Identifying Opportunities to Reduce Hazardous Effects of the Dry Cleaning Industry in Tirana, Albania

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Abbreviations and Notations

CDC: Center for Disease Control

EDEN: Environmental Center for Development Education and Networking

EPA: Environmental Protection Agency

MassDEP: Massachusetts Department of Environmental Protection

OSHA: Occupational Safety and Health Administration

Perc: Perchloroethylene

Chapter 1: Introduction

While the use of dry cleaners amongst the younger population in America is declining, their use in Tirana, Albania is on the rise. Because of an abnormally high concentration of dry cleaners in the region, prices are driven down, making dry cleaning incredibly cheap in Tirana. Often times, however, people do not know the health risks that result from the dry cleaning process. These health risks are due to the combination of the dry cleaning machine itself and the solvent used inside the machine. A typical solvent used in dry cleaning called perchlorethylene (also known as perc) is a very hazardous substance and a known carcinogen. Due to its potency as a solvent, perchlorethylene often seeps into the air, water and ground. If breathed in, the hazardous vapors can cause esophageal, lung and respiratory cancer (EPA, 2012). With extreme exposure to perc, neurological and physical damage, cancer, or even death can occur. This is why regulation of perc and limiting exposure in dry cleaners is so important.

In the United States, dry cleaners must comply with regulations and guidelines which many organizations have contributed to. These regulations are often varied, and often do not include specific directions for dry cleaners, only general statements concerned with increasing focus on the management of hazardous solvents, fire prevention, and ergonomic practices (OSHA, 2005). There is also legislation targeted at the disposal of waste from dry cleaners once it has left the dry cleaning shop, in order to preserve the environment and keep it free from hazardous chemical substances (EPA, 2018). Although this legislation is often complex, support exists for dry cleaners attempting compliance. Trade organizations provide industry help ("Dry Cleaning", 2017), and various local regulators produce documents (e.g. checklists, handbooks, etc.) to make the regulation more digestible (Massachusetts Department of Environmental Protection, 2015). Stringent regulations combined with compliance aids and further suggestions are intended to make the dry cleaning industry as safe as possible.

If dry cleaners decide to shift their work to include less perc and mitigate some of the risk in their industry, they have options. 'Green' dry cleaners use chemical alternatives to perc in an effort to make the dry cleaning process safer. These chemical alternatives include silicon-based solvents such as D5 (Green Dry Cleaning Solvents, 2017) or petroleum based solvents including Stoddard and 140-F (EPA, 1981). Another alternative to a dry cleaning machine is a new process called wet cleaning. This process uses water, biodegradable soaps and gentle washing to clean

garments instead of liquid solvents that normally involve perc (WetCleanersUSA, 2017). There is also new technology available for machines that increase the reuse of perc that was originally put into the cycle for cleaning. These machines are called dry-to-dry closed looped machines, and while they still use the hazardous chemical perc, they reduce the machine operators exposure to the perc vapor generated by venting the hazardous perc vapor and compressing them for reuse (OSHA, 2018).

The goal of this project is to identify feasible alternatives to the waste creation and waste management practices of the dry cleaning industry in Tirana, Albania in order to decrease their impact on workers in the dry cleaning industry, the environment, and the Albanian public. The team will map the current dry cleaning businesses in Tirana, identify the current cry cleaning practices and determine perspective of dry cleaners and the public on adopting greener practices. We also hope to gain specific information on dry cleaners in Tirana including the types of machines they have, chemicals they use, how they dispose of waste and how willing they are to switch to an alternative. It is also important to gain an understanding of how the public perceives more environmentally friendly alternatives that can benefit them long term. Through the accumulation of all this information the team will provide recommendations for alternatives to hazardous solvents and general ways the dry cleaners of Tirana can become safer.

Chapter 2: Background

2.1 Common Dry Cleaning Practices and Associated Risks

Typical Dry Cleaning Process

Usually, a dry cleaning process consists of about four steps. The first is when the dry cleaner receives the clothes from the customers and inspects the stains on the clothes. If there are large, visible stains on the garments, the stains are pretreated with chemicals before being washed. The clothes are then sorted into categories by weight, color and fabric type (Gary, Lynda, & Avima, 2011). Next, when it is time for the clothes to be washed, the operator places them in a large dry cleaning machines that automatically fills itself with a liquid solvent. Depending on the type of dry cleaner, the solvent can either be petroleum based or a synthetic solvent. Some examples of petroleum solvents include Stoddard and 140-F, which are "inexpensive combustible hydrocarbon mixtures" (EPA, 1981). Synthetic solvents are more common, and consist of perchloroethylene and trichlorotrifluoroethane. These solvents are very hazardous and even proven carcinogens. A typical synthetic machine, contains two solvent tanks; one pure solvent and the other "charged" solvent. Charged solvent contains water and detergent in addition to already used solvent. The clothes are typically cleaned in the charged solvent and then rinsed in the pure solvent tank. While the clothes are inside the machine, they are gently rotated to loosen the dirt from the stains. Then, the dirt is filtered out of the machine through a distillation process (EPA, 1981). Once all of the dirt and stains are removed from the clothes, part of the solvent is filtered and returned to the charged solvent tank. The small remaining part, that did not fit through the filter, is distilled to separate any oils, fats or greases in the solvent that were not removed during filtration. Once they are removed, the solvent is returned to the pure solvent tank. The clothes are then dried by tumbling them in heated air to extract all the solvent still on the clothes. Solvent can also be recovered from the drying process, because exhaust gases from the drying process are sent to a water-cooled condenser and water separator. After the solvent is recovered from these processes, it is sent back to the pure solvent tank to be reused on the next wash. Figure 1 below shows a detailed typical process of dry cleaning involving perchlorethylene, along with ways the solvent can be reused and where it is emitted (CDC, 1997). Finally, the clothes are removed from drying and pressed to evaporate any remaining solvent on the clothes and the odor that results from soaking in the solvent (Gary, Lynda, &

Avima, 2011). When the remaining hazardous solvent is evaporated off the clothes, it turns into a hazardous vapor instead which is harmful to breath in. This is one specific reason ventilation and regulation of dry cleaners is very important to consider.

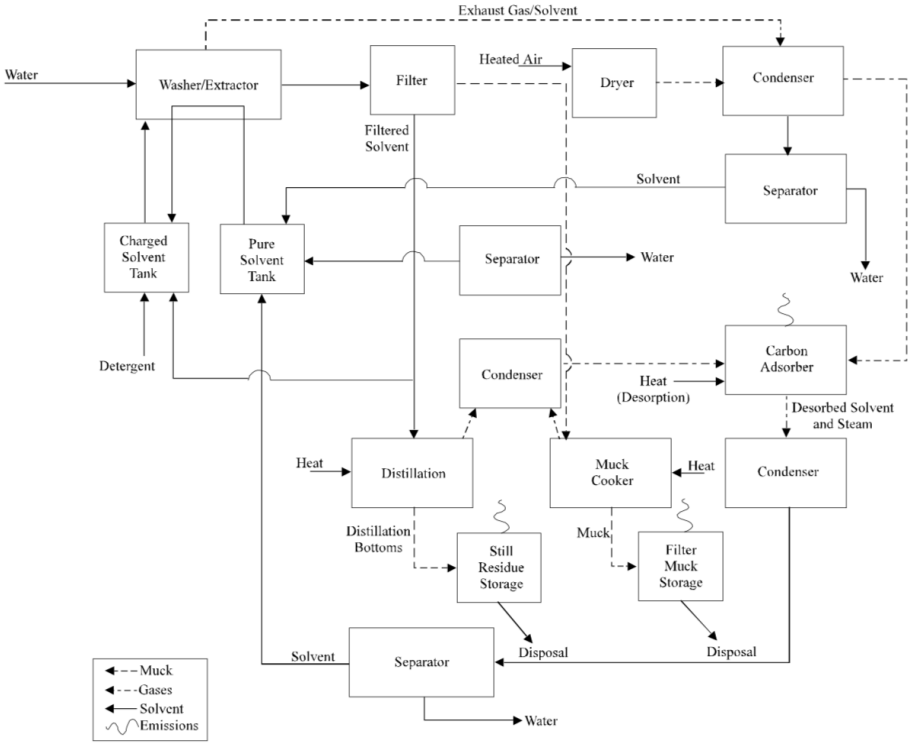

Figure 1: Perchlorethylene dry cleaning plant flow diagram (EPA, 1981)

There are two types of typical dry cleaning machines, transfer and dry-to-dry machines. The main difference between the two is that dry-to-dry machines complete the entire process in one machine, whereas there are two separate washing and drying machines in a transfer process. Petroleum solvents are used in only transfer machines, while synthetic solvent plants can include machines of either type (EPA, 1981). Transfer machines are older and require an operator to manually switch the clothes from washing to drying machines. This causes operators to be exposed to the hazardous solvents typically used in a dry cleaning machine. The exposure is significant because the operator has to not only directly touch the solvent soaked clothes but also open the door of the machine, so hazardous vapor also leaks out into the air. The solvent inside the machine produces a vapor while the clothes are being soaked and cleaned. Transfer machines are no longer manufactured in the United States because of the extreme risks imposed upon the operators, however, Albania may still use these outdated machines inside their dry cleaners

(Gary, Lynda, & Avima, 2011). There are two types of dry-to-dry machines, vented or ventless. Vented dry-to-dry machines have the ability to vent the solvent vapors produced during the process to either the atmosphere outside the dry cleaner or to a recovery system to decrease exposure to hazardous vapors. On the other hand, ventless do not have this ability and act as closed systems until the door is open. In this system, only when the operator opens the machine door are the hazardous chemicals exposed to the environment inside the dry cleaner. While the door is closed, the vapor is recovered and sent back to the drying drum of the machine. because of this process, large portions of solvent still remain in the drying drum (CDC, 1997).

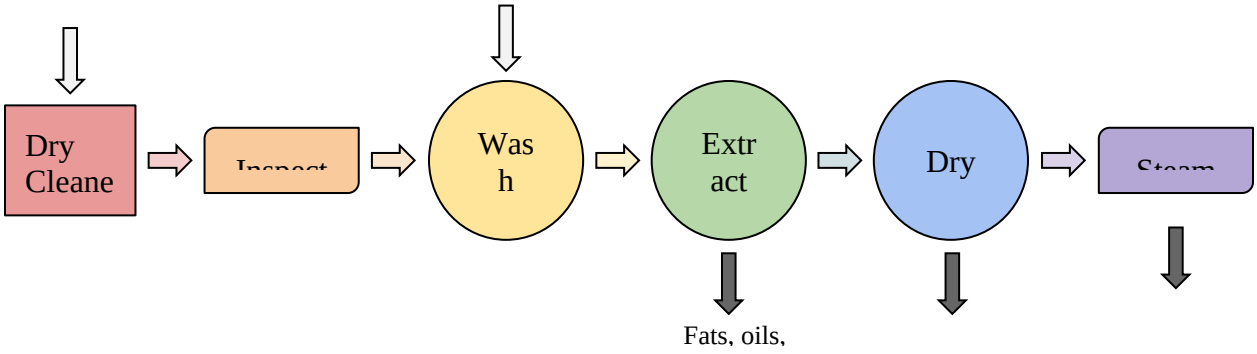

Figure 2: Dry cleaning process with inputs and emissions

Perchlorethylene

Perchlorethylene - commonly shortened to “perc” - is a powerful solvent most commonly used in the dry cleaning process. In some estimates, about 80% of dry cleaners utilize perchlorethylene in their operations (Bureau of Toxic Substance Assessment New York State Department of Health, 2015). Due to its potency as a solvent, it is incredibly adept at removing stains from fabric.

While an effective stain remover, perchlorethylene also has the potential to be incredibly dangerous to those exposed. In certain concentrations, perchlorethylene has been shown to increase the chances of developing cancers such as Non-Hodgkin's lymphoma and Bladder cancer (Papker, Bahlman, Leidel, Stein, Thomas, Wolf, Baier, 2016). The EPA has published an extensive report regarding the toxicity of perchlorethylene, citing liver cancer, esophageal cancer, lung and respiratory cancer, cancer of the immune system, and reproductive cancer resulting from overexposure to perchlorethylene. Even death is listed amongst the potential

hazards of excessive perchlorethylene exposure (EPA Integrated Risk Information System Division, 2012).

Perchlorethylene has also been shown to have neurological and physical effects in high doses. Numerous human and animal studies have provided evidence to suggest that faculties such as color vision, visuo-spacial memory, vigilance, information processing, and reaction time, are all affected negatively by exposure to perchlorethylene (EPA Integrated Risk Information System Division, 2012).

Waste Streams

Due to its potency as a solvent, it is extremely easy for perchlorethylene to contaminate the environment around it. Some examples of waste streams it can contaminate include air, water, soil, and food. This often means that those who come into occupational contact with perchlorethylene tend to be exposed to the chemical in almost every aspect of their life, and often place family and acquaintances at risk. Because of this, the waste streams that include perchlorethylene are especially important to be mindful of when considering occupational hazards of jobs working with the chemical.

Air

Near points of use, such as dry cleaners, indoor exposure to perchlorethylene is more significant than outdoor exposure. Indoor air concentrations in apartments above dry cleaning shops have been reported at 4.9 mg/m^3 (compared to normally negligible levels) (EPA Integrated Risk Information System Division, 2012). Furthermore, there is one recorded mortality case due to air exposure. "A 2-year-old boy was found dead after being put to sleep in a room with curtains that had been incorrectly dry-cleaned" (EPA Integrated Risk Information System Division, 2012).

Water

Large bodies of water, as well as drinking water are often highly contaminated by exposure to perchlorethylene vapors. Because of this, small children are often highly exposed to perchlorethylene through bathing, or being formula-fed from drinking water sources. This is especially troubling since the uptake of perchlorethylene on infants is nearly ten-times that of

adults, meaning that risks of side effects are exacerbated (EPA Integrated Risk Information System Division, 2012).

Food

Since perchlorethylene is naturally soluble with fats and lipids, it is very common for it to bind with the lipid molecules in margarine, oils, meats, and other fatty foods stored in places where perchlorethylene is in the air. In particular, elevated perchlorethylene levels were observed in food samples obtained from grocers located near dry cleaners (EPA Integrated Risk Information System Division, 2012). In addition to contaminating food, breast milk has also been shown to contaminate easily. Due to its lipid solubility, milk from human mothers, cows, rats, and goats have all been shown to retain perchlorethylene at an alarming rate upon exposure (Food and Drug Administration, 2003). In one particular instance, a woman's breast milk was shown to contain 10 mg/L of perchlorethylene one hour after visiting a dry cleaning establishment (compared to normally negligible levels) (EPA Integrated Risk Information System Division, 2012). Small children who ingest contaminated breast milk often do not have the metabolic capacity to properly filter the harmful chemical out of the body, which increases the child's risk of adverse effects.

Regulation of Perchlorethylene and Dry Cleaners in the United States

The wastes which dry cleaners produce can be extremely dangerous, and so governments regulate the industry in order to ensure the safety of dry cleaning workers and members of the general public. Legislative bodies in the United States concentrate this regulation on limiting accidental exposure to hazardous chemicals both in the workplace and in the environment, as well as minimizing harms of the day-to-day exposure for workers.

In the workplace, stringent regulations from OSHA, the EPA, and other local agencies aim to require dry cleaners to operate safely. OSHA does not provide specific dry cleaner regulation, although it expects that dry cleaners adhere to general workplace safety such as guidance related to fire safety, and hazardous waste (OSHA, 2005). It expects dry cleaners to comply with OSHA guidance concerning perchlorethylene, as well as take any measures deemed appropriate to make the workplace safer per the Occupational Safety and Health Act.

OSHA's standards for dry cleaners contain basic requirements about levels of dangerous substances and general workplace preparedness. The exposure limit of 100 ppm over 8 hours for any given worker is required by law, along with several other time-based exposure ceilings. OSHA recommends an even stricter maximum: 25 ppm of perchloroethylene over 8 hours for any given worker (OSHA, 2005). The broad-strokes legislation also includes instructions for perchlorethylene not specific to the dry cleaning industry. This includes providing personal protective equipment (PPE) when high exposure to the chemical is expected, and hazard training for all workers which entails learning the effects of extreme exposure to perchloroethylene and proper handling procedures (OSHA, 2005). The law addresses many of the fundamental needs of workers dealing with perchlorethylene and the dry cleaning industry workplace environment, though even the agencies that create the law think industry guidelines should be stricter.

Dry cleaning businesses are recommended to be fully equipped for their workers to deal with any potentially dangerous eventuality, including those unrelated to perchlorethylene exposure. As their workplace contains many easily burning chemicals and materials, they must be aware of fire safety and are required by law to have some protections against fire in place, including fire detection and suppression systems (CDC - NIOSH, 1997). Dry cleaners also must keep the ergonomic risks of their workers in mind as they perform hefty physical labor throughout the workday (CDC - NIOSH, 1997). Although much of the guidance specific to dry cleaners focuses on hazardous solvents, it is vital that they must pay attention to the considerations all industries must as well.

American regulation also protects the environment from being contaminated by the regular practices of dry cleaners. Waste from dry cleaners, especially perchlorethylene, can easily enter the surrounding environment via the air or groundwater if improperly managed or disposed. The EPA regulates hazardous waste generators by amount of waste generated, and apply a myriad of standards to how waste is managed for each based on the kinds of waste, including spent dry cleaning solvent, filter cartridges, and wastewater (Environmental Protection Agency, 2015). The EPA's broad environmental protection acts including the Clean Air Act and the Clean Water also apply to perchlorethylene pollution (Environmental Protection Agency, 2015). To this end, the EPA reserves the right to collect data on generators and respond to heavy releases of hazardous material through the Toxic Substances Control Act, Planning and

Community Right-to-Know Act, and The Comprehensive Environmental Response, Compensation, and Liability Act (Environmental Protection Agency, 2015).

Agencies on the state and local level can be more specific in their guidance regarding workplace safety and pollution. The Massachusetts Department of Environmental Protection (MassDEP) requires dry cleaners to submit a yearly compliance form and does occasional random inspections (Massachusetts Department of Environmental Protection, 2015). In California, legislators have chosen to phase out Perchloroethylene completely from the dry cleaning process by 2023 (California Air Resources Board, 2018). In New Jersey, local legislature provides dry cleaners with a checklist to keep their businesses in compliance (New Jersey Department of Environmental Protection, nd). The state and local levels often impose stricter and more varied requirements on dry cleaners, generally in conjunction with easily digestible forms, handbooks, and other guidance.

Dry cleaners are saddled with many layers of responsibility on the local, state, and national level. These regulatory items can be detailed or extremely general. Ultimately, all serve the purpose of increasing general industry safety.

2.2 Risk Reduction and Best Practices

Best Practices for Dry Cleaners Who Use Perc

Regulators provide dry cleaners with guidelines for keeping their businesses as safe as possible, in conjunction with the regulations they must follow. Many of these guidelines are described by OSHA, and while they are highly recommended, they are not required by law. Other best practices are provided by organizations specifically dealing with dry cleaners, and groups who informally aid this industry (National Cleaners Association, 2018).

The first, and simplest, step for dry cleaners attempting to keep their workplace safe is inspection and maintenance. The goal of inspection is to ensure the building has operational safety measures as required by law, but more regular inspections, especially inspections of the machines, will detect hazards earlier and therefore, when proper response is taken, keep workers safer. This protects against so-called “fugitive emissions”, or harmful vapors escaping the dry cleaning machine when they are not expected to; such as when a part is leaking (OSHA, 2005). OSHA requires perchloroethylene levels to be at or below 100ppm in the air, but it recommends

that these levels actually be at 25ppm or below (OSHA, 2005). OSHA postulates that leaks account for roughly 25 percent of overall perchlorethylene emissions (OSHA, 2005). Workers, following all manufacturer guidelines can reduce fugitive emissions from a machine. If it is economically feasible for the workplace, machines should also be replaced with newer models, since newer machines and newer parts often expose workers to less perchlorethylene, and reuse perchlorethylene more efficiently (OSHA, 2005). A device to monitor perchlorethylene levels in the air may also prove helpful to ensure that the standards are being met (OSHA, 2005).

Dry cleaners already complying by requirements for hazardous waste can make their operation even safer by using a variety of required equipment to its fullest potential. Workers should be trained on the use of personal protective equipment including solvent-resistant gloves, goggles, and aprons to be used at vulnerable points in the dry cleaning process (CDC - NIOSH, 1997). Requirements to help maintain these levels include proper venting in the workplace to prevent the concentration of dangerous vapor in any one area (OSHA, 2005). Through detailed planning of improved venting, fans, and respirators, employers can increase the airflow beyond what is required (OSHA, 1989).

The most significant change a dry cleaner can make to increase safety while still using perchlorethylene in the dry cleaning process is to increase worker training. Workers in the dry cleaning industry should already be trained in the use of personal protective equipment, machine operation, hazardous substance handling, and other safety resources (OSHA, 2005). If dry cleaning businesses increase this training and workers are given the most information possible about the machines they are operating, then they will be exposed to less perchloroethylene. Changes as small as instructing workers to change their posture when loading and unloading the machine can make a significant difference in how much solvent they are exposed to (OSHA, 2005).

Green Alternatives

Wet Cleaning

The main difference between wet cleaning and dry cleaning, although there are many, is that wet cleaning mainly uses water to wash the clothes instead of a solvent like in dry cleaning. There are four factors that contribute to how well a garment can be cleaned: temperature, time,

mechanical action and chemical agents. There needs to be a balance of these factors to achieve the best possible cleaning of the clothes. It is typical in wet cleaning to use low temperatures and low mechanical action to eliminate the expansion of natural fibers as they soak in water. Delicate garments are often only dried with hot air for a short amount of time before switching to air drying methods (CDC, 1997).

There are many pros and cons to this type of dry cleaning method. A huge advantage stems from the fact that because there is no solvent used in this process, most of the hazardous and health risks are eliminated. This not only provides a better quality of life for operators of dry cleaning machines, but also reduces the amount of regulation that the dry cleaner has to go through. It even lowers the cost as perchlorethylene, among other solvents, is often expensive. Other pros for wet cleaning include that water soluble stains are more easily removed in wet cleaning than dry cleaning, overall wet cleaning machines are less expensive than chemical solvent based dry cleaning machines, and finally, wet cleaning machines often finish with brighter and better smelling clothes. However; wet cleaning machines are shown to shrink specific clothing made of wool, silk or rayon more times than typical perchlorethylene dry cleaning machines. The figure below shows a comparison between the shrinkage occurring in wet cleaning and dry cleaning. The graph clearly shows wet cleaning increases the amount of shrinkage occurring. Wet cleaning machines also require more skill and labor from the dry cleaner as air dried garments require more pressing. Finally, even though wet cleaning eliminates much of the hazardous waste produced, wet cleaning generates significant amounts of contaminated water that is challenging to handle (CDC, 1997). Wet cleaning is not a perfect alternative to dry cleaning, but it is effective in reducing the amount of health hazards the operators in the dry cleaner are exposed to.

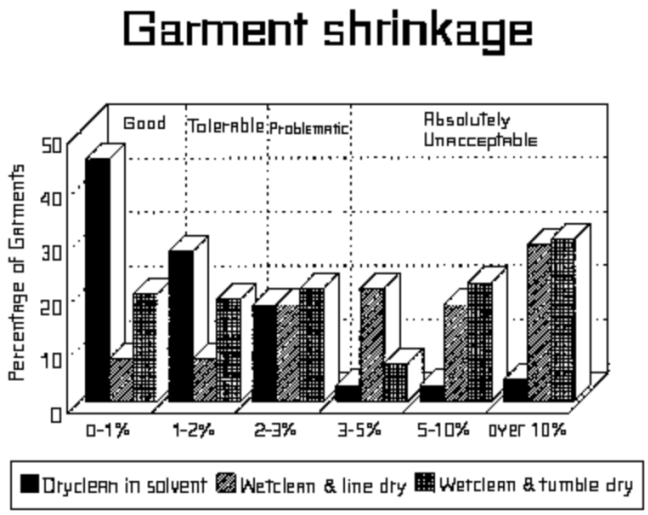

Figure 3: Shrinkage comparison between wool, silk and rayon from solvent based dry cleaning and wet cleaning (CDC, 1997)

Perc Alternatives

Instead of using a synthetic solvent such as perchlorethylene, or investing in a wet cleaning machine, there are other solvent options that can create less hazardous waste. Some examples of these alternatives include petroleum based solvents such as stoddard solvent and 140-F (EPA, 1981) or silicon based solvent such as decamethylcyclopentasiloxane, also known as D5 (Green Dry Cleaning Solvents, 2017). There had been an increase in petroleum-based solvents, especially in Europe, as people start to realize the harm synthetic solvents often causes. These solvents are colorless, non-water miscible liquids, and show trace amounts of polycrylic aromatics. They also have high flash points, which will reduce the amount of hazardous vapor contaminating the dry cleaner because the temperature of the solvent has to be higher for it to give off vapor (EPA, 1981). Silicon based solvents are a viable alternative because their chemical properties, including being non-toxic and non-hazardous, and so health risks are basically eliminated. Some properties that make the solvent efficient in cleaning include low surface tension for more effective release of dirt, and being chemically inert, which eliminates problems such as dye removal and dye bleeding (Green Dry Cleaning Solvents, 2017).

Updated Machine Technology

In general, the design of a dry cleaning machine is the cause of the excessive amount of exposure that operators are subjected to. Exposure from loading and unloading of the machine can be controlled by concentrating the perc in the machine cylinder, and directing where the air in the machine cylinder goes during the loading and unloading process. By updating machines to follow these few procedures, the exposure of workers to hazardous vapors can be greatly reduced. If a dry cleaner switches to a petroleum or silicon based solvent, their machine must also be updated so that it operates with the correct solvent. Dry cleaning machines have been improved over time and include safety features that reduce the risk of fires and machine explosions. Some updates include using an inert gas to prevent dangerous chemical reactions, and being able to control temperature and vapor concentrations inside the dry cleaning machine (CDC, 1997). Not only can machines be updated to reduce the amount of hazardous vapors or improve technology, it is possible to increase the amount of perc that is recovered and reused in the machine. This is done through filtration and distillation processes that are common in dry-to-dry machines as opposed to older transfer machines. Recovery is done through condensers, water/solvent separators, and carbon absorption units. In a carbon absorption unit, solvent is desorbed with steam, condensed, filtered from water and, finally, sent to the pure solvent tank (EPA, 1981). By increasing the amount of reused perc through filtering and distillation, there is a reduced amount of hazardous waste produced and therefore a reduced amount of exposure and subsequent negative health effects from the hazardous waste.

Trade Associations Furthering Safe Practices

Regulatory measures for dry cleaners can be difficult to follow, but are vital to understand in order to keep workers safe. The extensive and detailed guidance surrounding dry cleaners is not easily digestible for an industry composed of many small businesses, and so these businesses often require help in learning about what they need to accomplish to be in compliance.

Groups forming regulation generally introduce support. In Massachusetts, MassDEP has introduced a comprehensive website, workbook for compliance, and multiple help phone lines (Massachusetts Department of Environmental Protection, 2015). OSHA offers consultations with businesses, and recommends the use of stewardship programs operated by perchlorethylene suppliers (OSHA, 2005). This kind of legislative assistance is usually focused on ensuring that

dry cleaners can easily understand their regulatory burdens, rather than being intended to ‘catch’ those not in compliance.

Trade organizations also provide substantial assistance. The Retail Compliance Center is an entire organization which has formed to aid retailers in the hefty task of complying to industry-specific regulation, and it provides resources to dry cleaners (“Dry Cleaning”, 2017). The Dry Cleaning and Laundry Institute International offers education on dry cleaning, dry cleaning news, and industry advice (Dry Cleaning and Laundry Institute International, 2018). The National Cleaners Association offers similar advice to its members (National Cleaners Association, 2018). These organizations work from within the industry to provide specific advice and exchange information between dry cleaners; providing another layer of potentially helpful information.

Although dry cleaners face a vast and potentially confusing array of regulatory burdens and safety advisories; state regulators, local regulators, and trade organizations provide help.

2.3 Dry Cleaning Industry of Albania

As of right now, the team has minimal information on the exact dry cleaning process in Albania. Although dry cleaners are abundant in Tirana, the type of machine, solvent and disposal practices are unknown. While in Albania the team will gather this information to compare the dry cleaning in Tirana to typical dry cleaning in the United States. They will be compared by price, prevalence and cultural relevance. There are a few case studies on Eco Washing in Tirana which will be more explored once the team is in the country (Eco Wash Albania).

2.4 Our Sponsor

Our sponsor organization is the Environmental Center for Development, Education, and Networking, also known as EDEN. EDEN is an environmental advocacy non-governmental organization aiming to, “contribute to sustainable development and a healthy environment through the provision of services in partnership with stakeholders” (“About Us”). The organization is fifteen years old. It is one of the most active environmental advocacy organizations in Tirana, and it has a strong network of related organizations both nationally and globally.

EDEN separates its work into four pillars: Environmental Education, Environmental Management Practices, Capacity Building, and Public Information and Participation. The Environmental Education pillar's purpose is to excite the youth about environmental projects, good environmental practices, and sustainable development. The Environmental Management Practices pillar's purpose is to promote successful environmental practices within the community. The Capacity Building pillar aims to obtain and improve environmental knowledge and sustainability skills, and the Public Information and Participation pillar serves as a "watchdog" for International Financial Institutions. EDEN's broad body of work is varied between its four pillars. They have sponsored multiple Interactive Qualifying Projects for WPI in the past relating to waste disposal in Tirana (Towle, Bruno, Hemingway, & Eaton). Currently, they are working on programs related to waste. In this vein, EDEN would like to learn more about how the dry cleaning industry in Tirana produces waste, and how the risks of this waste can be mitigated.

EDEN has tasked the group with collecting data about the hazardous waste production and disposal of dry cleaners. This includes learning about the key actors: Tirana's dry cleaners, and the regulators who are responsible for keeping them safe.

Chapter 3: Methods

The goal of our project is to identify feasible alternatives to the waste creation and waste management practices of the dry cleaning industry in Tirana, Albania in order to decrease their impact on workers in the dry cleaning industry, the environment, and the Albanian public. An assessment of current practices along with a recommendation for more environmentally practices will be given to our sponsor. Our objectives are as follows:

1. Map Dry Cleaners Currently Operating in Tirana
2. Identify the Current Dry Cleaning Practices within Tirana
3. Determine the Perspectives of Dry Cleaners and the Public on Adopting Greener Practices
4. Provide Alternatives to Hazardous Chemicals or Recommendations for a Green Dry Cleaner.

To accomplish our objectives, we have devised intertwined plans to gather information and analyze our findings.

Objectives and Research Methods Graphic:

This diagram concisely shows how our objectives and methods fit together. The squares at the top represent each of our four objectives. Each objective has arrows pointing to the methods (in green boxes) it will involve. All methods point to the final step in our data collection; qualitative or qualitative analysis.

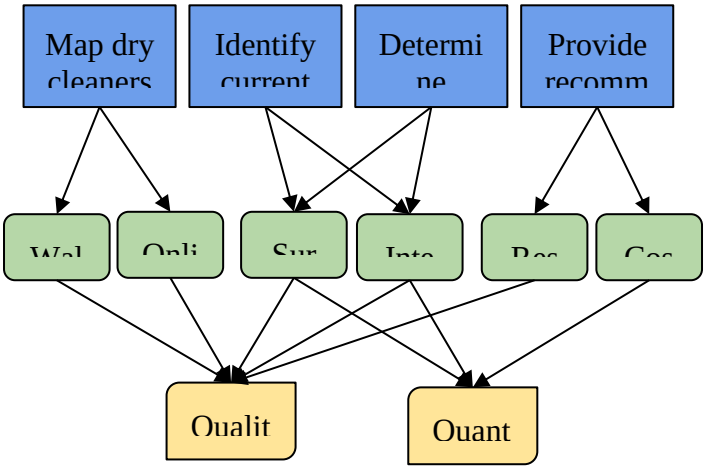

Figure 4: Overview of methods map

3.1 Mapping Dry Cleaners Currently Operating in Tirana

To complete our goal, the team must first identify the locations of the operating dry cleaners in Tirana. Since the team has no prior background on the layout of Tirana and the dry cleaners in it, we will have to conduct extensive background as well as observe the city and dry cleaners operating in it.

Online Background Research

To achieve an understanding of where dry cleaners are located in Tirana, the team will conduct background research by utilizing online maps of the city. With this information, the team will create our own map of the dry cleaners that will guide us through our project. Specifically, our map will include the address of the dry cleaner, hours of operation, and landmarks to help us identify the building.

In order to avoid potentially unsafe areas of Tirana, the team will also conduct research on the background of the neighborhoods around the dry cleaners noted in previous research. This will be done in both with our sponsor and through archival research. Since our sponsor is located in Tirana they have extensive knowledge of the area and can help us determine neighborhoods to avoid.

Figure 5: Map of dry cleaners in Tirana (Google Maps)

Walking Tour of the City

The map created from background research will help guide us on our walking tour through Tirana. The team hopes to obtain more information on the whereabouts of dry cleaners and whether the ones found online are still operating or not. The dry cleaners found to be

abandoned or no longer functioning will be removed from the map which will help narrow the amount of dry cleaners on the teams map. Any dry cleaners found from walking through the city that were not observed through online maps will be added in order to include all dry cleaners in Tirana. Additionally, characteristics of these dry cleaners will be recorded to help the team select a few to study in-depth. Some of these characteristics include:

- The size of the dry cleaner (square footage)
- The type of buildings are the dry cleaners located in? (basement of apartments, store front, etc.)
- What are the surroundings of the dry cleaner (park, apartments, etc.)?

Based off of these characteristics, the team will interview select dry cleaners to obtain more information about their practices.

The areas deemed potentially unsafe by our sponsor or history research will be avoided to reduce any possibly dangerous situations. Dry cleaners within these areas will not be selected for further interviewing.

3.2 Identify the Current Dry Cleaning Practices within Tirana

Our second objective is to identify the current practices of dry cleaners within Tirana, so that the group will have a baseline level of knowledge for areas of improvement. The team will need to identify hazardous chemicals used in the process which workers are exposed to, and hazardous pollutants entering the environment as a result of the dry cleaning process, as well as examine general operational practices. All of this information will be synthesized to determine current risks for dry cleaning workers and the Albanian public.

Interviews with Dry Cleaners

To accomplish this objective, the group's first step will be to conduct interviews with the owners and employees of dry cleaners selected from the walking tour. These select few will serve as exemplars for the population of dry cleaners in Albania, and will be consistent with the common characteristics of Albanian dry cleaners observed on the walking tour. The team will structure these interviews in order to learn about the general daily activities of the dry cleaners. The interview will also include demographic questions, such as how long the dry cleaner has been open, the relative size of the dry cleaner, and the rough amount of laundry they receive, to place their practices in a broader context of the dry cleaning industry. Questions for interviews

with dry cleaners and interview protocols are in Appendix B. The purpose of these questions is to gain information on the following subjects:

- What kind of machines are used in the dry cleaning process (how old are they, etc)
- Why kinds of chemicals are used in the process
- What kinds of training do workers receive, and what regular operational procedures do they follow?
- How long the dry cleaner has been open, and
- How large of a clientele they serve?

In order to prepare for potential language barriers, the team will be accompanied when conducting interviews by a translator provided by the EDEN center. This translator will most consistently be the specific advisor of the project, but if circumstances require another EDEN employee to be used, the project team will train them before beginning interviews. This training will include reviewing the prepared interview questions with the translator to ensure they know precisely what is being asked and why, as well as a more big picture view of the types of information we need. The team will brief them on the project as a whole, and the group will ensure they have the opportunity to ask any questions they have. The group and translator will work together to ensure the team consistently knows what the interviewee is saying during the interview, while clarifying the pacing and number of questions is at a comfortable level for the translator.

Survey For Dry Cleaners Not Interviewed

In order to gain more insight into dry cleaners the team does not have time to visit, we will collaborate with EDEN to create and distribute a survey. Questions from the interviews with the most useful answers based on preliminary data analysis will become part of the survey. From there, the team will test the created survey on a small sample of dry cleaners. If the survey is deemed effective because it provides detailed and informative answers from participants, the team will distribute the survey in person, while accompanied by a translator, to a larger group in order to collect more data. The actual survey delivery method will operate similarly to interviews in that it is in person with a translator, but will be more structured and limited in scope. The data collected by the survey will be similar to the information collected in the interview: machines used, chemicals used, and operational practices.

3.3 Determine the Perspectives of Dry Cleaners and the Public on Adopting Greener Practices

Our third objective is to determine the perspectives of dry cleaners and the public on adopting greener practices. By doing this, the group will begin to understand the scope of how much it is reasonable for dry cleaners to expect to change, and how receptive the public will be to this change. This information will allow us to better shape our suggestions in order to ensure their feasibility.

Interview with Dry Cleaners

Our first course of action with respect to this objective will be to determine the extent to which dry cleaners have the ability and willingness to change. To this end, in the team's interviews with dry cleaners, we will ask questions about:

- the cost of their current infrastructure
- how much it would cost them to change systems
- how much they know about "greener" alternatives to their current system
- what, if any, non-monetary factors discourage them from switching to "greener" alternatives?

Furthermore, the team will ask questions about the regulation in order to better understand why they dry cleaners may or may not feel pressured to alter their practices. In these questions, we will ask about topics such as:

- to what extent they are under government regulation
- how (if at all) the government enforces any regulation in place
- what would inspire them to comply more closely with regulation (contingent on the regulation's existence, and the dry cleaner's willingness to share that they do [or do not] follow it)?

Lastly, the team will inquire if dry cleaners are aware of the risks and dangers associated with their line of work, and whether or not this influences their decisions to adapt or otherwise change their methods. We will ask about their knowledge of the dangers of perchlorethylene, as well as their knowledge of how to properly mitigate those dangers.

The team will conduct these interviews in conjunction with those done in section 2.2,

Survey the Public

The second half of this objective will be to investigate the consumer base's opinions on changes in the dry cleaning industry such as changes in cleaning techniques or chemicals. This information will be a powerful tool since the public's opinion towards a greener dry cleaning industry may be a large incentive for the industry to enact change.

Based on the interviews that the team will conduct with the dry cleaners, the group will develop a survey that ascertains the sorts of concessions that dry cleaning business would be willing to make order to see the industry become safer. This survey will also examine the extent to which the public is aware of said dangers. Included in this will be details such as:

- How they feel about various dangers of the dry cleaning industry
- How receptive they would be to inconvenience derived from adopting safer practices by the industry (e.g. higher costs, longer wait times)?

The group will develop this survey and provide it to our sponsor so that they may utilize it at their discretion. This survey will allow our sponsor to gather evidence that will justify to dry cleaners why they should alter their practices.

3.4 Provide Alternatives to Hazardous Chemicals or Recommendations for a Green Dry Cleaner

Finally, the team aims to provide alternatives to potentially harmful practices of dry cleaners in the region. These alternatives will be informed by what is reasonably available within Tirana, what is possible for the average dry cleaner to change, and what will maximize the safety of workers, the public, and the environment.

Research

The first step the team will take towards this goal is to conduct research with the sponsor to determine the feasibility of various alternative practices in Albania. Building off of information the team has collected about safer and greener options, the team will work with the sponsor to determine the extent to which it is possible for businesses to source chemical or mechanical alternatives within the country. The broad questions the team hopes to answer are:

- Are chemicals that are international groups consider to be safe solvents available in Albania?

- Are dry cleaning machines able to use safe solvents or water in a “wet” cleaning process available in Albania?
- Are regular repairs reasonable for dry cleaning machines?
- Given the landscape of the market and general availability of equipment, to what extent do Albanian dry cleaners have a choice about how they operate?

Cost-Benefit Analysis

In order to provide data to back up our recommendations, the team will conduct a cost-benefit analysis. This will entail the comparison of perc based dry cleaners with other methods such as:

- Wet cleaning which utilizes water and biodegradable substances in place of of hazardous solvents
- Alternatives to perc (Ex. D5, which is silicon based, and DF 2000 Hydrocarbon)
- More efficient machines that reuse extra perc and reduce hazardous waste.

The cost-benefit analysis will compare specific costs associated with these alternatives as shown in Table 4 of Appendix C.

The four main categories of cost comparison relating to these alternatives are capital costs, performance cost, operational cost and resource cost. The main component of capital costs is the price of equipment or machine bought for the dry cleaner. The total capital cost is compared to the other three categories in Table 4 of Appendix C. The data for performance costs resulted from send-outs, re-dos and claims. Send-outs are clothing sent to another dry cleaner to be cleaned there because of performance capabilities. For example, leather would be sent to a leather processor instead of being cleaned at a dry cleaner. Re-dos are clothing that did not meet cleaning standards and have to be re-processed to fix the issue. Claims are made by customers that were not satisfied with the job and desired a reimbursement. The three alternatives to perc machines compare this data in Table 1 of Appendix C. Operational data is received from the combination or labor, maintenance, filters, solvents, detergents, spotting agents, hazardous waste disposal and regulatory costs. This data, compared to each method, is shown in Table 2 of Appendix C. Finally, resource cost data includes electricity for equipment and the facility, natural gas for boilers, water use and sewage disposal. These categories are compared across alternative methods in Table 3 of Appendix C.

By analyzing this data with specific categories, the team will provide evidence to drycleaners of how expensive alternatives are to perc based dry cleaning machines. This will ideally prove the feasibility of switching to a more environmentally friendly dry cleaning methods in Tirana.

3.5 Data Analysis

In order to analyze data, the group will use thematic analysis and information coding. The process of information coding we will follow is outlined by scholars Ellen Taylor-Powell and Marcus Renner (Renner & Taylor-Powell, 2003). Once the team has conducted interviews and surveys, we will examine the data. During our analysis, each data set will be stored in Microsoft Excel. The group will use the data to form key themes within the category's choice of dry cleaning method and environmentalist mindset. These categories will then be used to focus the analysis. We will draw on researcher James Beebe's concept of indigenous knowledge by letting local attitudes, discovered through our conversations with businesses, shape our themes (Beebe, 2014). Once the process of identifying themes is complete, the team will aggregate the themes of data based on relation to current practices and the changes they do or do not recommend. Team members will search for patterns and connections in the categories, and use them to interpret the data for meaning and significance. The team will analyze these findings, share their data related to the current system and compliance with EDEN, and make specific informed recommendations aimed at increasing the safety of the dry cleaning industry.

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Appendix A: Interview Considerations

Preventing Bias:

The team will also make it clear to the subject that the interview is confidential, and meet in a place tailored to the interviewee in order to ensure the interviewee feels comfortable and able to share their genuine answers.

Interview Introduction Questions

These questions will be asked for all subjects interviewed.

I1	Do we have your permission to record this interview?
I2	Do we have your permission to quote this interview in our report to EDEN?

Interview Conclusion Statement

Thank you for taking the time to speak with us. Is there anything else you think we could have asked, or anything else you would like to tell us? Would you like to review our notes, or the recording of the interview? If we make a transcript, would you like to review it? If you have any questions about the interview or our work, you can reach us through email, phone, or through the EDEN center at -insert email/phone number/EDEN contact information-. Thank you so much for your time.

Appendix B: Tirana Dry Cleaner Interview Protocol

Interview Subject:

Date and Time:

Attendees:

Location:

Përshëndetje/ Hello! We are a group of American students studying the current dry cleaning system in Tirana. We are working with EDEN to perform this research. EDEN is the Environmental Center for Development, Education, and Networking, and it is a Tirana-based non-governmental organization. Our team would like to interview you about your opinions and habits about dry cleaning practices. If possible, we would like to record this interview, but if you

are uncomfortable with that we can take notes instead. If you do participate, you can choose not to answer any of the questions we ask you. Your responses will be used as data in our report for our school and for EDEN. Your participation in this interview will be confidential. The report will be available online at EDEN's discretion, and if you would like we can send you a copy of the completed report. Before we start, do you have any questions for us?

Questionnaire:

Number	Question	Employee	Owner
A1	How long has your business been open?		X
A2	About how many people do you dry clean for on a given day?	X	X
A3	How many people work here?	X	X
A4	What chemicals do you use to spot treat clothing?	X	X
A5	What chemicals do you use to wash clothing?		X
A6	How old is your dry cleaning machine?		X
A7	What training do you give new workers about the process?		X
A8	How often do you inspect your machines, or get your machines inspected?		X
A9	How much did your current machines cost?		X
A10	Are you aware of any alternative systems to the one that you currently use?		X
A11	Are you aware of how much it would cost you to change		X

	systems?		
A12	(If yes to A11) About how much would it cost?		X
A13	What, if anything, is preventing you from changing systems aside from the financial burden?		X
A14	To your knowledge, is your industry regulated by the government?		X
A15	(If "yes" to A14) How is this regulation enforced?		X
A16	What would inspire you to comply more with the regulation in place?		X
A17	Are you aware of the dangers of Perc?	X	X
A18	Are you aware of how to properly manage the Perc that you use?	X	X

Appendix C: Cost-Benefit Analysis Tables

Table 1: Performance Cost Comparison

Performance Cost	Send-Outs	Redos	Claims	Total
Wet Cleaning				
Perc Alternatives				
More Efficient Machines				

Table 2: Operational Costs Comparison

Operational Cost	labor	maintenance	filters	solvents	detergents	Spotting agents	Hazardous waste disposal	Regulatory costs
Wet Cleaning								
Perc Alternatives								
More Efficient Machines								

Table 3: Resource Cost Comparison

Resource Cost	Electricity Use	Natural Gas use	Water usage	Sewage disposal
Wet Cleaning				
Perc Alternatives				
More Efficient Machines				

Table 4: Total Cost Comparison

	Capital	Performance	Operational	Resource	Grand	Investment

	Cost Total	Cost Total	Cost Total	Cost Total	Total	return (yr)
Wet Cleaning						
Perc Alternatives						
More efficient machines						