FORT WORTH FIRE DEPARTMENT CANCER REDUCTION STRATEGY: EXTRACTOR IMPLEMENTATION

by

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Abstract

Exposure to chemicals and carcinogens through contaminated bunker gear in the fire department is raising the cancer rate among firefighters. The following manuscript provides a strategy and implementation process for the gear-cleaning technology known as extractors. This research will outline multiple critical factors that lead to the success and failure of technology adoptions. The study will also provide implementation recommendations based on statistical analysis aligned with the wants and needs of Fort Worth Fire Department. The strategies are recommended specifically for the city of Fort Worth; however, the study can also be generalized and applied to other cities looking to improve the overall health and wellness of their fire personnel.

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Purpose

The career path of a firefighter, in and of itself, is one of the most dangerous and tactical professions one could pursue. However, when analyzing those dangers, many overlook the ones that can't be seen to the naked eye. One of these invisible hazards is the combustion of carcinogenic chemicals in high temperature areas such as fires. It is obvious that the fire itself poses a potential risk to firefighters, but only recently has the emphasis on certain chemicals coating firefighter gear been addressed. In recent studies, an alarming 68% of firefighters have been diagnosed with cancer, which has raised the question of how this is happening, and how can it be stopped (Harrison, 2017). Through research, a majority of these cancer-causing carcinogens have been traced back to various substances found in fires. The areas that lead to the highest exposure rates are the fire itself, as well as the residuals on the gear and person post-fire. If not tended to within an hour of contact, these chemicals, in the form of soot and debris, impose an enormous health hazard to firefighters. Most would believe, however, that firefighters have the gear necessary to suppress the negative effects and health hazards posed to them. Although that may be true to an extent, there is a gap in this logic.

The so called "gap" in the fire department is the lack of cleaning ability for firefighters' gear. Due to the combustion of chemicals and release of carcinogens in fires, firefighters' gear should be washed on a regular basis. The term "washed" refers to the deep cleaning of gear in special extractors accompanied by citrosqueeze, which is an all-purpose chemical cleaner. For some time, bunker gear has only been washed once a year due to regulations, lack of equipment, willingness to change norms, and other factors. However, within recent months the National Fire

Protection Agency (NFPA), an organization that sets rules and regulations for fire departments, has adjusted the requirement of cleaning bunker gear to twice a year and after every fire. Specifically, NFPA 1851 looks into the maintenance and care firefighters and their gear will receive. The question proposed aims to provide an answer to the opposing factors by finding a way to implement a strategy to clean gear with ample equipment, while addressing any possible speedbumps in technological adoption. This question carries importance because of the consequences it holds if it isn't answered for firefighters, their families, and loved ones as well. Although the bunker gear is meant to mitigate the risks these chemicals pose, the lack of clean gear is resulting in an unnecessary rise in cancer among firefighters. With the new NFPA requirement being released, cities and departments are having to adjust their cleaning capabilities to accommodate the increased demand for cleaning. Among many of those cities, the Fort Worth Fire Department is currently looking for an answer and implementation strategy for NFPA's new requirement.

Throughout this manuscript, the data and research provided will strive to answer the research question focusing on establishing a strategy that the Fort Worth Fire Department and other cities/departments could use to adjust to the new demands and capacity of NFPA. To begin, there will be a literary review of prior research and findings focused on technology adoption and change management in organizations that experienced similar adjustments. Next, through professional insight, fire department officials, and accredited literature, a viable option and implementation strategy will be provided for fire departments to utilize. Lastly, the manuscript will cover the implications this study will have on fire departments currently and provide ideas for studies that could be considered to increase effectiveness in the future.

Literature Review

In regards to cancer prevention, one of the most effective ways of maintaining clean and carcinogen-free gear is through the use of extractors. Although this has proven to be one of the most useful forms of cancer prevention, the extractor equipment is not being used to its full potential in many departments. With technology implementation on the rise, it is crucial that fire departments plan accordingly and effectively to ensure successful and optimized transitions. Various industries, companies, and organizations utilize new technologies often. Therefore, fire departments should take similar measures as these, in addition to observing other fire departments who have already implemented extractors.

Generally, there are two different categories that yield the most prohibitors and promoters. The use of the word "prohibitor" refers to possible issue's personnel could face with implementation, while "promoters" are generally going to be topics that will allow the process to run more smoothly. The first is technology adoption. Technology, in general is the collection of techniques, skills, methods, tools, and processes used to accomplish a practical objective. The second is change management, which, instead of pertaining to the technology itself, focuses more on the impact it has on the people of an organization and how receptive they are to the change in their organization. By analyzing critical factors in these categories (which have been identified as crucial or detrimental to success in other companies and organizations), a general list of factors can then be drawn up for fire departments as they move to install more extractors. From that list, fire departments can identify what is relatable, and how they can properly prepare and develop an implementation strategy and eliminate risks.

Technology Adoption		Change Management	
Factor	Citation(s)	Factor	Citation(s)
Budgetary Priorities/Cost	(Treumann, 2014), (Gyben, 2018), (Acquisition Cost, 2017), (Kenton, 2018), (Delaney, D'Agostino, 2018)	Education	(Fruhlinger, 2017), (Craig, 2017)
Time/Downtime	(Bose, 2018)	Norms	(Eskierka, 2014), (Schein, 2004), (Lewin, 1999)

Technology Adoption

Budgetary Priorities/Cost

Among other factors, one of the most important to all companies and industries is budgetary priorities and cost. When speaking in terms of budgetary priorities, this means to allocate percentages of your budget to the most important parts of your business. In other words, what are the most critical parts of your business that require a majority of your finances. If a company or industry doesn't have the budget required to fund the critical parts of their business, as well as a new technological implementation, insufficient funds will lead to failure (Treumann, 2014). Fire departments rely on vast amounts of equipment to complete their day to day tasks. If the purchasing of extractors means they will be allocating finances from already existing funds for specific equipment, it may lead to disruptions in their day-to-day operations.

The second piece that is complementary to budgetary priorities is the cost of the specific technology. Although it is easy to assume that the purchase of the technology is the end all be all of price, it is far from it. Alessandra Gyben wrote an article in May of 2018 emphasizing the total

cost of ownership (TOC) in technology. Much of this cost is broken down into three categories: acquisition costs, operating costs, and personnel/resource costs.

Acquisition costs refers to the all-in cost to purchase an asset. These costs include shipping, sales taxes, and customs fees, as well as the costs of site preparation, installation, and testing. When acquiring property, acquisition costs can include surveying, closing fees, and paying off liens (Acquisition Cost, 2017).
Operating costs are expenses associated with the maintenance and administration of a business on a day-to-day basis (Kenton, 2018).
Personnel/resource costs are expenses associated with the costs of employment on an employer. It also includes the individual resources required to maintain operation.

Those businesses and organizations that are implementing new technologies run into problems when they don't account for the cost of all these categories and their subcategories as well.

Typical extractors range from $8,000-$12,000. For a city like Fort Worth, with 42 stations, the bill is going to be expensive. Making sure the technology performs well is going to be crucial to quality. Being that carcinogens embed themselves in the gear, the extractors need to clean the gear to a substantial quality, and therefore need a high-performance rate. Furthermore, making sure the type of extractor being purchased will be reliable is important as well. A lack of reliability could not only affect the health of firefighters, but it could also drastically raise costs.

Maintenance can result in a higher cost if your technology isn't reliable. Think about reliability in terms of a brand-new car. If a company or a consumer purchases a reliable car like Toyota, which is known for their reliability, they are likelier to have a lower maintenance expense and more longevity on their car. In contrast, if the car purchased was a Cadillac, will it continue to provide value for as long as the Toyota? The answer is most likely no, and the expenses you incur due to a low reliability will be exponentially larger. Taking this back to the adoption of a new technology is very similar. Making sure the technology you purchase is

reliable and durable guarantees minimized cost A research paper written by Rob Delaney and Robert D'Agostino was noted as saying, "An additional area to research is monitoring of an organization's performance after the technology is implemented." (Delaney, D'Agostino, 2018). The constant monitoring of the extractors' efficacy in fire departments will ensure they are doing their job while minimizing cost through constant adaptation toward cost saving techniques.

Time/Downtime

Downtime is detrimental to businesses and organizations and has cost an average of $1.55 million every year (Bose, 2018). Furthermore, an article written by Shubhomita Bose also mentions that downtime caused by the implementation of new technology accredits for 545 hours of staff productivity lost annually. There are many factors that go into the successful implementation and adoption of a new technology—therefore, it is important to have a specific (and or detailed) implementation strategy that covers all bases, especially for the fire department's extractor adoption. Although fire departments aren't selling products and downtime doesn't mean less money, longer implementation means firefighters will continue to be exposed to toxic, cancer-causing carcinogens.

With new technology implementations accounting for 545 hours of staff productivity lost, fire departments also need to consider a strategy that mitigates the downtime of their stations. In a line of work like the fire department, a station can't afford to have downtime of even a single hour. Therefore, fire departments will need to look for ways to expedite their implementation time. Two main factors that will increase installation time for fire departments are directly correlated to management of change: the education given to firefighters about the new technology, as well as the challenges to current practices which firefighters must be willing to change.

Change Management

Education

To begin, one struggle many companies go through with technology adoption is the understanding of and ability to implement said technology. An Australian company that went by the name “Woolies” ran into this problem when implementing a technological system to replace their 30-year-old in-house system (Fruhlinger, 2017). Having to move from something the company was used to doing for 30 years is difficult enough. However, when you throw in the lack of understanding when it comes to the technology replacing it, that leads to a failure in implementation. As a result, the company wasn’t able to produce reports they were used to getting every week, for 18 months. An analyst on SAP implementation in Fruhlinger’s article said,

> "They make it a part-time job, or they hire new people to tell the system guys what to build. None of that works. You have to really dedicate the people who know the process that you’re trying to get right, full-time. And it’s a common theme that, when you don’t dedicate those people, you get into trouble." (Fruhlinger, 2017).

As seen in the Australian company’s case, after having an in-house system for 30 years, it was very difficult to transfer over to a new system, and part of that reason was due to education. For firefighters, a lack of education on the system could lead to negligence, improper use, or an unwillingness to operate. When using a piece of machinery like the extractors, carcinogens and chemicals are ever-present. Failure to educate firefighters on the operations of the extractors could lead to injury and/or unnecessary exposure. In addition, if firefighters aren’t educated on

how to use the extractors properly, they may simply refrain from using them and migrate back to their old tactics and cleaning techniques.

Currently, firefighters are using buckets filled with citrosqueeze and only getting their gear washed once a year through an extractor. Therefore, for firefighters, they will be moving from a process that was established in-house to the technology of the extractors, which is a new system to current firefighters. One of the largest issues that came to be from this new technology implementation for "Woolies" (and something that fire departments will have to look for) is making sure they dedicate the people who know the process that they are trying to get right, full-time. An article written by Mathew Craig, a business development consultant at Assemble Systems, talks about how an organization can become more open to change. To prevent a case like "Woolies" from happening again, education is among one of the most important factors (Craig, 2017).

Norms

One of the biggest challenges any "new system" can face is the willingness an organization has to adapt to it. In the fire department, dirty gear has always been a symbol of an experienced, decorated firefighter with seniority. Asking firefighters to constantly clean their gear goes against the norms and culture of a fire department and it may not be welcomed by everyone. However, just because there is resistance does not mean it is conducive to risk behavior. In fact, "Harvey (1995) believed that change without resistance was no change at all, but was an illusion of change." (Eskierka, 2014). Eskierka, an author on the development of policy for decontamination in the fire department, provides ample research on the norms and resistance to change among firefighters. Firefighters are starting to develop a form of cognitive dissonance on the matter (Eskierka, 2014). This term refers to individuals that are conflicted

between belief and information. Now that firefighters are being presented with concrete evidence referring to the hazards dirty gear can impose, firefighters must change their way of thinking. A survey was conducted in conjunction with Eskierka's research to show the various levels of change firefighters have on the matter.

- Respondent number 44, "Surveys are a joke. Your cancer task force is a joke."
- Respondent number 8, "The guys won't clean their gear, they want to look salty."
- Respondent number 10, "I am an FEO so my gear does not see the same usage as captains and firefighters."

(Eskierka, 2014).

Furthermore, other questions like, "How important to you is cleaning your turnout gear?" and "How often do you clean your turnout gear?" are rather alarming. Out of a pool of 200 individuals who took the survey, just over 50% of respondents said that cleaning their turnout gear was somewhat important or not important, and only 16% admit they clean their gear after every fire (Eskierka, 2014). It is evident that firefighters need to change their way of thinking, the only question is how.

Lewin, an author on group decision and social change, described the changing process in three steps: unfreezing, moving, and refreezing. "Lewin postulated that the unfreezing stage involved developing motivation and preparing for change, the moving stage involved restructuring individuals' perspectives, and the refreezing stage involved reinforcing and integrating the change (Schein, 2004)" (Eskierka, 2014). With this three-step process, fire departments should be informing firefighters of the risks that come with not cleaning their gear properly, showing them the simplicity of washing their gear and preventative measures, and hopefully by then fire fighters will change their way of thinking. Eskierka's survey asked

respondents, “Would having access to a turnout gear washer (extractor) in every fire station increase your frequency of cleaning turnout gear?” Out of the 200 respondents, 171 (85.50%) said yes. Although there is a small percentage that said no, having a majority of firefighters willing to buy into the new process is a great first step in changing the culture of the fire department.

If fire departments prepare accordingly for the prohibiting and promoting factors of this new technology, they will be successful. Through the analyzation of technology adoption and change management a proper plan can be put in place with further research and analysis.

Methods and Results

After conducting a literature review on the prohibiting and promoting factors of technology adoption, determining the strategy that best suits the new requirements of NFPA and Fort Worth Fire Departments' needs has to be identified. In order to determine that answer, field research would need to be conducted: specifically, going to the current cleaning facility of FWFD and talking with Fort Worth executives about their resources and preferences. The cleaning facility will be researched to determine the current efficiencies of the cleaning process and the adjustments that will need to be made to increase capacity. Furthermore, the FWFD executives will be crucial to logistics (pricing, resources, preferences) of this research. The personnel are as follows:

Fort Worth Fire Department Executive Communication	
Personnel	**Reason/Background**
Fire Chief Davis	Fort Worth Fire Chief
Captain Webb	Professional/Specialist in cancer research in the fire department
Captain Jandrucko	Lead of extractor facility in Fort Worth Fire Department

The following research will be presented in a sequential order of: the current state of FWFD, the driving factors for change, methodologies and criteria considered to solve the problem, and analytical results.

Current State of Fort Worth Fire Department

There are three categories of Fort Worth Fire Department that are worth noting. First, the methods of decontamination of firefighter's gear needs to be recognized. Next, the actual process Fort Worth is using to annually deep clean the gear. Lastly, which was briefly mentioned in the literature review, the culture of FWFD and the firefighter's willingness to adapt to cleaning efforts.

To begin, decontamination is done in two separate fashions. As per NFPA's annual deep clean requirement, bunker gear is being washed once a year through the use of extractors and citrosqueeze. This is conducted at one centralized location located at 2900 W Bolt in Fort Worth, which is just south of downtown. Aside from the annual deep clean of the gear, firefighters are personally washing their gear through the use of trash cans and citrosqueeze. Basically, after any fire, or event causing substantial contamination to the gear, stations will fill buckets/trash cans with the neutralizing chemical of citrosqueeze and simply soak their gear in it. This is extremely ineffective when it comes to the overall decontamination of bunker gear, and, in part, the reason NFPA's new requirement requires bunker gear to be deep cleaned after every fire. Regardless of the method of decontamination, drying of the gear must be done. At the annual washing location, gear is hung on "PVC pipe, heated mannequins" to expedite the heating process, whereas when the gear is washed at stations, they are simply hung up to dry in the fire house.

Fort Worth Fire Department is currently made up of 42 stations (Exhibit 1) and approximately 1000 sets of bunker gear that require the annual cleaning. Although there are two extractors, one at 2900 W Bolt (near station 21 and used daily) and one at Bob Bolen Safety Complex (near station 17 and used as a backup), all 1000 sets of gear are being serviced by the first extractor at 2900 W Bolt. The second extractor at Bob Bolen Safety Complex is much smaller and older than the other, therefore, it is used as a backup and is open to firefighters to use at any time. Even though it is available to firefighters, it is extremely underutilized. This can be accredited to different factors such as the culture of fire departments, accessibility, as well as education/knowledge. Another element to note is the distance between extractor locations, as well as distance between extractor locations and fire stations. The extractors are extremely close

to each other and make servicing the farther stations more difficult and time consuming. With the way the process is currently being run, the saving of time, in any way, is crucial.

Right now, FWFD's cleaning process is being done by two personnel: one cleaner and one seamstress. The process can be broken up into four separate parts: pick-up, wash, repair, and drop-off. On the first day, the cleaner picks up the gear, breaks it down, washes, and dries them overnight. Then on the second day the seamstress goes through and makes any necessary repairs to the gear, reassembles the gear, and delivers them back to the stations. Through the conduction of field research, Exhibit 2 provides findings in the form of a process map and is broken down into individual steps with times. The overall conclusion that was made from this research was that the current method of cleaning was running at or above capacity. As of right now, this process works, however, both employees were experiencing numerous occasions of overtime, and most of that can be accredited to the variability of the process.

Variability comes in the form of walk-ins, repairs, travel time—and with NFPA's new requirements going into effect—cleanings after every fire. While conducting field research at the cleaning facility, multiple firefighters came in to get their gear serviced. Employees at the cleaning station call these walk-ins. Firefighters are able to come in at any time to get their gear serviced if it needs repairs or is simply too dirty. After talking with employees, they can receive anywhere from one to ten walk ins in a day. Next, the repairs and maintenance given to the gear. The seamstress can have anywhere from twenty to two hundred repairs in a day and leaves a large sense of uncertainty when time stamping the process. As mentioned before, extractor locations are currently much closer to some stations than others. Along with distance, time of day, weather, and other factors make the travel time from fire station to extractor location and back questionable. Lastly, because fire incidents cannot be predicted, the amount of extra gear

washings and repairs due to fire related incidents is unknown. Considering all these factors, it is important that FWFD implements a strategy that has large amounts of excess capacity. This will allow the cleaning process flexibility in times of high demand.

One of the most important elements in making this adjustment successful, however, is firefighter's willingness to change to cleaning efforts. In the past, when FWFD's cleaner would receive gear from stations, he would notice pieces on the helmets and coats missing. This is because firefighters would hide them until their gear was cleaned, so they could maintain the look of a dirty firefighter. As briefly mentioned before, dirty gear has always been a sign of seniority and heroism in the fire department. With that fact in mind, firefighter's mindsets will have to change. Luckily, the research and survey conducted by Eskierka was done in 2014. Since then, ample amounts of research and studies have been publicized linking high rates of cancer to the job of a firefighter. Fortunately, the culture of fire departments is beginning to change, however, in order for the implantation of NFPA's new requirements to be successful in Fort Worth, officers will need to enforce change.

Driving Factors for Change

Fort Worth Fire Department is looking to adjust their cleaning process as soon as possible. Through the advice of Fort Worth Executives, three driving factors for change were established. Economic, being the first factor, looks at the benefit that arises from lowering the cancer rate among firefighters. The second factor is morality, which basically looks into protecting those who protect the public. Lastly, NFPA's 1851 regulation lay's out a time frame and establishes requirements for FWFD.

Workers compensation claims, for the most part, are rather straight forward. If you fall of the ladder and injure yourself, it is obvious that the injury was caused while performing in the

line of duty of a firefighter. Conversely, firefighters that file workers compensation claims for cancer are, more times than not, denied. This is simply because proving that a given cancer was caused by the chemicals and carcinogens a firefighter was exposed to on duty is very difficult to do. Captain Robert Webb, of Fort Worth Fire Department, had a very similar case. When he was diagnosed with cancer and filed a worker's compensation claim, he was unfortunately denied. Determined, however, Captain Webb developed a packet that scientifically linked his cancer to the job of a firefighter and was the first firefighter to win his workers compensation claim. Ever since then, Captain Webb has been developing packets for his fellow firefighters and is increasing the amount of successful workers compensation claims. With the average cancer treatment causing $150,000 and up, economically, it would make sense for FWFD to implement a strategy that lowers the overall cancer rate in Fort Worth. In turn, this will lower the overall costs the city of Fort Worth incurs for cancer treatments.

Along with financial incentive, there is also the incentive of morality. Firefighters, as well as other first responders, act with a heart of service and put their lives on the line ever day to keep their community safe. They constantly put others needs before their own, and for once, it should be the other way around. Due to the apparent rise in cancer amongst firefighters, the humane response is to provide preventative measures to lower cancer rates for firefighters. One organization that is doing that, and is the last reason for change in Fort Worth: The National Fire Protection Agency. NFPA 1851 states, "This standard establishes requirements for the selection, care, and maintenance of the firefighting protective ensembles to reduce health and safety risks associated with improper maintenance, contamination, or damage." In an effort to reach the goals of this statement, as mentioned before, firefighters' gear must be cleaned and repaired twice a year and after every fire. According to Fort Worth executives, this new regulation goes into effect

in August, therefore, it is important that the overall strategy decided on can be implemented in that time frame.

Methodologies and Criteria Considered

Being that NFPA is moving from cleaning once a year, to twice a year, the logical adjustment that should be made is double capacity. Unfortunately, as mentioned before, the current process is being run at capacity and at times employees are even working overtime. Along with doubling capacity, the decision should include flexibility and excess capacity to eliminate constraints. To achieve this goal, three methods were considered: local, regional, and centralized.

Local – Installing extractors in all stations and having firefighters clean their own gear.
Regional – Break the city of Fort Worth up regionally and develop multiple centralized locations to service each region.
Centralized (current method) – Having one extractor location and organize a pick up and drop off routine for gear.

In order to compare the three methods to each other, selection criteria were develop based on the needs and wants of Fort Worth Fire Department's executives. The four criteria used to analyze the effectiveness of the methods above are quality, gear availability, flexibility, and cost.

Quality – Having gear be serviced by trained personnel versus firefighters
Gear Availability – Having extractor locations placed close to stations in order to minimize the time to deliver gear if needed for an emergency.
Flexibility – The ability to handle unscheduled demand (eg., post-fire/event cleanings), in addition to scheduled cleaning operations
Cost – Total cost of each alternative

Exhibit 3.1 provides the calculations of the analysis. The analysis takes each individual criteria and weights it against the others. The weights are given based on the preferences and opinions of Fort Worth Fire Department executives.

Quality	Rank	Reason
Local	Low	Gear will be serviced by firefighters instead of trained professionals at the extractor locations
Regional	High	Gear will be serviced by trained professionals at the extractor locations instead of firefighters
Centralized	High	Gear will be serviced by trained professionals at the extractor locations instead of firefighters

Gear Availability	Rank	Reason
Local	High	Extractors will be located in all fire stations, minimizing travel time to cleaning locations, making gear available
Regional	Moderate	Multiple extractor locations will allow for shorter travel times, and gear will be available more than centralized.
Centralized	Low	Extractors and fire stations distance will lead to exponentially more travel time and less availability

Flexibility	Rank	Reason
Local	High	The utilization percentage of extractors will be very low, meaning flexibility in demand and cleanings can be met
Regional	Moderate	Extractor utilization will be higher than local, however, still low enough to meet variability
Centralized	Low	Due to distance and limited locations, extractor utilization will be high and may have problems with variability

Cost	Rank	Reason – Exhibit 5.4
Local	High	$1,035,100
Regional	Low	$375,900
Centralized	Low	$331,200

After conducting the analysis in Exhibit 3.1, the costs and benefits of each method were compared. Exhibit 3.2 provides the graph comparing those results. Overall, the method that received the highest benefit was the local method, however, that benefit came at a cost of just over $1,000,000. On the other end of the spectrum, a centralized method was the lowest cost. Unfortunately, it also had over 10% less benefit than the local method. A regional approach however, had almost the same amount of benefit as a local method for almost the same cost as a centralized method. Based on this analysis, it is recommended that Fort Worth Fire Department go with a regional approach when attempting to meet the new regulations of NFPA 1851.

Assuming that FWFD decided to go with a regional approach, determining a second, third, or fourth extractor location would be critical. By comparing the personnel, utilization, and flexibility in Exhibits 5.1, 5.2, and 5.3, the adequate amount of personnel and extractor locations was determined. Two extractor locations would be the final point of positive return, and at each location would be one cleaner and two seamstresses. With this strategy Fort Worth will be able to meet the annual demands of their cleaning, as well as be able to adjust to the variability of the process. Once again, assuming that Fort Worth Fire Department implemented a two extractor, regional approach, a second extractor location would need to be determined.

Based on the placement of the current extractor, a weighted analysis was conducted using latitude and longitudes to define a second extractor location. Exhibit 4 provides the work behind the analysis, as well as the address of the second extractor location: 1513 Glen Garden Dr., Fort Worth, TX, 76104.

Results

Overall, the results reached through field research, statistical analysis, and Fort Worth executive input are to go with a regional approach. Implementing a regional strategy will allow

Fort Worth Fire Department to achieve the highest amount of benefit at the lowest possible cost. Furthermore, by constraining their purchasing to two extractor locations and three personnel per location, they will be able to meet the demands of their new cleaning requirements and reach the ultimate goal of lowering cancer rates in the fire department.

Discussion

Implementation

Understanding now that the best approach for Fort Worth is a regional method, they would need an implementation strategy to meet the August deadline NFPA has set. It is recommended that Fort Worth Fire Department breaks up this strategy into three separate sprints or adjustment periods (Exhibit 6). Fort Worth needs to establish and develop the second extractor location, acquire the personnel needed for each extractor, and then finally do onsite final preparation.

Sprint one, which is developing the second extractor location, can be done in three steps. First, FWFD would need to finalize a location for the second extractor. Although there is a recommendation given in this manuscript, there may be qualitative reasoning Fort Worth deems important enough to adjust that location. Furthermore, other factors such as traffic times during the day and plans for future growth in the city may play a role in the location decision as well. Next, which will most likely take the longest time, is converting the building. To implement extractors, buildings require specific water line hookups and draining systems. This must all be done before the last step of purchasing and implementing the extractor can be done.

Even though time is a constraint in this situation, the second sprint can be done simultaneously with the first. Acquiring new personnel does not require the extractor location to be developed. While sprint one is being completed, Fort Worth can go through an application, hiring, and training process. As mentioned before, extractor location employees are trained professionals. They are sent to the manufacturer of the bunker gear to be trained and understand the proper techniques of cleaning and repairing gear. If done properly, sprints one and two can be

completed by the beginning/middle of July. This leaves the rest of July and the beginning of August to complete the last sprint.

Sprint three involves final preparation and the clearance to be fully operational. After the extractor locations have been finalized and the personnel have been trained, onsite training can begin. This will allow employees to familiarize themselves with their equipment. After onsite training is completed, the gear cleaning process can be attempted, and if all runs smoothly, they will be fully operational by August and meet the demands of NFPA 1851.

Limitations

Throughout this research, multiple limitations were identified. The most pertinent limitation, however, relates to cost. Fort Worth Fire Department, is in the process of receiving money to undertake a project such as this one. Unfortunately, whether they receive the grant or not, this is still an issue that needs to be addressed. Cost plays an enormous role in FWFD's decision because this is also not the only project that requires the allocation of money. With new stations in the works of being developed, funds are being needed in other areas as well.

Future Considerations

After concluding research, two future steps could be identified. One of the biggest issues arising from this entire process is the variability. Furthermore, because firefighters work every three days, their gear must be returned to them within that time frame. Something FWFD could consider is the purchasing of an extra set of bunker gear for every firefighter. Although this is a large, upfront cost, it will eliminate some variability in the process. Cleaning locations will be able to wash gear in bulk loads because they would have more time to return the gear to firefighters. While the second set of gear is being washed, firefighters will still have a set of fully operational gear to use. Something that needs to be considered, however, is the increase in

inventory. Instead of 1000 sets of gear requiring a semi-annual wash and repair, 2000 sets of gear will be required. This may be possible, however, given the lower variability and the ability to wash in bulk loads.

The second consideration, and less costly idea, is hiring a driver. Currently, the cleaner and seamstress are the ones picking-up and dropping off the gear. Unfortunately, this is a waste of time and resources. Trained professionals on the subject of bunker gear cleaning and maintenance are doing the job of a taxi driver. By hiring a driver to pick-up and drop-off gear, Fort Worth would then be freeing up time in the day for the cleaners and seamstresses to complete more of the work they are trained to do.

Implications

The point of this manuscript was not only to help Fort Worth Fire Department develop an implementation strategy to meet the new demands of bunker gear cleaning and extractor usage. As the research question poses, the overarching goal of the research was to lower the cancer rates among firefighters. NFPA has taken steps in hopes of lowering that percentage through rules and regulations. Luckily, the only questionable factor of, how will FWFD meet these new demands, can be answered through this manuscript. Although this research seems to be specifically focused towards Fort Worth, which it is, it can also be generalized and applied to any city or department looking to raise the capacity of their cleaning process. Exhibits 5.1, 5.2, and 5.3 provide a template for the cleaning and repairing process bunker gear must undergo. By utilizing this template, cities can determine the number of extractors and employees needed to successfully meet the capacity of their demands.

Conclusion

Firefighters are being exposed to life threatening dangers day in and day out. Perhaps the most prominent of those dangers, that 68% of firefighters share, is cancer. Due to the exposure to chemicals and carcinogens, accompanied with a once a year deep clean wash and repair, firefighter cancer rates are nearly triple that of the general public. Fortunately, with the new requirement set by the National Fire Protection Agency, to wash gear twice a year and after every fire, the rate of exposure firefighters will receive will drastically decrease. Although this new requirement is justified, Fort Worth Fire Department, as well as other departments following the rules and regulations of NFPA, will need to make drastic changes to the new demands of the cleaning process. These changes will require the implementation of more extractors.

Just like with any new technology implementation, Fort Worth will have to analyze prohibiting and promoting factors to determine the best strategy. By utilizing the experiences of other organizations and companies that have been successful, as well as unsuccessful, in terms of technology adoption and change management, Fort Worth Fire Department will be able to minimize the negative effects the implementation of new extractors may have. While considering factors such as cost, downtime, education, and firefighter culture, three approaches were developed and analyzed to provide the best solution.

Local, regional, and centralized methods are all viable solutions to the current issue at hand, however, a regional approach undoubtedly provides the most benefit while maintaining the lowest cost. Proven by the use of statistical analysis, Fort Worth Fire Department should consider implementing one additional extractor while also hiring one cleaner and two seamstresses per location. Due to the time sensitivity of the situation, extractor locations, personnel, and final preparation all need to be completed by August of this year. If followed correctly, the

implementation strategy provided in this manuscript should allow Fort Worth to achieve the status of fully operational by August.

To conclude, if extractor implementation is done correctly, Fort Worth Fire Department will be able to meet the new requirements of the National Fire Protection Agency's regulations while lowering the cancer rate among their city firefighters.

References

"Acquisition Cost." *AccountingTools*, www.accountingtools.com/articles/2017/5/8/acquisition cost.

Used for definition.

Bose, Shubhomita. "IT Downtime Costs Businesses $1.55 Million Per Year, Report Says ." *Small Business Trends*, 28 Jan. 2018, smallbiztrends.com/2018/01/cost-of-a-tech-fail-small-business.html.

The author of this article focuses on the detrimental effects of downtime due to technology adoption in businesses. With the implementation of extractors into fire departments, there will be some downtime experienced. Therefore, this article warns technology implementers that the time spent focusing on the implementation can seriously take away from the productivity of a business or industry. When the fire departments adopt more extractors into their stations they will need to watch out for the effects of downtime and try to minimize the time wasted as much as possible.

Carter, H., Weston, D., Betts, N., Wilkinson, S., & Amlot, R. (2018). Public perceptions of emergency decontamination: Effects of intervention type and responder management strategy during a focus group study. *Plos One, 13*(4), e0195922. doi:10.1371/journal.pone.0195922

The authors, researchers on decontamination management, use focus group data to determine the effectiveness of different strategies pertaining to the effectiveness of decontamination techniques. The researchers use a 2 x 2 x 3 design starting with decontamination intervention type and type of management strategy, followed by three questionnaires; pre-, post-, and 3-months post-. The overall determination of the study was the decontamination shower was deemed to be more effective than dry decontamination methods and the management strategy including communication resulted in a higher willingness to comply.

Craig, Mathew. "Why Is Changing a Business Work Process So Difficult?" *Assemble Systems*, 8 June 2017, assemblesystems.com/blog/why-is-changing-a-business-work-process-so-difficult/.

This author, a business development consultant at Assemble Systems, reviews proper implantation tactics for new technology. The article emphasizes the prerequisites of education and developing a plan with expectations, prior to implanting the new system or technology. When the extractors are getting ready to be purchased and installed it is important that the firefighters have been educated and have clear guidelines and expectations on how the equipment should be used. The article also reflects on metrics to measure success and how to document, repeat, and improve the process.

Delaney, Rob and D'Agostino, Robert, "The Challenges of Integrating New Technology into an Organization" (2015). Mathematics and Computer Science Capstones. 25.

The authors of this research focus on the difficulties associated with the integration of new technologies. One of the main points emphasized is the measurement of performance after a technology has been implemented into a new system. Similarly, to the new technology implemented into fire departments, in the form of extractors, this research solidifies the importance of measuring performance metrics to determine the overall effectiveness of the technology.

Eskierka, Jeffrey A. "Developing a Policy for Decontamination of Firefighter Personal Protective Equipment in the Saint Paul Fire Department." ProQuest Dissertations Publishing, 2014. Web.

The authors, researchers at the College of St. Scholastica, further research the exposure to contaminated personal protective gear fin in the fire department. This source highlights a procedure and policy to mitigate the threat posed by contaminants in the world of an active duty firefighter. Not only does this research provide procedures and policies, but it also provides recommended training and education for firefighter to increase the awareness of carcinogens and other inherent dangers in the fire service. Being that the withholding to change is an attitude in normality in the fire service, this study looks to inform firefighters of long-term health and wellness.

Fruhlinger, Josh, and Thomas Wailgum. "15 Famous ERP Disasters, Dustups and Disappointments." *CIO*, CIO, 10 July 2017, www.cio.com/article/2429865/enterprise-resource-planning/enterprise-resource-planning-10-famous-erp-disasters-dustups-and-disappointments.html.

The author of this article highlights some of the worst ERP implementation disasters in history. Although this doesn't directly corollate to the fire department extractors, it represents the difficulty with implementing new technologies and the catastrophic failures that can come if you don't take them seriously. One of the main similarities is this article highlights a company that moved from an in-house operating system to a SAP program, and due to improper training, preparation, and norm adjustments, the technology adoption did not work.

Gyben, Alessandra. "Total Cost of Ownership in Technology: The True Cost of Implementing CRM & Marketing Automation." *TechnologyAdvice*, 25 May 2018, technologyadvice.com/blog/sales/total-cost-ownership-crm-marketing-automation/.

The author of this article focuses in on the Total Cost of Ownership with technology. The costs are broken up into acquisition costs, operating costs, and personnel/resources costs. When looking at this article in reference to the extractors fire departments will be purchasing, it is important to remember that there are much more costs associated with a technological implementation that meets the eye. The author emphasizes customization, licensing, training, maintenance, downtime, personnel support and others.

Harrison, T. R., Muhamad, J. W., Yang, F., Morgan, S. E., Talavera, E., Caban-Martinez, A., & Kobetz, E. (2018). Firefighter attitudes, norms, beliefs, barriers, and behaviors toward post-fire decontamination processes in an era of increased cancer risk. *Journal of Occupational and Environmental Hygiene, 15*(4), 279-284. doi:10.1080/15459624.2017.1416389

The authors, researchers on the attitudes and norms within the fire service, use qualitative data to analyze the effectiveness of post-fire decontamination processes. In past years the significance of dirty gear has been a badge of honor in the fire service, however, in recent times, that is beginning to change. The article uses surveys with four department's firefighters, totaling 485 total personnel. The overall determination was that the norms about decontamination are welcomed by firefighters, however, concerns over wet gear in field remain a barrier for decontamination.

Harrison, T. R., Yang, F., Anderson, D., Morgan, S. E., Wendorf Muhamad, J., Talavera, E., . . . Kobetz, E. (2017). Resilience, culture change, and cancer risk reduction in a fire rescue organization: Clean gear as the new badge of honor. *Journal of Contingencies & Crisis Management, 25*(3), 171-181. doi:10.1111/1468-5973.12182

The authors, researchers on preemptive norms in the fire service, analyze qualitative data to undermine the stigma of "dirty gear" being seen as a badge of honor. This resource shows that throughout the years it has become apparent that cancer is reaching an epidemic in the fire service and has climb to 68% of firefighters getting cancer in their life. It also touches on gender specific facts like woman having a higher risk of generating cancer. Also, this source looks at the medical background of some of the combustion of chemicals and the carcinogens that are cause cancers in firefighters

Harvey, T. (1995). Checklist for change: A pragmatic approach to creating and controlling change. Lancaster, PA: Technomic Publishing Inc.

The author of this literature discusses a checklist of steps that need to be achieved in order for an organization to change. Much of what fire departments are going through revolves around change. Moving away from the norms of a system can be difficult for those who have done things a certain way for a long time. Therefore, Harvey's checklist on change management can help the process run more smoothly in the fire department.

Hendricks, Mike. “Cancer Prevention Programs Stress Keeping Firefighters' Gear Clean.” *Kansascity*, The Kansas City Star, www.kansascity.com/living/health-fitness/article135023294.html.

The author of this article focuses on the social norms amongst firefighters. The original badge of honor represented by filth, grit, and grime on gear is now fading due to the rising knowledge of what that residue causes. The author mainly focuses on a Kansas state fire marshal who announced a new cancer-prevention program and received grant money to fund new extractors. Although it would be a change in the firefighters’ norms, providing these extractors is vital for the protection of firefighters’ health. Lastly, the article covers some of the price ranges of extractors, as well as the time sensitivity on the matter of cleaning gear.

Kenton, Will. “Operating Cost.” *Investopedia*, Investopedia, 13 Dec. 2018, www.investopedia.com/terms/o/operating-cost.asp.

Used for definition.

Lewin, K. G. (1999). Group decision and social change. In K. Lewin, The complete social scientist: A Kurt Lewin reader (pp. 265-28r4). Washington, DC: American Psychological Association.

The author of this text focuses on change management. Lewin takes the changing process and breaks it into three categories of unfreezing, moving, and refreezing. This is relative to the fire departments because it the new extractor systems are going to require an adaptation in the way firefighters are doing things. Lewin’s total change management system is accompanied by many other elements and could be deemed as useful when adjusting fire departments way of life.

Schein, E. (2004). Organizational culture and leadership, (3rd ed.). San Francisco, CA: JosseyBass

The author of this article expands on some of the change management styles Lewin provides. Schein gives insight, perspective, and definition to a successful change in a social setting. These definitive characteristics are crucial in breaking away from norms in the fire department and developing a new way of doing things. Firefighters are resistant to change, therefore, having an explanation in steps, like what Schein does in this article, will prove to be rather helpful.

Stern, R. C., & Emery, R. E. (2016). July 2016. *Family Court Review, 54*(3), 333-335. doi:10.1111/fcre.12228

The authors of this research used statistical analysis of 29,993 firefighters with at least one day of active duty between 1950 and 2009. Specifically, they targeted fire departments from Chicago, Philadelphia, and San Francisco, which are some of the highest fire rated cities. Up to the year 2009, they gathered statistical data from the nation and determined how many former fire fighters had died, and from what cause. After identifying those dead, they used measurements such as exposed-days, fire-runs, and fire-hours, and related this data to firefighter who died due to the cause of cancer.

Study: Firefighters have higher rates of cancers. (2013). *Industrial Safety & Hygiene News, 47*(12), 12. Retrieved from http://lib.tcu.edu/PURL/EZproxy_link.asp?url=http://search.ebscohost.com/login.aspx?direct=true&AuthType=cookie,ip,uid&db=bth&AN=92709948&site=ehost-live

The authors of this research focus on the cancer rate in firefighters in comparison to the general public. Along with the fact that those who face occupational expose to contaminants have a higher risk, this source also shows that mesothelioma is twice as likely as well. After analyzing 60 years of data on 30,000 firefighters, researchers found that cancers of the respiratory, digestive, and urinary systems maintained the highest rates of cancer. This source also talks about the collaboration with the National Institute of Occupational Safety and Health and the National Cancer Institute.

Treumann, Robert. “Top 15 Barriers to Adopting New Technology.” *LinkedIn*, 4 July 2014, www.linkedin.com/pulse/20140704145017-392712-top-15-barriers-to-adopting-new technology/.

The author, CEO/President of eSCRIBE Software, highlights some of the largest barriers a company or group of individuals may face when adopting a new technology. One of the largest issues with the implementation of extractors, and therefore lack of extractors, can be brought to reason when analyzing the authors issues with new technology adoption. In order for the fire department to be able to successfully implement a strategy and extractors themselves, they will need to overcome some of the barriers presented in this article.

Weidinger, J., S. Schlauderer, and S. Overhage. "Is the Frontier Shifting into the Right Direction? A Qualitative Analysis of Acceptance Factors for Novel Firefighter Information Technologies." *Information Systems Frontiers* 20.4 (2018): 669-92. Print.

The authors, researchers in technological innovation in emergency response processes, use a qualitative study to interview 21 members of German fire departments on the upcoming possible emerging technologies in the fire service. The research further concludes that firefighters find emerging technologies to deliver potential advantages. However, this article touches on the fact that with every new technological adoption comes the issues of complexity, compatibility, as well as other barriers. The article stresses the importance of considering the complexity of new innovations in the fire service in order to guarantee its effectiveness.

Weiler, M. R., et al. "Identification of Factors that Affect the Adoption of an Ergonomic Intervention among Emergency Medical Service Workers." *Ergonomics* 55.11 (2012): 1362-72. Print.

The authors of this article focus on the adoption of intervention within the Emergency Medical Service workers position. This study uses six different organizations and had them participate in a two-month longitudinal study. The effects of this study highlight the differing positions fire fighter hold. Although this source is not directly related to the overall research of my thesis, it puts into perspective the differing positions in Emergency Medical Service, and the differing and cancer rates accordingly.

Wener, R., et al. "Assessment of Web-Based Interactive Game System Methodology for Dissemination and Diffusion to Improve Firefighter Safety and Wellness." *Fire Safety Journal* 72 (2015): 59-67. Print.

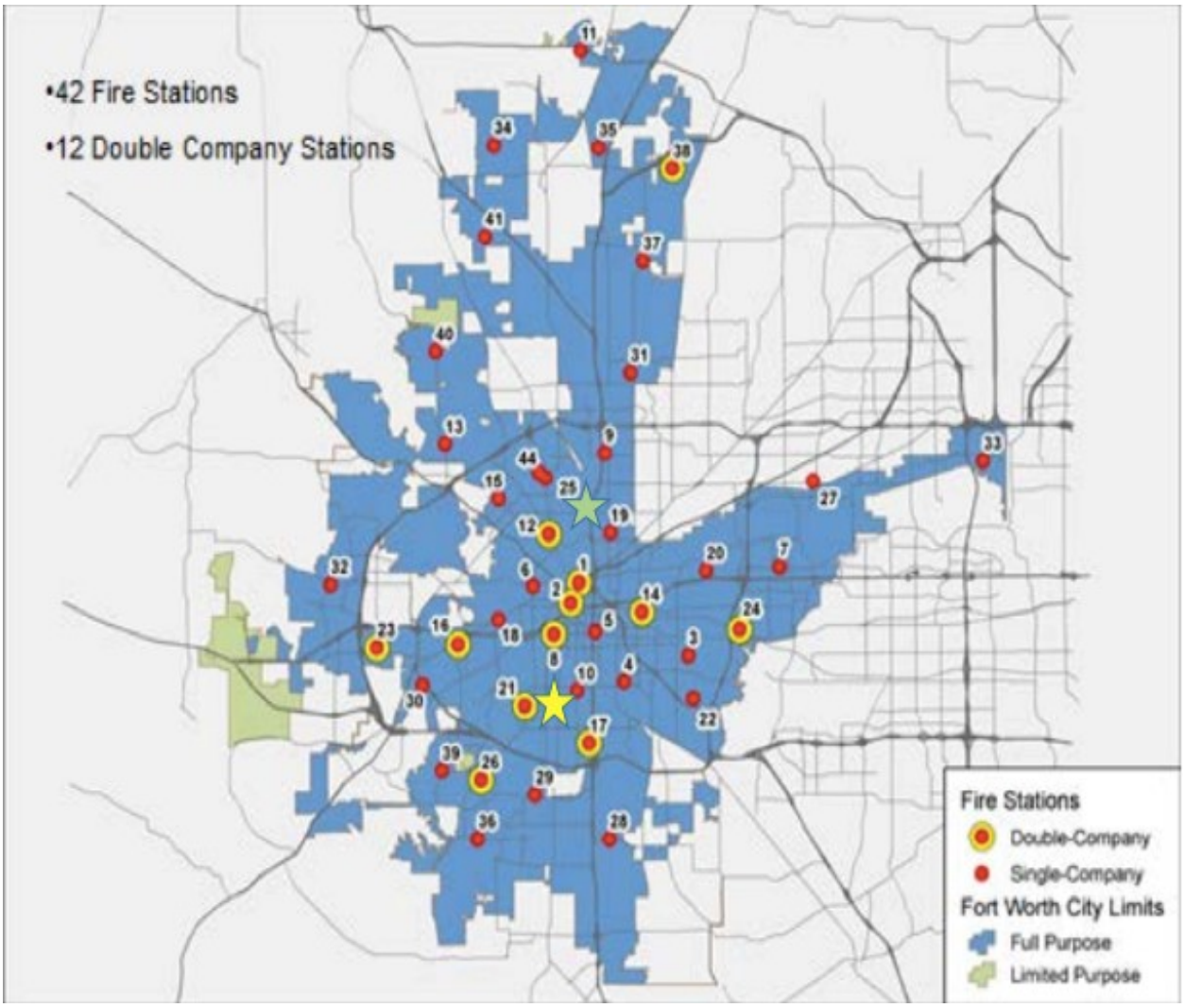
The authors of this article focus on using training methodologies that keep firefighters from actually being exposed to carcinogens and harmful chemicals. ALIVE is an interactive multimedia training tool being used by the fire service to train recruits and prevents them from actually being exposed to actual fire’s and harmful effects when not necessary. This resource can be used as a baseline analysis to cancer rates in those who train using interactive multimedia training and those using general techniques.

Zbigniew, D., Małgorzata, D., Romuald, O., & Piotr, S. (2016). Decontamination of a diving suit. *Polish Hyperbaric Research, 57*(4), 45-51. doi:10.1515/phr-2016-0025

The authors, researchers in general chemical or biological environments, make known the basic facts of working in fields of contamination. This source touches on protective overalls worn by firefighters and their proven sufficient protection. However, it is reassured that after a firefighter leaves a scene there is need for contamination. As pertaining to my research, the question with this article is how do you ensure fire fighters have safe clean gear but are still readily accessible. This source not only gives insight into the need for extractors, but also proves that second sets of bunker gear may be a requirement in safety as well.

Appendix

Exhibit 1



Maintaining Current Extractor Location

Region 1 Extractor Location Recommendation

Region 2 Extractor Location Recommendation

Exhibit 2

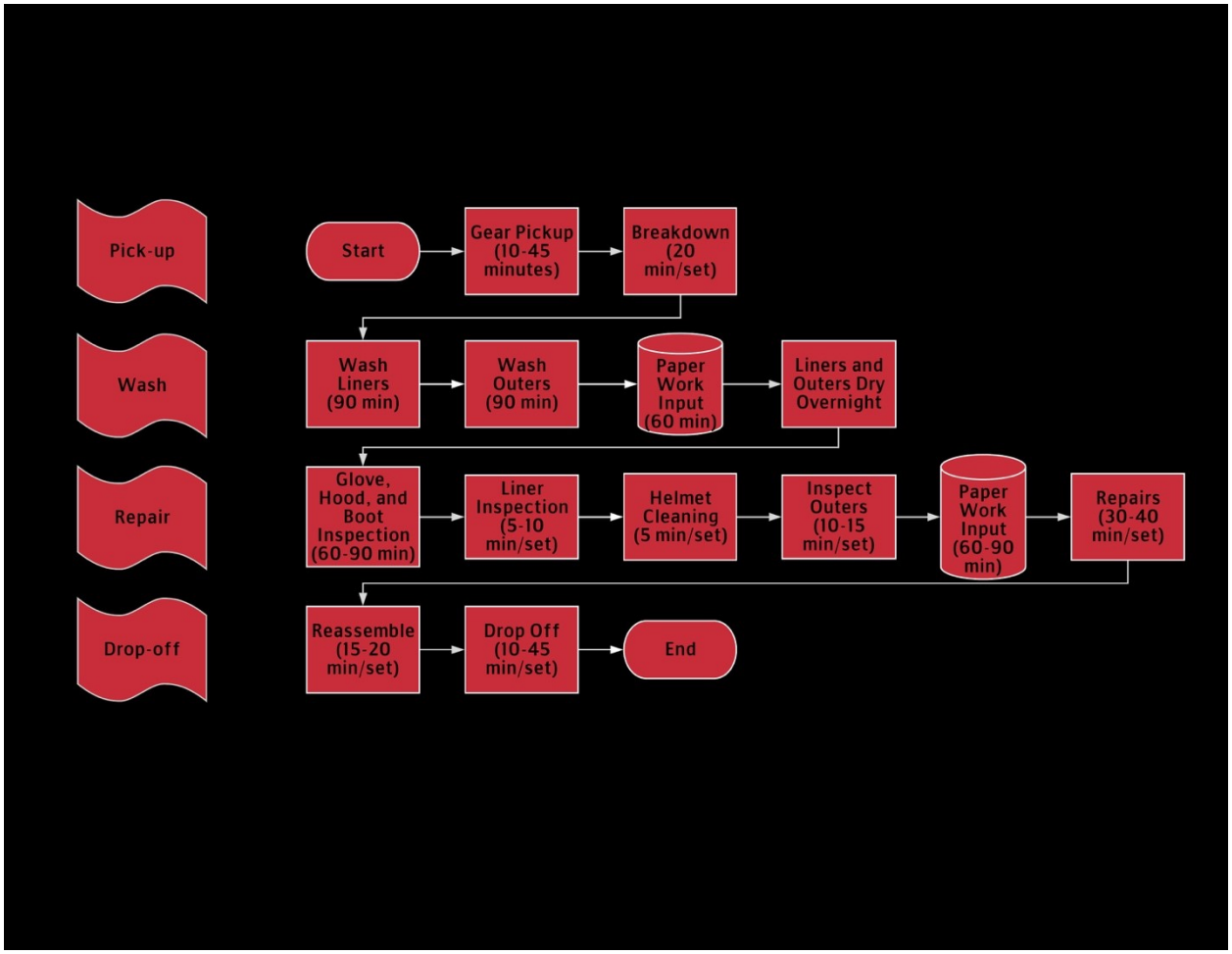

Pick-up
Wash
Repair
Drop-off
Start
Gear Pickup (10-45 minutes)
Breakdown (20 min/set)
Wash Liners (90 min)
Wash Outers (90 min)
Paper Work Input (60 min)
Liners and Outers Dry Overnight
Glove, Hood, and Boot Inspection (60-90 min)
Liner Inspection (5-10 min/set)
Helmet Cleaning (5 min/set)
Inspect Outers (10-15 min/set)
Paper Work Input (60-90 min)
Repairs (30-40 min/set)
Reassemble (15-20 min/set)
Drop Off (10-45 min/set)
End

Exhibit 3.1

	Quality	Availability	Flexibility	Normalized values			Vector
Quality	1.00	4.00	1.00	0.444	0.444	0.444	0.444
Availability	0.25	1.00	0.25	0.111	0.111	0.111	0.111
Flexibility	1.00	4.00	1.00	0.444	0.444	0.444	0.444
sum	2.25	9.00	2.25	1.000	1.000	1.000	1.000

Quality	Central	Local	Regional	Normalized values			Vector
Central	1.00	4.00	1.00	0.444	0.444	0.444	0.444
Local	0.25	1.00	0.25	0.111	0.111	0.111	0.111
Regional	1.00	4.00	1.00	0.444	0.444	0.444	0.444
sum	2.25	9.00	2.25	1.000	1.000	1.000	1.000

Availability	Central	Local	Regional	Normalized values			Vector
Central	1.00	0.20	0.33	0.111	0.131	0.076	0.106
Local	5.00	1.00	3.00	0.556	0.654	0.693	0.634
Regional	3.00	0.33	1.00	0.333	0.216	0.231	0.260
sum	9.00	1.53	4.33	1.000	1.000	1.000	1.000

Flexibility	Central	Local	Regional	Normalized values			Vector
Central	1.00	0.20	0.33	0.111	0.118	0.099	0.109
Local	5.00	1.00	2.00	0.556	0.588	0.601	0.581
Regional	3.00	0.50	1.00	0.333	0.294	0.300	0.309
sum	9.00	1.70	3.33	1.000	1.000	1.000	1.000

Benfit Solution

	Quality	Delivery	Flexibility	Attributes	Solution
Central	0.444	0.106	0.109	0.444	0.258
Local	0.111	0.634	0.581	0.111	0.378
Regional	0.444	0.260	0.309	0.444	0.364

Cost		Cost		Cost	Benefit	Benefit /Cost
	Central	$ 331,200	Central	0.190	0.258	1.357
	Local	$ 1,035,100	Local	0.594	0.378	0.637
	Regional	$ 375,900	Regional	0.216	0.364	1.686
	Sum	$ 1,742,200.00		1.00	1.00	

Exhibit 3.2

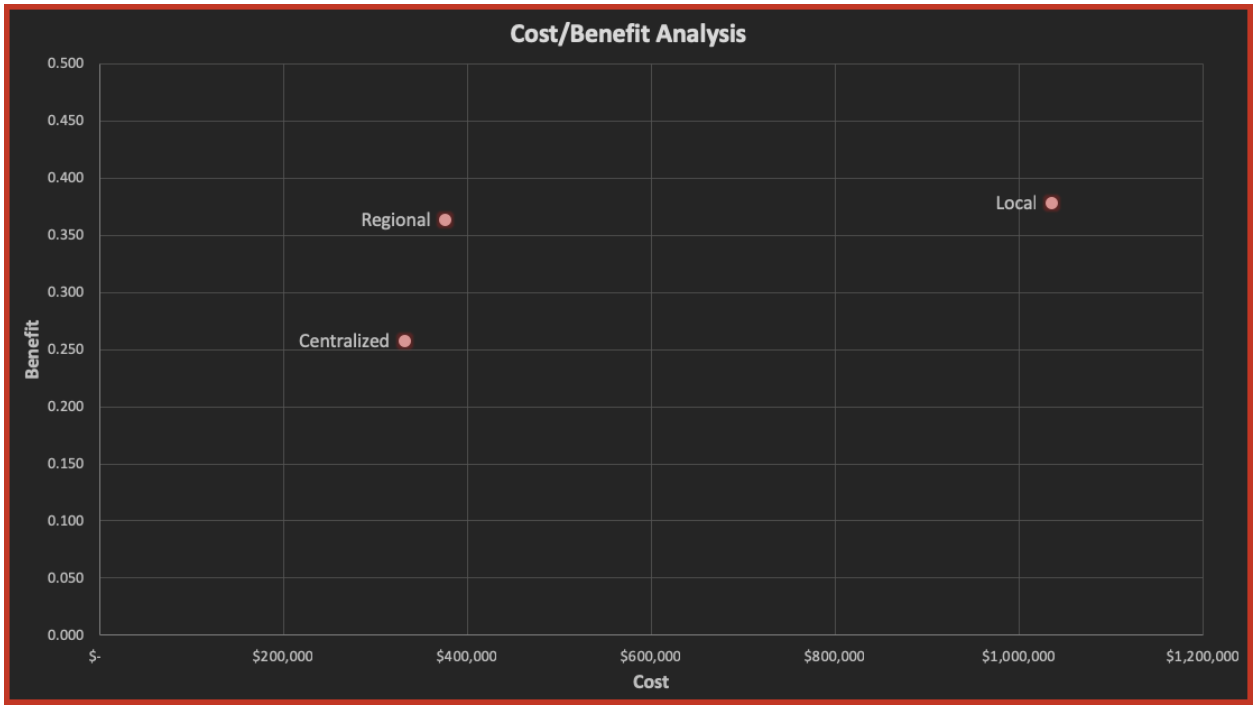

Cost/Benefit Analysis
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Benefit
Regional
Local
Centralized
$-
$200,000
$400,000
$600,000
$800,000
$1,000,000
$1,200,000
Cost

Exhibit 4

CoG Analysis for Fort Worth Fire Departmnet Extractor Placement

	Locations	Lat	Long	Station Personnel	Constant	F * G	Weighted Lat	Weighted Long
Region 1	Sation 30	32.707539	-97.437561	12	1.00	12.00	392.49047	-1169.25073
	Sation 8	32.732935	-97.347198	24	1.00	24.00	785.59044	-2336.33275
	Sation 21	32.696082	-97.367422	24	1.00	24.00	784.70597	-2336.81813
	Station 29	32.650451	-97.361264	12	1.00	12.00	391.80541	-1168.33517
	Sation 36	32.627861	-97.400894	12	1.00	12.00	391.53433	-1168.81073
	Sation 26	32.6568	-97.395511	24	1.00	24.00	783.76320	-2337.49226
	Sation 39	32.663198	-97.424983	12	1.00	12.00	391.95838	-1169.09980
	Sation 5	32.730672	-97.318949	12	1.00	12.00	392.76806	-1167.82739
	Sation 10	32.703526	-97.331276	12	1.00	12.00	392.44231	-1167.97531
	Sation 17	32.68	-97.32	24	1.00	24.00	784.32000	-2335.68000
	Sation 28	32.62714	-97.309888	12	1.00	12.00	391.52568	-1167.71866
	Sation 4	32.708098	-97.299089	12	1.00	12.00	392.49718	-1167.58907
	Sation 14	32.743811	-97.286769	24	1.00	24.00	785.85146	-2334.88246
	Sation 20	32.764737	-97.241117	12	1.00	12.00	393.17684	-1166.89340
	Sation 7	32.766168	-97.190485	12	1.00	12.00	393.19402	-1166.28582
	Sation 27	32.801716	-97.182178	12	1.00	12.00	393.62059	-1166.18614
	Sation 33	32.81871	-97.049658	12	1.00	12.00	393.82452	-1164.59590
	Sation 24	32.73431	-97.218914	24	1.00	24.00	785.62344	-2333.25394
	Sation 3	32.72086	-97.254084	12	1.00	12.00	392.65032	-1167.04901
	Sation 22	32.699203	-97.251404	12	1.00	12.00	392.39044	-1167.01685
	Region Total				20.00	312.00	10206	-30359
	RESULT	1513 Glen Garden Dr. , Fort Worth, TX 76104				CoG Location	32.71068	-97.30479

	Locations	Lat	Long	Station Personnel	Constant	F * G	Weighted Lat	Weighted Long
Region 2	Station 32	32.75954	-97.50118	12	1.00	12.00	393.11448	-1170.01416
	Staion 1	32.758715	-97.329126	24	1.00	24.00	786.20916	-2335.89902
	Sation 12	32.784508	-97.359406	24	1.00	24.00	786.82819	-2336.62574
	Station 6	32.757386	-97.361002	12	1.00	12.00	393.08863	-1168.33202
	Sation 19	32.784733	-97.308255	12	1.00	12.00	393.41680	-1167.69906
	Sation 25	32.827049	-97.35652	12	1.00	12.00	393.92459	-1168.27824
	Station 23	32.727145	-97.468975	24	1.00	24.00	785.45148	-2339.25540
	Sation 16	32.728286	-97.41223	24	1.00	24.00	785.47886	-2337.89352
	Sation 18	32.740964	-97.38545	12	1.00	12.00	392.89157	-1168.62540
	Station 2	32.748519	-97.33522	24	1.00	24.00	785.96446	-2336.04528
	Sation 15	32.803041	-97.383845	12	1.00	12.00	393.63649	-1168.60614
	Sation 44	32.815696	-97.355986	12	1.00	12.00	393.78835	-1168.27183
	Sation 9	32.825975	-97.309874	12	1.00	12.00	393.91170	-1167.71849
	Sation 13	32.831359	-97.421305	12	1.00	12.00	393.97631	-1169.05566
	Sation 31	32.867148	-97.292421	12	1.00	12.00	394.40578	-1167.50905
	Sation 40	32.878868	-97.426795	12	1.00	12.00	394.54642	-1169.12154
	Sation 37	32.924125	-97.281996	12	1.00	12.00	395.08950	-1167.38395
	Sation 41	32.936567	-97.391486	12	1.00	12.00	395.23880	-1168.69783
	Sation 38	32.971218	-97.263143	24	1.00	24.00	791.30923	-2334.31543
	Sation 35	32.982739	-97.310369	12	1.00	12.00	395.79287	-1167.72443
	Sation 13	33.033076	-97.324743	12	1.00	12.00	396.39691	-1167.89692
	Station 7	32.987017	-97.388421	12	1.00	12.00	395.84420	-1168.66105
	Region Total				22.00	336.00	11030	-32714
	RESULT	7401 Lazy Spur Boulevard, Fort Worth, TX 76131				CoG Location	32.82829	-97.36199

Exhibit 5.1

				Current		
				Personnel	2	
		Scheduled sets of Gear Washed Annually			1000	
			Workable days per year		188	
Workable Weeks for PPE Gear Personnel (2,400 minutes per Week)						
					Weeks	Minutes
Workable possible weeks in a year per PPE Gear Personnel					52	124,800
Vacation weeks in a year per PPE Gear Personnel					2	4,800
Project sick/family illness weeks in a year per PPE Gear Personnel					1	2,400
Holliday weeks in a year per PPE Gear Personnel					2	4,800
Projected/Actual work weeks in a year					47	112,800
Total Workable Minutes in a Year						225,600
	Down Time to Clean/Repair PPE Gear in Minutes					
Travel time round trip in minutes per day						120
Breakdown Time per set in minutes						20
Repair and Inspection Time per set in minutes						120
Assemble Time per set I minutes						20
Wash Time per day in minutes						180
Paper Work and Filing						120
Counter Walk Ins						Variable
Unscheduled Cleaning/Inspection for Fires/Events						NA
	Miscellaneous Infortmation					
Total Wash time per year						33,840
Total Travel Tme per year						22,560
Total Breakdown time per year						20,000
Total Repair and Inspection time per year						120,000
Total Assemble time per year						20,000
Total Counter Walk In time per year						NA
Unscheduled Cleaning/Inspection for Fires/Events per year						NA
Total Turn-around Time per year in minutes						216,400
Balance of workable minutes in a year						9,200

Exhibit 5.2

Regional Method W/O Predicted Variability		
Personnel	3	
Scheduled sets of Gear Washed Annually	1000	
Workable days per year	188	
Gear Repaired Annually	500	
Per Location		
	Week	Minutes
Workable possible weeks in a year per PPE Gear Personnel	52	124,800
Vacation weeks in a year per PPE Gear Personnel	2	4,800
Project sick/family illness weeks in a year per PPE Gear Personnel	1	2,400
Holliday weeks in a year per PPE Gear Personnel	2	4,800
Projected/Actual work weeks in a year	47	112,800
Total Workable Minutes in a Year		338,400
Travel time round trip in minutes per day		120
Breakdown Time per set in minutes		20
Repair and Inspection Time per set in minutes		120
Assemble Time per set I minutes		20
Wash Time per day in minutes		180
Paper Work and Filing		120
Counter Walk Ins		Variable
Unscheduled Cleaning/Inspection for Fires/Events		Variable
Total Wash time per year		33,840
Total Travel Tme per year		22,560
Total Breakdown time per year		20,000
Total Repair and Inspection time per year		60,000
Total Assemble time per year		20,000
Total Counter Walk In time per year		NA
Unscheduled Cleaning/Inspection for Fires/Events per year		NA
Total Turn-around Time per year in minutes		156,400
Balance of workable minutes in a year		182,000
"What if" scenario with 2 personnel		69,200

Exhibit 5.3

Regional Method W Predicted Variability						
				Personnel	3	
		Scheduled sets of Gear Washed Annually			1000	
			Workable days per year		188	
			Gear Repaired Annually		500	
			Walk Ins Prediction annually		150	
			Fire/Event Prediction annually		150	
				Per Location		
					Week	Minutes
Workable possible weeks in a year per PPE Gear Personnel					52	124,800
Vacation weeks in a year per PPE Gear Personnel					2	4,800
Project sick/family illness weeks in a year per PPE Gear Personnel					1	2,400
Holliday weeks in a year per PPE Gear Personnel					2	4,800
Projected/Actual work weeks in a year					47	112,800
Total Workable Minutes in a Year						338,400
Travel time round trip in minutes per day						120
Breakdown Time per set in minutes						20
Repair and Inspection Time per set in minutes						120
Assemble Time per set I minutes						20
Wash Time per day in minutes						180
Paper Work and Filing						120
Counter Walk Ins						280
Unscheduled Cleaning/Inspection for Fires/Events						340
Total Wash time per year						33,840
Total Travel Tme per year						22,560
Total Breakdown time per year						20,000
Total Repair and Inspection time per year						60,000
Total Assemble time per year						20,000
Total Counter Walk In time per year						42,000
Unscheduled Cleaning/Inspection for Fires/Events per year						51,000
Total Turn-around Time per year in minutes						249,400
Balance of workable minutes in a year						89,000
			"What if" scenario with 2 personnel			(23,800)

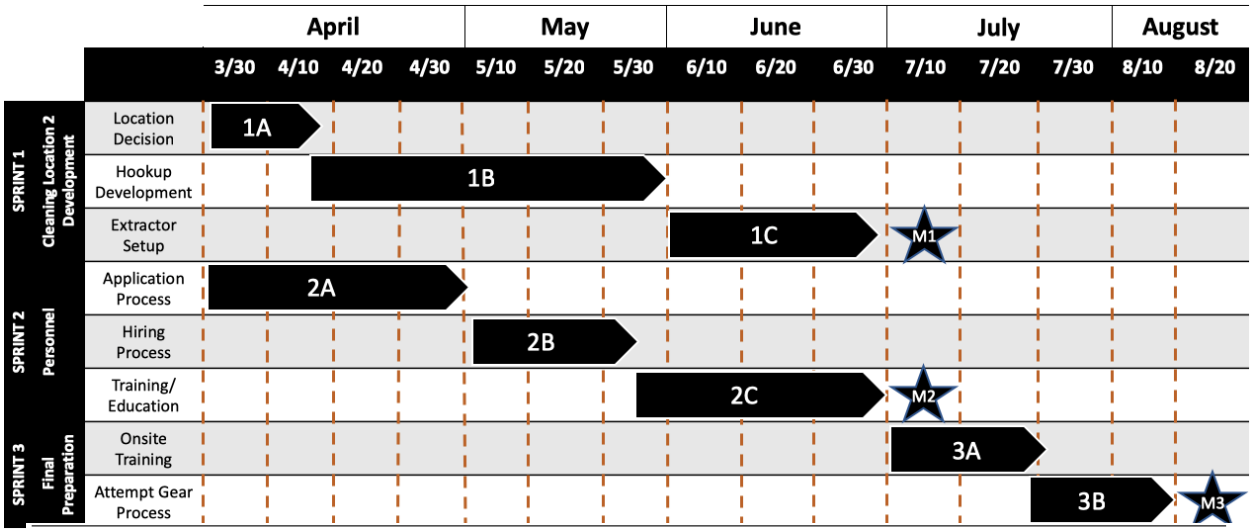
Exhibit 5.4

Stations
42

Pricing Components		Price	Additional Info
Large Extractor	$	24,000.00	Low maintenance
Small Extractor	$	12,000.00	Low maintenance
Pump for Chemicals	$	700.00	One time purchase
Citrosqueeze (55 gal drum)	$	1,200.00	3 month supply
Car costs	$	30,000.00	
Develop Building Hookup (Large)	$	20,000.00	
Develop Building Hookup (Small)	$	10,000.00	
Cleaner	$	60,000.00	
Seemstress	$	60,000.00	

Centralized Total Cost	Local Total Cost	Regional Total Cost
$331,200.00	$1,035,100.00	$375,900.00

Exhibit 6



MILESTONES:

M1 – Finalize Extractor Location Development
M2 – New Employees Hired and Trained
M3 – Ready to be Fully Operational