeholders within the sci

function. This form of airborne cross contamination was examined within Dr. Huang's study which compared the bacterial dispersal of both hot air dryers and paper towels. This study found that the standard electric hot air dryer effectively causes a dispersal of bacteria within the radius of approximately three feet from hot air dryers. It was also found that some of the bacterial particulate matter was blown onto the investigator's laboratory coat. (Huang, pp 794). In comparison to EHD's within this study, the paper towels did not spread any airborne bacteria. This specific information was helpful in regard to the overall scope of this research because it proved that the use of EHD's causes a dispersal of bacteria throughout the air. One major concern of our research was regarding the distance of bacterial dispersal. This study proves that the bacteria is not spread in a rampant manner throughout the entirety of a restroom; which is a common concern of many on this particular matter.

Another interesting aspect of this article also identifies a stronger vector of bacterial dispersal within the bathroom that is often overlooked. Dr. Huang's study was able to identify that every time a toilet is flushed, a fine aerosol mist is dispersed as far as six meters away (Huang, 794). This factoid is interesting because it invalidates EHD's bacterial dispersal arguments partially. This mist, which is directly from the source of fecal bacteria, is dispersed three times further, and is still overlooked and not perceived as an issue of public health. Within the Mendez & Lynch experiments, it was found that 47% of bacteria within restrooms come from fecal origin. This statistic draws upon a sanitation issue that could potentially affects our public health (Mendez & Lynch, 1976). Since this fecal spraying from toilets is not addressed by

factor is one of the most deterring. Within Dr. Huang's study, a decibel reader was used to analyze the overall volume of numerous devices. The mean decibel level of EHD's within this study was found to be 94 dB from a distance of one meter. These measurements were found beneficial towards our study because this form of volume measurement can be easily replicated. This base model of volume detection will be used as the model for our experimental design later in the report.

Within Huang's analysis, researchers took decibel measurements from one meter as well as two meters away. This experimental design also investigates the volume of multiple EHD's functioning at the same time. This is an important aspect of the overall scope of our research that we at first did not consider. Within Huang's study, it was found that when two jet air dryers were used at the same time, the mean decibel reading was 92 dB from two meters away (Huang, 2012).

These decibel recordings within Huang's study raise concern towards hearing health. On the Dangerous Decibel's website, it is quoted that for every three decibels over 85 dB's, the permissible exposure time before possible damage is cut in half. This statistic is reported within figure three below. Within our experimentation, we will be using this chart as a guide to analyze individual model's dB readings.

Figure 3: Decibel Safety (Dangerous Decibels, 2016)

This is an extremely important observation because the type of elctric hand dryer, the Xlerator, has been proven to be at the very loudest of 90 dBs. This proves that these hand dryers could not put anyone in danger.

Electrical Efficiency: (United States' Grid)

When considering the overall feasibility of large-scale EHD implementation, it is important to consider the overall efficiency of the source of power. Even though the United States' national grid is currently improving, it is still highly powered via fossil fuels and coal. This United States relies upon coal to power about forty-five percent of the total energy supplied to the grid (Montalbo, 2011). This grid also functions accordingly to a continuous peak-schedule without any battery storage capabilities. This large inefficiency creates a difficult obstacle for EHD's to combat due to the fact that they rely exclusively on electricity. For our project on Skidmore College Campus, our energy source is more ecologically sustainable than the common consumer and is boosted in power from a small off-campus hydro plant, off-and-on

being charged .0505 cents for every kWh, in comparison to New York States rate of .14 cents per kWh (Kellogg, 2017).

Within figure 4 below, the overall eff(l)-2 (e)-6 (f)3 thHof .14 ( )]TJ(e)4 (n ( )]T9 0 Td4 (r)3 (a)4n4 (r)3

innovation is also very important to consider within this field of study. It is reported that batteries are becoming cheaper by 50 percent per year while continuously increasing efficiency by approximately 8 percent annually (Davies, pp. 5). Battery potential and grid integration remains to be the facet of grid technologies that stakeholders are most optimistic about.

Cradle to Grave / Life Cycle Analysis – Waste:

In order to compare overall efficiencies of the two hand drying methods, EHD's and paper towels, it is important to consider all facets of production, transportation, and materials used. Within Montalbo's study, nine different methodologies were compared via cradle-to-cradle processes. These models consisted of six EHD's, two types of paper towels and one type of cotton roll towels. The criteria used within this C2C analysis were materials used, manufacturing processes, transportation, use (electricity) and end-of-life (landfill). These measurements were all made in term

Montalbo's model greatly influenced our methodologies for producing our own C2C analysis on Skidmore College Campus.

Post-Consumer Waste:

In order to compare the overall environmental impact of the current hand drying methodologies at Skidmore, it is important to consider the materials in which they are produced from. The current paper towels that Skidmore using in rest rooms are made up of post-consumer waste materials. PCW is the purest form of recycling, in comparison to standard recycling, post-consumer waste must be used my society and the consumer before being shipped to a recycling facility and being remanufactured into a new materiel. In comparison, standard recycling can be unjustifiably represented by materials like scraps from a factory floor.

In the last five years Skidmore has been using PCW paper towels in their restrooms across campus. Prior to this year, the college was using 80 percent post-consumer waste paper towels, and has of last year switched to a less environmentally friendly roll of 50 percent post-consumer waste. We found this to be important for our study, because the greater percentage of PCW contents means more economic and environmental benefits. When considering the recent change that Skidmore has made regarding post-consumer paper towels, we will be analyzing the disadvantages of this change and the alternatives that would be more feasible for the college.

Geographic Information System (GIS):

When considering possible locations where electric hand dryers could be implemented in restrooms at Skidmore, we needed to first identity specific locations where they would be feasible in an academic environment. Once we completed our decibel tests across campus, we used a geographic information system to show which areas EHD could be implemented. By using the software, we categorized three areas; very possible integration (green), possible integration(yellow) and could not be integrated (red). Using GIS, we used these colors and highlighted the areas on Skidmore's campus in regards to the possibly of electric hand dryers implementation.

Methodologies:

Setting & Population:

Within this analysis, we would like to investigate the possibilities of reducing paper waste on Skidmore College by installing electric hand dryers. We were particularly motivated to conduct this analysis because Skidmore College is about to build an entire new Center for Integrated Sciences building (CIS). The new 200,000 square foot CIS building will encompass 23 teaching and 46 research labs, 22 instrumentation rooms, 41 project and preparation spaces, five technology suites, 15 classrooms and meeting rooms, as well as social, display, and other public areas. This facility must offer many restrooms in order to adhere to the needs of students and faculty. This demand for newly established restrooms engages our School towards an interesting question; which hand drying methodologies should be installed throughout campus?

Economic Analysis:

When comparing the differences between two hand drying mechanisms, paper towels (PT's) and electric hand dryers (EHD's), economics must be investigated in order to determine the overall potential benefits of a "paper-free" movement. Within our economic analysis, the

specifications were operating at 78-80 dB±. This sound level was measured in front of the *dryer/speaker* at a height of 5 feet (152 cm) from the floor and 18 inches (46cm) from the wall (Xlerator Inc., 2017). We specifically selected the most likely place of integration, to our best ability, and analyzed this volume from outside the restroom as well as within the most local classroom or offices.

Surveys - Qualtrics Data:

We distributed surveys online via Qualtrics. One purpose of this investigation was to identify people's overall opinions towards paper towels and the utilization of Electric hand dryers. This topic must be addressed because it directly reveals how easily people's behaviors could change. Our survey sample size was 110 and included the following questions.

SURVEY DATA QUESTIONS

1. **Are you a Skidmore College Student OR currently employed by Skidmore College?**
2.

4. **If any, which problems do you associate with electric hand dryers? Choose all that apply.**

    ¢ Volume-too noisy, dry duration too long, do not work properly, spread germs, n/a.

Northwood's Parking Lot. We planned on investigating the composting process throughout the span of approximately two months.

Local Investigation / Stakeholder Analysis:

We also explored the local surrounding restaurants, shopping centers, and bars in order to locate an ideal model to replicate within Skidmore College. Throughout this investigation, we were able to determine that the newly constructed Burgerfi restaurant on Broadway perfectly constructed their restroom to our specifications. They utilize only the Xlerator hand dryer and do not use paper towels. We have determined this location to be the Gold standard for replication at Skidmore College.

Methods Triangulation + Data Triangulation:

We will be utilizing data triangulation within our capstone study in order to provide corroborating evidence. In order to properly utilize this methodology, we must make use of multiple and different sources, methods, investigators, and theories to create the most statistically relevant data set (Creswell, pp. 151). Creswell acknowledges that data triangulation functions as a validation strategy for data collection. This is why this form of methodology was chosen for our capstone project.

Limitations:

One of the largest limitations to this study is regarding that this project would require a lot of labor to entire integrate electric hand drytnton cahisowuld require vat(a)4 mnts

We were able to find out that Skidmore College has been paying nearly $27,000 every

that we used consisted of only 750 sheets and the newer roll now consist of 1050 sheets. We believe that this switch to the less environmentally friendly roll within 2016 (Figure 7) was made primarily because the newer roll has more sheets and therefore must be replaced less often.

Figure 11: Electric Hand Dryer Model Comparison - Xlerator vs. Standard Model

Within figure 11, it is shown that on every form of the Xlerator expectation model was vastly more efficient that the standard electric hand dryer in comparison. The Xlerator estimates are the three furthest to the left and are shown to be more than three times as efficient. We created these calculation by analyzing the comparative lifecycle estimates of Xlerator versus the standard conventional electric hand dryer. We were able to discover that the Xlerator on average will utilize 1381 kWh's for every 260,000 dry cycles. In comparison the conventional dryer would use 5108 kWh's for every 260,000 dry cycles (Figure 12).

Figure 12:

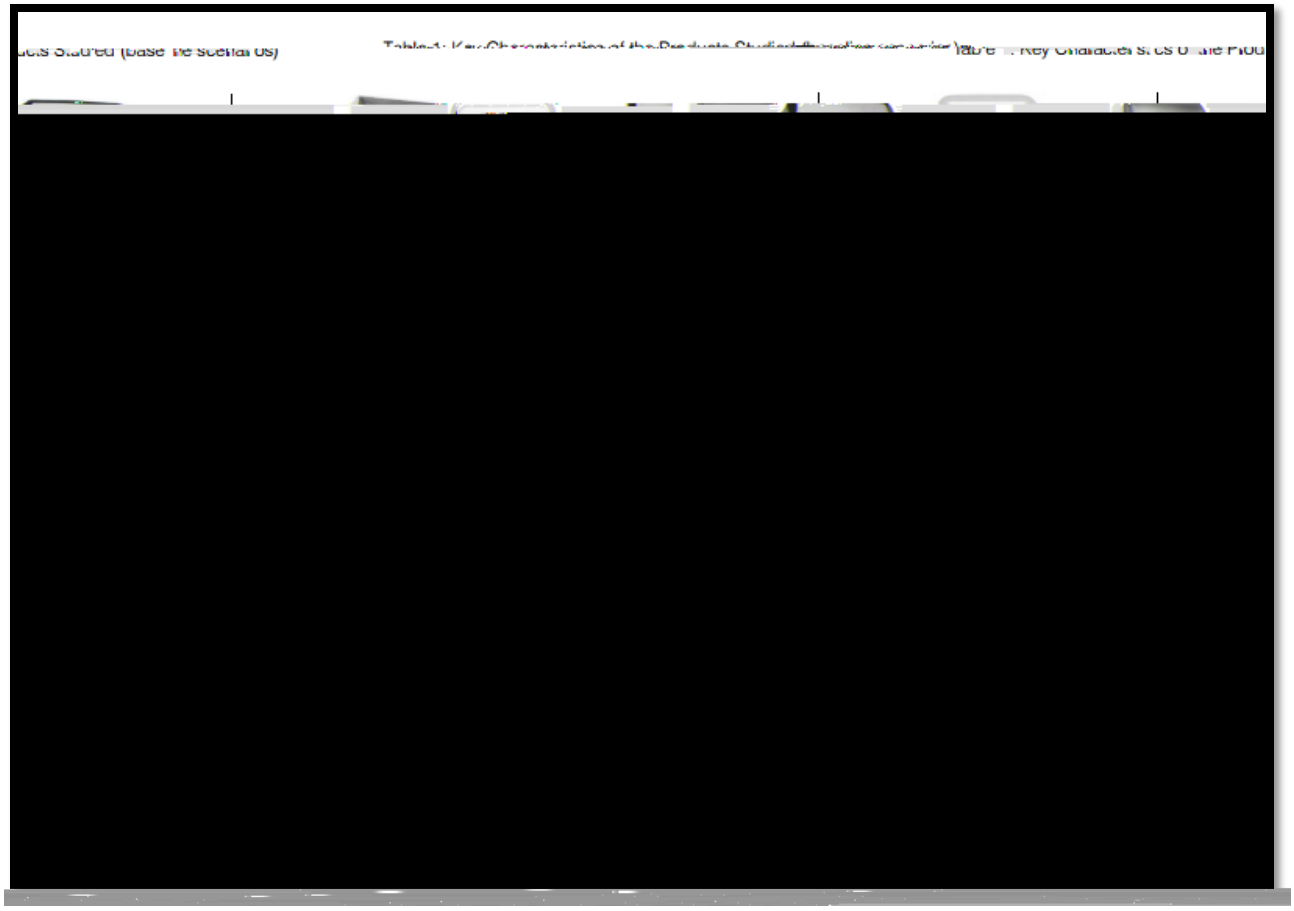
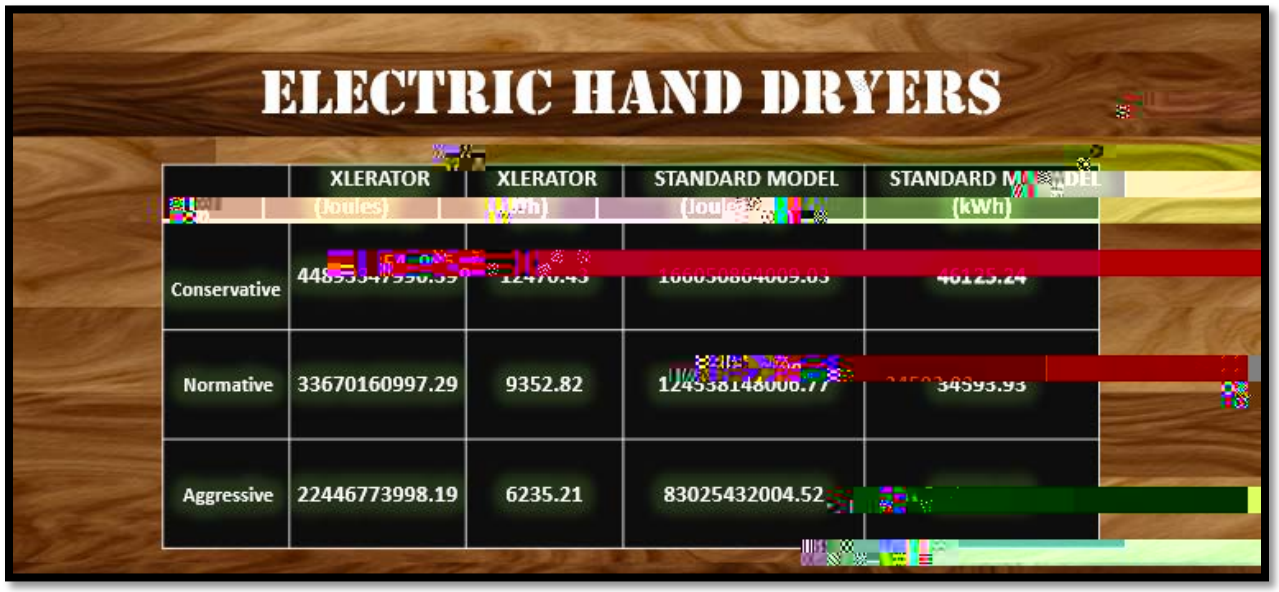


Figure 13: Conservative, Normative, and Agressive EHD use Calculations



Within figure 13

Figure 16: Total Hand Drying C02 Emissions Equivalency Calculations

Results - Survey Analysis:

Figure 17: Skidmore College Hand Drying Preference Survey

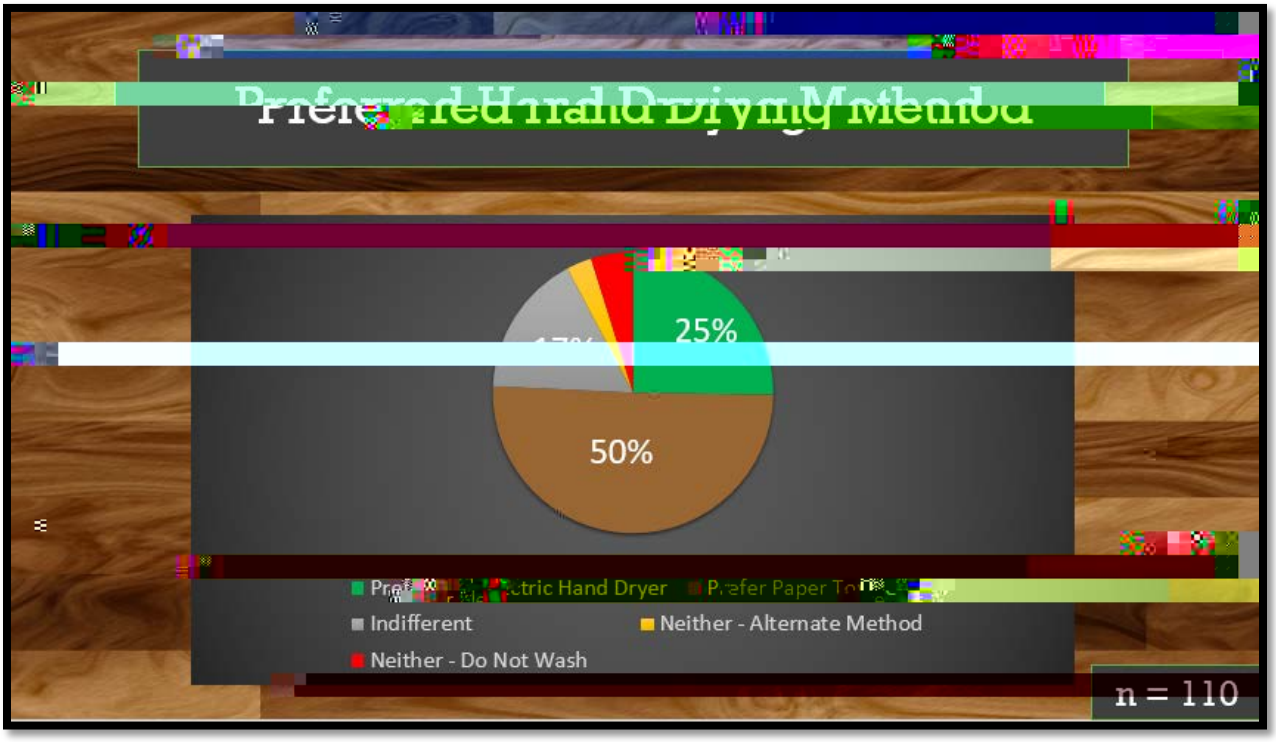


Figure 18: Associated Problems with Electric Hand Dryers - Student Perceptions

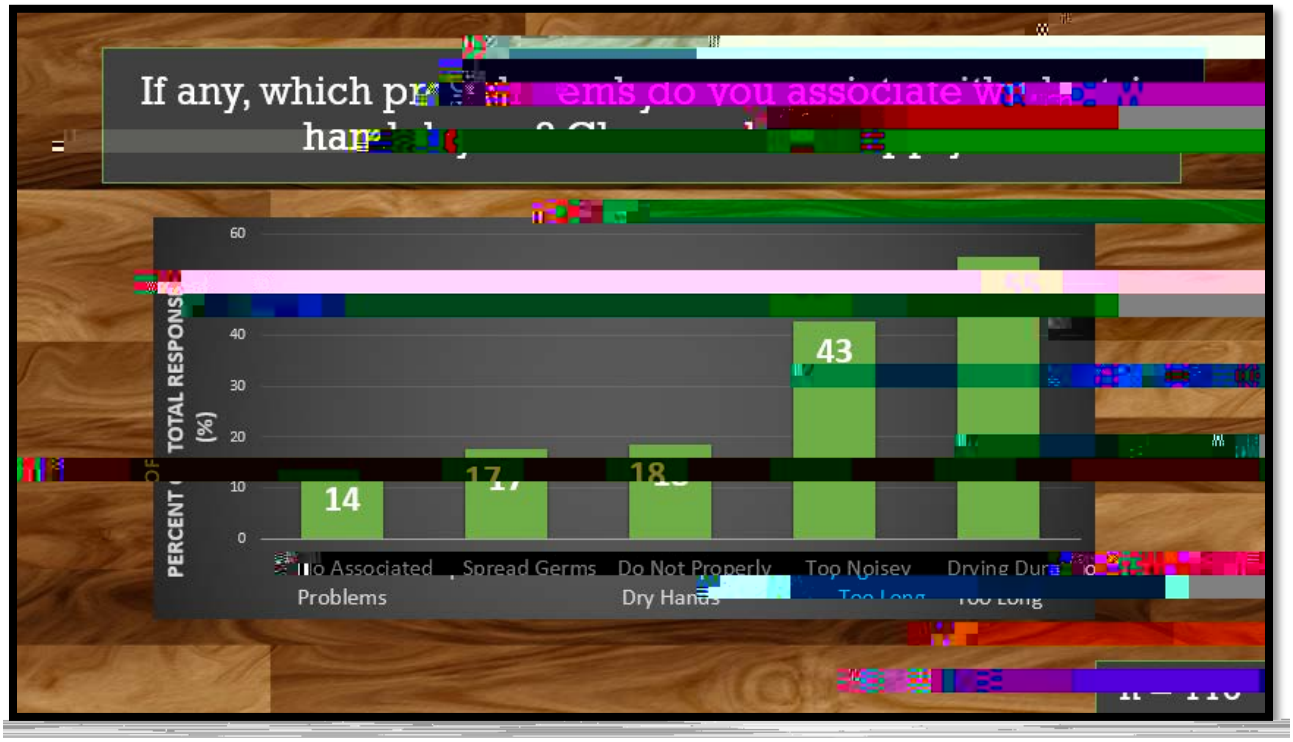


Figure 19: Associated Problems with Paper Towels - Student Perceptions

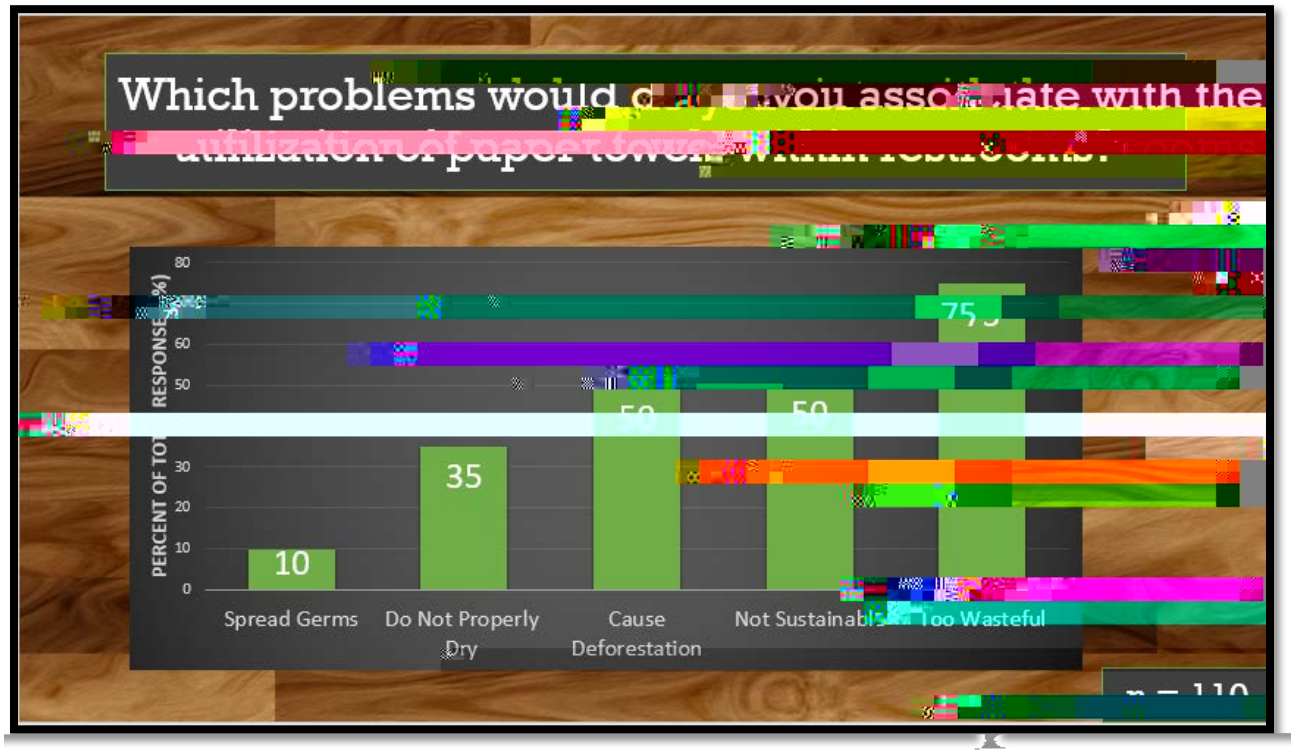
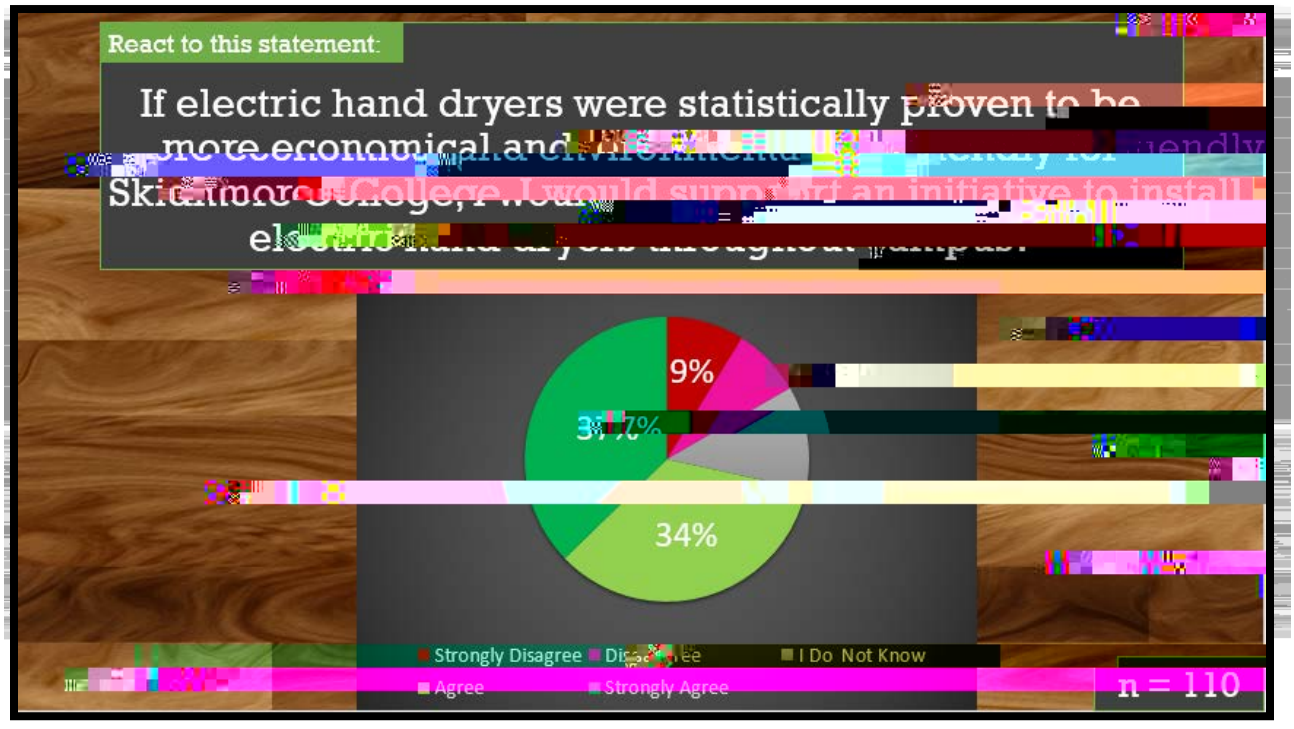


Figure 20: Willingness to Change Behavior - Thesis Question



Our survey results are shown graphically above throughout figures 17-20. Figure 17 first portrays the overall preference of Skidmore students regarding hand drying methodologies. This graph shows that exactly half of the respondents told us that they prefer to use paper towels more than any other methodology if given the option. Figure 18 shows what Skidmore Students believe to perceive as the largest problems associated with electric hand dryers. The results of this question showed that Skidmore Students found electric hand dryers take too long to dry hands, are too noisy, and do not properly dry hands to be the most concerning issues. Figure 19 discusses the problems that Skidmore College students associate with paper towel utilization. Skidmore students found that fact that paper towels were too wasteful, not sustainable, and cause deforestation to be the most impacting problems associated with their use. Finally, figure 20

Results - Decibel Testing Analysis:

Figure 21: Electric Hand Dryer Integration Potential Experiment Procedures

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