

UBC Social, Ecological Economic Development Studies (SEEDS) Student Reports

An Investigation into Sustainable Hand Drying Methods

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Impact of Technology
on Society

Instructor:

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An Investigation into Sustainable Hand Drying Methods



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Abstract

This report is meant to outline the findings, of research, into the debate over whether paper towels or electric hand dryers are more sustainable. Utilizing a triple bottom line assessment the impacts of the products in question are categorized into: environmental, economical, and social.

An economical look into the life cycle analysis of paper towels shows a strong negative effect on the environment in comparison to electric hand dryers. Large amounts of pollution/deforestation are created for every ton of paper towels being manufactured. Pulp and paper mills contribute to the air and water pollution, which can adversely affect neighboring wildlife and humans. The cost of paper towels in comparison to conventional and high-speed dryers is quite expensive. Due to the disposability factor, paper towels are far more wasteful than electric hand dryers, which have the advantage of producing zero physical waste.

It is necessary to observe the differences in hand dryers available to the market before approaching a recommendable decision. The conventional warm air hand dryer has been employed in countless washrooms around the country for many years. The environmental problem with using these dryers is they still lack the ability to fully dry a person's hands and have double the energy consumption when compared to high speed hand dryers like the Mitsubishi Jet Towel or the Dyson Airblade. These high-speed dryers appeared on the market in 1996 and 2006 exclusively, and produce much better energy consumption values compared to the warm air dryers. The new technologies associated with the high-speed dryers emphasize a much lower carbon footprint in comparison to paper towels and warm air dryers.

Dyson Airblade employs a HEPA-grade filter that captures microbes, from inlet air, without transferring it to the user's hands. The Dyson Airblade's analysis showed that it performs exceptionally in all three categories of impact, more so than the runner-up technology, the Mitsubishi Jet Towel. A higher level of hygiene, economical benefit and environmental awareness make the Dyson Airblade the recommended choice for the new student union building.

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Glossary & Abbreviations

Sustainability: Improving the quality of human life while living within the carrying capacity of supporting eco-systems.

LEED: Leadership in Energy and Environmental Design

HEPA: High Efficiency Particle Air – a type of high efficiency air filter

kWh: kilowatt hour

1.0 - Introduction

The purpose of this report is to investigate the feasibility of using paper towels versus electric hand dryers using the triple-bottom-line comparison method (i.e. comparison based on social, environmental and economical impact). Research, based on those factors, was done on paper towels and three different types and brands of electric hand dryers, specifically: the AirMax Automatic Hand Dryer, the Mitsubishi Jet Towel High-Speed Hand Dryer, and the Dyson Airblade. From this research, a recommendation of which method to use will be presented for the new Student Union Building at the University of British Columbia.

2.0 – Overview

In the upcoming sections the sustainability of both the paper towel and the electric hand dryer options is discussed. The options are presented as a triple bottom line comparison. The first presented will be the paper towel option followed by the three electric hand dryer options. The conventional hot air dryer is presented in section 2.2, followed by the Dyson Airblade in section 2.3 and finally the Mitsubishi Jet Towel in 2.4. A comparison between the options based on this method of assessment on sustainability is presented in section 2.5.

2.1 - Paper Towels

Studies show that for ongoing usage, paper towels cost more money, require more work and are less environmentally friendly than hand dryers. The following is a detailed analysis of the paper towel system from environmental, social and economical standpoints.

2.1.1 - Environmental Impact

The use of paper towels has a strong negative effect on the environment when compared to electric hand dryers. The production and recycling of paper towel results in notable environmental issues, including deforestation, air and water pollution from pulp mills, high energy and water use in production and disposal.

The use of one ton of paper towels contributes to the waste of thousands of kWhs of energy, thousands of gallons of water and releases large amounts of pollutants into the air.

During the life cycle of paper towels, the some of the greenhouse gases emitted (e.g. sulfur oxides) are enough to cause acid rain [Word Press], which can cause significant harm to the environment. Pulp and paper mills release air pollutants such as carbon dioxide, sulfur oxides and nitrogen oxides. Moreover, paper towels are sometimes bleached during the production process to make them whiter. With the growing concern of global warming, the emissions of carbon dioxide per use of paper towels and hand dryers were compared, which is shown in Figure 1, below. Based on the graph, it illustrates that hand dryers are more environmentally friendly than paper towels when it comes to greenhouse gas emissions [Six Links].

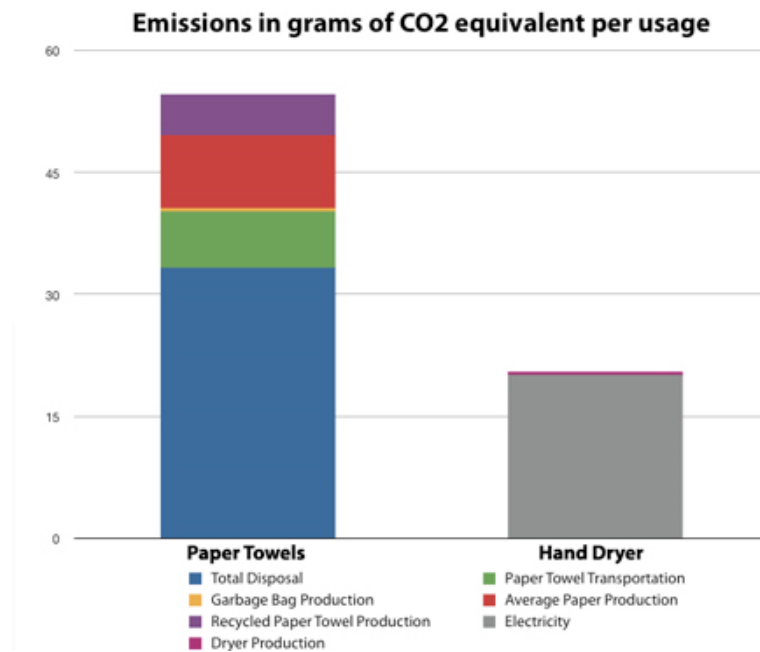


Figure 1: Paper Towel vs. Hand Dryer Emissions [Six Links, 2009]

In addition, deforestation is quite a significant problem as it contributes to species loss and global warming, because forests both provide habitats and absorb carbon dioxide from the atmosphere. The production of paper towels requires the destruction of trees, which are potential homes for wildlife; therefore, the production of paper towels is not entirely eco-friendly.

The most significant impact by paper towels on the environment would be the amount of landfill waste that is produced from their use since some paper towels cannot be recycled since they could spread germs and bacteria. People also tend to use more paper towels than they need and therefore contribute more to the waste. For example, “an everyday fast food restaurant that uses

paper towels will go through the equivalent of nine full grown trees”, which contributes “1000 pounds of landfill waste” whereas electric hand dryers contribute virtually no landfill waste at all [Home and Garden Dude, 2009].

A study conducted in by US Environmental Protection Agency shows that paper made up the largest share of municipal solid waste at 34 %.Only half of the paper towel waste is recovered for recycling or compost and the other half ends up in landfills [Ehow].

Dee Janis claimed in his paper that switching from paper towels to 102 of its wall-mounted dryers system-wide would save annually 587 trees, 690,000 gallons of water, 34.5 tons of solid waste, 103.5 cubic yards of landfill space, and almost \$90,000 per year (including electricity costs), with less than a six-month initial payback period for the cost of installation [Buzzle].

2.1.2 - Social Impact

The social impact of using paper towels is also quite negative, the main reason being that it requires additional labour and could cause potentially unsafe conditions for workers. When a person uses a paper towel, the towel is usually deposited in a garbage can, on the floor, or even in toilets or sinks after use. Some employees (i.e. janitors) have the task of cleaning the washrooms and garbage bins. In addition to the task not being particularly enjoyable, there is a health risk related to that job, as paper towels are not necessarily free of bacteria, especially with wet and/or used paper towels [Word Press]. Furthermore, with the new technology of high-speed electric hand dryers being able to dry hands at the same rate as, or faster than, paper towels in addition to reducing bacteria. It does not make sense to continue using paper towels in bathrooms.

2.1.3 - Economic Impact

The cost of paper towels is also on the negative side when compared to electric hand dryers. Cost of paper towels vary according to quality and volume acquired. According to various internet sources, the cost of a case of 2,400 paper towels is roughly \$25, which is good for approximately 960 hand-dries (2.5 towels per drying application); and therefore, costs \$0.03 per hand-drying application, whereas hand dryers that take 30 seconds per use only cost \$0.0020 per hand dry.

Furthermore, there is some cost associated with wasting paper towel. People often accidentally pull several multi-fold towels from the dispenser and then throw them away.

Additionally, the maintenance cost of paper towels requires plumbing when paper towels clog the toilets or sinks; and janitors to refill the paper towel dispensers, to empty the garbage bins, and to pick up any paper towels left on the floor. The touch-free hand dryers eliminate physical contact, thus significantly reducing exposure to bacteria. Therefore, using hand dryer eliminates associated labor costs for ordering, storing, replenishing, collecting and disposing of paper towels. Hand dryers, on the other hand, need virtually no maintenance.

To summarize, hand dryers can reduce costs by as much as 90%, when compared to paper towels. They require very little maintenance, whereas paper towel stocks need to be continuously replaced, and used paper towels need to be removed; both of which could cost a large sum of money in the long run.

2.2 - Hot Air Hand Dryers

For the conventional hot air hand dryer the model selected to be looked at is the AirMax Automatic Hand Dryer produced by World Dryer. This device dries hands by blowing ambient air past a heating element and then through the outlet to the hands below. The device has a sensor to automate the device. These types of hand dryers have a bad reputation of being slow and ineffective at drying hands leaving damp hands. A picture of the dryer is displayed below.



Figure 2: AirMax Automatic Hand Dryer [Supply Hero, 2009]

2.2.1 - Social Impacts

World Dryer, the manufacturer of the AirMax Automatic Hand Dryer is based in Berkeley, Illinois. The hand dryer itself is manufactured in a factory at this location. Therefore the manufacturing of this product does not abuse cheap labor in other countries. In terms of a social impact on society this device creates good fair paying jobs. It would be fair to say that this product has a positive social impact.

2.2.2 - Environmental Impacts

For the AirMax Automatic Hand Dryer the environmental impact comes from the manufacturing, the operation and the disposal of the device. Since the manufacture of the device is done in the United States the danger of unsafe environmental practices in the production of the device should be limited. The device has options to be made from various different materials depending on the use of the device; the materials used change the environmental impact of the device. The device contains porcelain and steel components with the option of iron, steel or polymer covers [World Dryer]. The device also has the sensor and associated electronics as components as parts that create additional environmental controls upon disposal. Most likely the disposal of this device would be through traditional methods not through recycling which generates another impact on the environment.

The operation of this device is the main source of environmental impact over the course of its lifetime. The device has a power consumption of 2300 watts [Supply Hero] and an average drying time of 15-30 seconds or approximately 0.0096 - 0.0192 kWh of electricity used per drying. This translates to 0.0052 – 0.0103 kg of CO₂ emissions per use of the device.

This device is GreenSpec listed and thus the use of this device can earn building credits towards being LEED certified based on the devices optimized energy performance. [World Dryer]

2.2.3 - Economic Impacts

The AirMax Automatic Hand Dryer retails for \$735.00 US [Supply Hero] but can be found for cheaper. In terms of maintenance the device comes with a 10 year limited warranty against defects, 5 year warranty on the sensor and 3 years on the motor. [World Dryer]

Replacement parts are available so maintenance on the devices is possible instead of complete replacement of the device.

The main cost besides the initial purchase is the cost of electricity. BC Hydro's commercial rate for electricity is \$0.0769 per kilowatt hour [BC Hydro] and thus given an energy use of 0.0096 – 0.0192 kWh per use the cost of each drying is in the range of \$0.00074-\$0.00148. The overall cost of operating the device therefore depends of how often it is used.

2.2.4 - Problems with Hot Air Hand Dryers

While the manufacturers claim that the AirMax Automatic Hand Dryer is capable of drying hands in 15s [World Dryer], competitors claim that it takes 30s [Dyson Airblade]. Hot air hand dryers tend to leave hands wetter after drying as users are not willing to wait the time it takes to dry their hands.

2.2.5 - Summary

While not the best at drying hands, the AirMax Automatic Hand Dryer is an environmentally friendly device. Its use aides in improving the LEED standing of the building it is in and it is manufactured in the United States and thus does not abuse cheap labor markets. Economically it is a cheap alternative to better performing more environmentally friendly devices.

2.3 - The Dyson Airblade

The Dyson Airblade is a product of exceptional innovation. This high-speed hand dryer utilizes bathroom air forced through a HEPA-grade filter (to remove harmful bacteria) before being propelled through two apertures. These apertures are no thicker than an eyelash and produce two sheets of air, travelling at 640km/h, which effectively strip the moisture from the user's hands [Dyson Airblade]. A figure of the Dyson Airblade is available below.

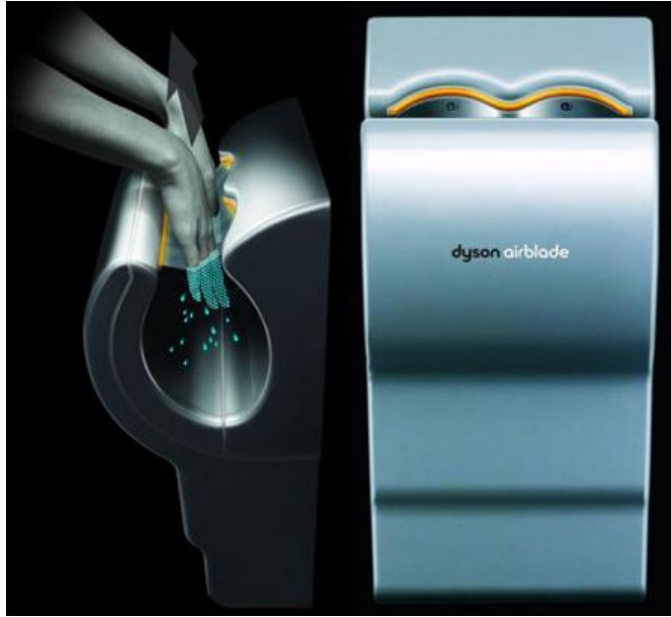


Figure 3: The Dyson Airblade Standard and Profile view [Dyson Airblade, 2009]

2.3.1 - Social Impacts

The production headquarters of Dyson moved from Malmesbury, Wiltshire to Malaysia, which ultimately led to the “loss of 800 jobs” [Gribben R., 2003]. This switch allowed Dyson to save money on production costs, while still allowing the “Malaysian-built product [to be] now sold in more than 3,000 outlets” in America [Gribben R., 2003]. The maintenance of this product is extremely minimal; it is built to withstand vandalism and other chemical abuse [Dyson Airblade]. The Airblade is easy to clean and employs antimicrobial additives in the surface to “reduce bacteria and mould growth by 99.99% for the lifetime of the machine” [Dyson Airblade, 2009]. It is important to note the hygienic disadvantages of damp hands after leaving a restroom; Damp hands are 1000 times more likely to cross contaminate than dry hands, with this in mind it is valuable to realize the Dyson Airblade’s ability to dry hands in just ten to twelve seconds [Science and Technology News]. The improved hygiene and the faster drying time of ten to twelve seconds are just a few of the many amazing advantages the Dyson Airblade employs.

2.3.2 - Environmental Impacts

The recyclable aluminum casing of the Dyson Airblade ensures a sustainable alternative to the “manufacture, transportation and maintenance of paper towels” [Dyson Appliances, 2008].

The Airblade contains all the materials listed here: Die cast aluminum, steel, copper, zinc, ferrite cores, polyurethane, polypropylene, Styrene, butadiene, glass, fiber fleece, wool adhesive and dyes [Dyson Airblade]. The carbon dioxide emissions, annual operating carbon footprint, are lowest with the Dyson Airblade at 69.84kg/CO₂, followed by conventional dryers with 263.14kg/CO₂ and finally paper towels with 657.00kg/CO₂ [Dyson Airblade]. The Airblade can efficiently dry 23 pairs of hands rather than consuming 23 paper towels for the same price [Dyson Airblade]. Emissions of the manufacturing plant are difficult to find and due to the different emission laws of Malaysia, it is difficult to approximate the overall or life cycle environmental impact.

2.3.3 - Economic Impacts

The Dyson Airblade utilizes a “Dyson digital motor” operating at a speed of 81,000 rpm to produce the necessary velocities of air utilized in the hand drying process [Dyson Airblade, 2009]. In a comparison with warm air hand dryers and paper towels, the Airblade proves its worth economically, with the lowest annual operating cost of \$32, compared to the warm air dryer’s \$123 and the paper towel’s total of \$1460 [Dyson Airblade]. This comparison assumes a two cent cost per paper towel and is based on 200 uses per day. The annual power consumed by the Airblade is a mere 349.18kWh, while the warm air conventional hand dryer is approximately 1315.69kWh, this analysis of the power consumption accentuates the energy cost of warming air prior to using it for drying [Dyson Airblade].

2.3.4 - Efficiency and Utilization

The Dyson Airblade has won awards in the following categories: Energy Efficient Product 2007, Carbon Positive Cutting Edge Award 2008, Best New Product 2007, Best Overall Product 2007, Best Workplace Innovation 2007, Observateur du Design Star 2007, and Janus de l’Industrie 2007 Laureate 2007 [Dyson Airblade]. Each award given to the Airblade encompasses values important to the design of the new Student Union Building on UBC campus. The Dyson Airblade is already being used on UBC campus at Mahoney and Son’s, a pub/restaurant, which shows the versatility and durability of this exceptionally designed machine; while the capital cost of \$1400 seems expensive the annual operating costs (\$32) in comparison to the alternative methods make the Dyson Airblade the best possible solution in the long run when compared to conventional dryers and paper towels [Dyson Airblade].

2.3.5 - Summary of Sustainable Features

The summary of sustainable features of the Airblade can be outlined mainly with three areas of consideration: energy, hygiene, and reduction of operational waste and pollution. The Airblade consumes up to 80% less energy than conventional dryers and utilizes a touch-free infrared sensor interface [SkySite Property]. Anti-microbial additives (reducing bacteria 99.99%) incorporated into the chassis of the product ensure hygienic protection against bacteria and moulds [SkySite Property]. The Airblade is the first hand dryer to meet National Sanitation Foundation protocol P335, which recognizes impeccable standards of hygiene, health and safety [NSF international]. This hand dryer would reduce the amount of paper towels sent to landfill and would therefore reduce the need for “waste [paper] hauling and disposal” [SkySite Property, 2009].

2.4 – The Mitsubishi Jet Towel

The Mitsubishi Jet Towel is what is considered a high-speed hand drier, it is both economically and environmentally feasible for the new Student union building at the University of British Columbia. It works by pumping air from the room at speeds close to 90 meters per second through small nozzles spaces closely together, therefore creating a flat plane of air that sweeps the water off of both sides of wet hands in 5 to 6 seconds [Mitsubishi Jet Towel]. It operates very similar to the Dyson Airblade, discussed in this report, with the difference that the jet towel has an option to heat the air that it uses to dry hands, this option is available only for custom models and does not come standard [Global - Mitsubishi Electric]. Unlike the AirBlade the Jet Towel does not use antimicrobial filters, the air simply passes through a filter designed to remove particulate to avoid damaging the motor.

2.4.1 – Social Impact

The Jet towel is extremely user friendly and more sanitary than conventional drying methods. It uses sensors to turn itself on when needed and comes with a built-in safety feature that automatically shuts the unit off after 30 seconds of use to avoid misuse and abuse; this resets itself every time it is shut off [Mitsubishi Jet Towel]. The water that's swept off wet hands is collected in a tank at the bottom of the unit that needs to be emptied every so often; this prevents

the floors of the restroom from becoming wet and potentially hazardous to those who use the facility. Also due to its contact-free design, the jet towel, is more sanitary and produces a lot less waste when compared to paper towels. Noisy hand driers are also a problem, conventional hand driers can emit anywhere from 75dB to 90dB of sound, whereas the jet towel emits only 65dB, this is the equivalent of a normal face to face conversation [Jet Towel - Mitsubishi Electric].

2.4.2 – Environmental Impact

The Mitsubishi Jet Towel is very environmentally friendly; it uses air from the room itself to dry hands. This cuts back dramatically on the amount of paper towels that would be used. It is also more energy efficient than warm-air hand driers due to the fact that it uses air at room temperatures, therefore eliminating the heating coil, which is what uses up most of the energy in hand driers. The Jet Towel uses 281kWh per year while conventional warm air hand driers use up to 1315 kWh [Jet Towel - Mitsubishi Electric]. Any sustainable alternative should have a reduced carbon footprint, the Jet towel produces the equivalent of 121kg CO₂ per year, and conventional warm air driers come in at 2935 kg CO₂ per year [Jet Towel- Mitsubishi Electric]. The Jet Towel is also GreenSpec approved and adds to the building's LEED certification, by having minimum energy performance, and optimal energy performance [Mitsubishi Electric].

2.4.3 – Economical Impact

At first glance the Jet Towel may seem more costly than using paper towels and warm air driers, the initial cost for a unit is approximately \$1400 [Gizmodo]. This is only an initial cost, as time elapses it quickly becomes the more economical solution, it is very energy efficient and does not waste any paper. It conserves energy by sensing when hands have been removed and shuts off. The cost of paper towels is approximately \$0.012 per sheet assuming two towels are used to dry hands with an average use of 200 times a day, this comes out to \$4.80 per day on paper towels alone, whereas the jet towel only costs \$0.020 per day given the same circumstances. This amounts to an annual savings of \$2,017[Mitsubishi Jet Towel], in the first year alone the jet towel pays for itself with savings left over. Comparing this to a warm air drier, where the operating costs are approximately \$123 per year, further shows the economical

advantages of the jet towel. Due to the quick drying time of the jet towel, only one need to be installed in a restroom, instead of 3 warm air driers or two paper towel dispensers.

2.4.4 – Sustainable Impact

The Mitsubishi Jet Towel is a lot more sustainable than paper towels, and conventional warm air hand driers. It is not only a good economical decision, but also a good environmental decision, by cutting back on paper products and electric bills. It will also help towards the buildings LEED certification, and is aesthetically pleasing due to the amount of paper waste that would otherwise be present. It dries hands in less than 6 seconds, and is quiet, therefore making the Jet Towel a good sustainable choice for any building.

2.5 – Option Comparison

2.5.1 - Social Comparison

In terms of a social impact, the two high speed hand dryers both demonstrated the greatest abilities. Neither produces the waste of that paper towels do. When compared to the hot air hand dryer, the faster speed and improved sanitary qualities of the high speed dryers show a far superior performance. When looking at manufacturing however the Dyson Airblade loses to the other options all which are produced in countries with high standards of working conditions, the Airblade has taken advantage of cheap labor laws in Malaysia.

2.5.2 - Environmental Comparison

With regards to the environmental impact of each method paper towels is the worst option due to the high waste generated from their use. The two high speed hand dryers are the lowest energy users with the Dyson Airblade showing the lowest.

2.5.3 - Economic Comparison

When looking at the costs of the options the two high speed hand dryers are the most expensive initially at ~\$1400 for both options. The hot air hand dryer is the next most expensive initially at \$700 and the paper towels are the cheapest initially. While running the paper towels

are by far the most expensive at \$0.012 per drying. The costs of operation of the electric options are based solely on their energy consumption per use, the Dyson Airblade being therefore the cheapest.

3.0 – Conclusions and Recommendations

The comparison presented showed that the two high speed hand dryers were the best performers. The paper towels had the problem of being environmentally unfriendly both in the manufacturing and in their disposal. Economically, they were also the last finishers as they were by far the most expensive in the long run. The hot air hand dryer, although the cheapest to purchase and more efficient than paper towels, was more expensive to operate than the high speed dryers due to a higher energy usage. They also are less effective at drying hands. Between the two high speed hand dryers there are two main differences. The Mitsubishi model is manufactured in a country with better worker standards than the Dyson model. The Mitsubishi also has the advantage of being a proven model having been developed over 10 years ago. On the other hand the Dyson model has an anti-microbial HEPA filter which improves the sanitary qualities of the air blown on the hands. Overall the recommended option based on the research done would be the Dyson Airblade.

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All citations were referenced with: (<http://www.library.ubc.ca/home/about/instruct/apastyle.html>)