Regulatory Fire Inspection Program for El Benemérito Cuerpo de Bomberos de Costa Rica, Unidad de Ingeniería, San José, Costa Rica

Michelle Acevedo, Heather Bartlett, Serhan Delareyna, and Tom Washburn

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This Interactive Qualifying Project Report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the opinions of the Benemérito Cuerpo de Bomberos de Costa Rica or Worcester Polytechnic Institute.

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Abstract

The Benemérito Cuerpo de Bomberos de Costa Rica's (CBCR) current voluntary fire inspection program of public buildings is not sustainable. The program is unable to meet the goal of ensuring all buildings are adequately protected against fires. We developed a framework for a regulatory fire inspection program for CBCR based upon international best practices and CBCR's current resources. We recommended that CBCR add a diagnostics team to their organizational structure, the Access database we created to systematize their records, and an educational component for both citizens and CBCR staff. We also suggested that they collaborate with the Ministry of Health to improve enforcement, thereby increasing prevention measures and potentially saving more Costa Rican lives.

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Executive Summary

Introduction

A lack of fire prevention can be detrimental to buildings and surrounding properties and most significantly to its occupants. When adequately implemented and enforced, fire prevention programs are meant to prevent and deter the start or spreading of fires. An absence of these preventative measures can put people at risk of imminent danger.

Over the past ten years, Costa Rica has had a steady increase in structural fires, in some cases so severe that the fires have led to multiple deaths. In order to decrease the despair caused by these fires, prevention mechanisms need to be implemented and verified to be working. Unless an owner requests a fire inspection, the country's current voluntary fire inspection program does not allow fire inspectors to determine if a building is safe,

To reduce the number of fire risks in Costa Rica, the country's national firefighting organization, El Benemérito Cuerpo de Bomberos de Costa Rica (CBCR), has sought to take preventative measures and standardize fire inspections for all buildings. Costa Rica lacks the necessary components of a program to allow the national fire department to inspect properties systematically and efficiently. CBCR's Engineering Department wants to develop a Regulatory Inspection Program that will resolve this issue and increase fire safety. A regulated fire inspection program will allow Costa Rica's firefighters to increase fire safety through the country in a consistent, efficient and improved manner.

Goals, Objectives, Methods

Our goal for this project was to develop a Regulatory Fire Inspection Program that would aid CBCR's Engineering Department in increasing the number of inspections they perform to ensure fire safety, while in turn decreasing the number of structural fires in Costa Rica. We generated three objectives to achieve this goal, as explored below:

Our first objective was to **gain insight into existing regulatory fire prevention programs around the world**. We needed to understand how successful programs from a variety of countries operated in order to propose a sustainable model that has been validated and commended. Our sponsor requested that we investigate information from around the world to develop a well-versed and systematic program while still being operated within Costa Rica's existing laws.

Our second objective was to **gain insight into current Costa Rican inspection techniques used by CBCR's Engineering Department and produce methods by which these techniques can be improved**. For this project, we needed to identify the issues and gaps associated with their current system so as to develop a truly beneficial program. This proposed inspection program needed to be mapped to the Engineering Department's existing structure as well as to CBCR's Legal Code while aligning with the needs and nuances of the Costa Rican community.

Our third and final objective was to **develop a refined regulatory inspection program** so that CBCR can receive a revised and well-functioning model. We wanted to ensure that our proposed model was a viable fit for the Engineering Department and for Costa Rica as a whole. The best way to validate that our program was the right fit for CBCR was by getting feedback from fire-prevention professionals within the CBCR who might be affected by this program and making revisions based on the issues that identified.

Findings

Through our methods of research, interviewing, shadowing, and surveying, we arrived at many findings that allowed us to develop a regulatory inspection program suitable for the CBCR's Engineering Department.

One of the first findings we established was that successfully standardized programs contain four fundamental components. These **essential components include an organizational structure, an educational program, a record-keeping system, and legislative action**. The successful interaction of these components allows a program to be sustainable. The rest of our findings were focused upon how each of these components could be developed within the Engineering Department to manage a standardized system and an increase in workload. This will allow adequately for the Engineering Department's program to be sustainable.

Initially, we found that the Engineering Department would need a position similar to a Fire Marshal because this authoritative role is present in several developed regulatory fire inspection programs. But we concluded that this type of structure would not be feasible within the parameters of current Costa Rican law. **For the organizational structure to work within said parameters, we determined the need for an additional team of inspectors** that would focus on certain regions in different teams and would assist the current organizational structure. In adapting the organizational structure with additional personnel, we determined that these **personnel would need to be trained adequately to regulate inspections.**

We concluded that the Engineering Department's records were not integrated, systematic, or able to handle a large increase in number of inspections. Therefore, **an improved record-keeping system** with easier access to data and the possibility of integrating information collected by different teams would help them handle an increased number of inspections. What about the database system you created for them?
Though most international fire departments have the power to enforce, we learned that CBCR does not have the right to sanction entities in violation of current codes. We thus determined that to develop a more regulated program fit for Costa Rica, **all components must work within the current laws and regulations**.

Lastly, through on-site interviews and surveys, we determined that the value of public education could not be overlooked. We determined that **many citizens lack the knowledge on fire prevention necessary to be capable of understanding the significance of complying with a** regulated inspection program.

Recommendations

Using the information from our findings and the analyses we made, we recommend that CBCR's Engineering Department:

- Create a new Diagnostic Team with regional sub-teams to perform preliminary and basic inspections on public buildings. By creating such a team, the Engineering Department can evaluate more buildings and assess where more detailed inspections are needed.
- Utilize the labor force formula we created. This formula allows the department to calculate the amount of inspector's necessary given the allotted time for these inspections to be completed. Similarly, this formula can also calculate how much time inspections would take given a certain amount of personnel.

- Transfer current records to an improved record-keeping system using a Microsoft Access database we created. This database will promote an efficient and integrated system within the department.
- Create more training programs for new and existing fire inspectors. These programs will expand their knowledge of the evolving regulations and codes of the Law of CBCR.
- Work with CBCR's Department of Education to develop methods such as video tutorials or fire prevention brochures to inform the public on fire prevention.
- Work within the law as a "competent authority" to assist the Ministry of Health in certifying operating permits. This will allow for the Engineering Department to inspect more buildings while strengthening their cohesiveness with the Ministry of Health and keeping an eye on fire safety risks in a regulated manner.
- Use what we have developed as a first step and continue to develop the program in phases over the next few years.
- Ultimately look to gain enforcement power within the Engineering Department by becoming an Authority Having Jurisdiction.

Conclusion

To propose a regulatory inspection program to the CBCR's Engineering Department, we concluded that they needed the four components adapted to their existing structure to improve efficiency and standardize inspections. Our proposal could be the first stage of a regulatory inspection program for Costa Rica and, if implemented correctly, would lay the foundation for a fully enforced, regulated fire inspection program that will decrease destruction and loss of life in Costa Rica

1.0 Introduction

On March 4, 2013 the inaugural soccer game at the National Stadium in San José ended poorly when fireworks were set off from the roof. Despite the warnings from the Bomberos, the fireworks were set off, igniting the roof in flames and endangering the lives of thousands of spectators. The firefighting organization of Costa Rica, Benemérito Cuerpo de Bomberos de Costa Rica (CBCR), took about an hour and 15 minutes to get the fire completely under control (Inside Costa Rica, 2013). Several thousand lives were put in danger that night, but they didn't need to be.

Established in 1865, the Benemérito Cuerpo de Bomberos have been fighting fires such as the National Stadium Fire that plague Costa Rican buildings, leaving behind destruction and a loss of life. Solely waiting to fight fires puts fire fighters and citizens at risk with dependency on response times and resources available at the time of emergency.
CBCR acknowledged this risk and started to focus on the area of fire prevention in addition to firefighting over the past 20 years. The movement of prevention began in 1995 with the creation of an Engineering Department within the organization that completes building plan reviews, voluntary fire inspections and fire investigations.

Even after investing 20 years into fire prevention, the National Stadium fire in 2013 indicates that the Engineering Department still needs to improve. CBCR's Engineering Department currently performs voluntary inspections and this system is problematic as most property owners choose not to have their property inspected. Even if the property owners decided to request inspections, CBCR currently does not have the capacity to inspect all the properties in Costa Rica, which creates a need to improve the current system and regulate fire inspections. Records collected by the Engineering Department indicate that in 2013 there were 1,077 reported fires within the country, which was an increase of 14.3% since 2009 (Bomberos, Publicaciones, 2014). These fires victimized 1544 people and 25% of these victims were minors (Bomberos, Publicaciones, 2014). Of these destructive fires, 76.2% were considered accidental. These shocking fire statistics and incidents such as the White Elephant Stadium fire indicate to the Engineering Department that their current voluntary inspection program is ineffective and inspections need to be regulated.

Currently the Engineering Department only complete inspections on existing buildings upon request or when designated by the Authority Having Jurisdiction. However, if the Engineering Department is to follow Chapter 3, Article 13 of the Law of Bomberos, where they are obligated to prevent fire related emergencies, the organization will need to begin regulating inspections. In the case of the National Stadium fire, the stadium did not have adequate fire prevention systems recommended by CBCR (U. Cornejo, personal interview, April 15, 2015) nor did the authorities or the stadium managers listen to the Engineering Department's cautions against launching fireworks from the roof. Without a more regulated inspection program buildings such as the stadium still may never have the protection needed. Through creating regulatory or standardized fire inspection, the Engineering Department will be able to meet their goal of bettering and preserving the country's fire safety (Bomberos, Nosotros, 2014).

In order to regulate inspections, the organization needed a standardized way to conduct inspections and communicate with the Authority Having Jurisdiction to require buildings owners to make the appropriate changes. Our team filled this gap by initiating a design for a regulatory fire inspection program model to propose to the Engineering Department. This program is hoped to be fully complete in two to three years (A. Solis Delgado, personal communication, March 16, 2015).

The design for the regulatory fire inspection program contains recommendations for four components: an organizational structure that contains a diagnostic team, a record keeping system to improve efficiency, an educational and training program for inspections and fire prevention, and a legislative procedure to work more efficiently with the Authorities Having Jurisdiction. All components must be created and adapted to the current Bomberos Law. By developing a program containing all of these components, the Engineering Department will be able to utilize their skills and knowledge to eliminate fire emergencies before they begin. In completing this investigation work prior to a fire event, countless lives and property will be saved.

2.0 The Foundation for a Sustainable Regulatory Fire Prevention Program

This chapter will begin with a brief overview of the need for fire prevention within Costa Rica and establish the history and geographical context that lead to this need. We will then provide a summary of the events in Costa Rica that stressed the significance of fire prevention, and provide significant dates that show the relevant steps taken by El Benemérito Cuerpo de Bomberos de Costa Rica (CBCR) to address fire prevention. We will continue by establishing and discussing the four components of a regulatory fire inspection program that are seen throughout developed regulatory fire inspection programs in the United States of America and internationally. We will conclude by introducing the steps that still need to be taken by the CBCR's Engineering Department to move into an improved regulatory inspection model that includes the four components and accounts for the specific needs of Costa Rica.

2.1 A History of Fire Prevention in Costa Rica

> "Changes within fire code or protection-based standards are often motivated by tragedy."
>
> ~Kristen Bates, Senior Fire Protection Engineer at the National Fire Protection Association (Interview 1-26-14)

Costa Rica's fire history influences the fire officials to improve the existing fire prevention methods. A large portion of damages caused by fire in Costa Rica is due to the lack of adequate safety precautions. It can be understood why there is an immediate need to improve fire prevention by reviewing past fire events and the current lack of fire safety in the buildings. An example of this lack of fire safety can be seen through the San Juan De Dios Hospital in San Jose. This large central hospital in San José only has fire protection systems in half of the hospital. If there is a fire in that hospital, all 7 fire stations within the city of San José have to respond to protect this high risk occupancy building in such a central area of the city. Currently

this building's condition has not been abated because the present inspection program of the Engineering Department is not regulated (H. Morales, personal communication, March 19, 2015).

The CBCR is the organization that deals with fire incidents. The organization focuses on "Helping, bettering and preserving the country through selflessness, honor, and discipline." The organization prides itself in working as a team to execute fire safety activities (Bomberos Nosotros, 2014). To have a better sense of the organization, it can be compared to any fire department in the United States in the state level, such as California Department of Forestry and Fire Protection.

Although the organization has been around for 150 years, fire *prevention* was not introduced to the CBCR until the 1990s. Costa Rica did not require the installation of fire prevention systems in new buildings until 1994 (A. Solis Delgado, U. Cornejo, personal communication, March 16, 2015, March 23, 2015). In 2005, the CBCR took further steps to develop their fire prevention methods by adopting the National Fire Protection Association (NFPA) codes as a standard to provide adequate fire prevention in buildings. However, there is no way of knowing whether these prevention standards are implemented in all buildings because the Engineering Department's current organizational structure does not support the inspection of all buildings.

This implementation issue can be seen through a popular children's museum in San Jose known as the Museo de Los Ninos. Museo de Los Ninos was inaugurated in 1994 as part of the Costa Rican Center of Science and Culture and annually has estimated 290,000 children visitors. Shockingly, despite the large number of visitors, the building had no fire prevention systems until last year. Finally in 2014, ten years after the NFPA requirements for fire prevention systems were adopted, the museum obtained some level of fire prevention. They acquired this fire prevention through the voluntary involvement of the Engineering Department. However, the Engineering Department cannot volunteer to inspect every single building of Costa Rica with the current fire prevention program. Furthermore, installing fire prevention systems in buildings such as a children museum or hospital where large amount of people gather should not be left to the building owner's discretion.

To inspect all buildings and verify that fire prevention systems are present, the Engineering Department needs to expand their organization, improve record keeping capabilities, educate fire personnel as well as the public, and do all of this within the current legal powers of CBCR. With the improvement or addition of all these elements, the Engineering Department will have started the development of a regulated inspection program.

2.2 Existing Operational Structure of the Benemérito Cuerpo de Bomberos de Costa Rica

This project was housed within the Engineering Department of the Benemérito Cuerpo de Bomberos, the department that deals with fire prevention in Costa Rica. To propose a sustainable and regulated inspection program for the organization, it is important to understand the current operational structure of this department. Currently, there are four different teams working under this department: Building Plans Revision Team, Risk Evaluation Team, Systems Testing Team, and Fire Investigations Team.

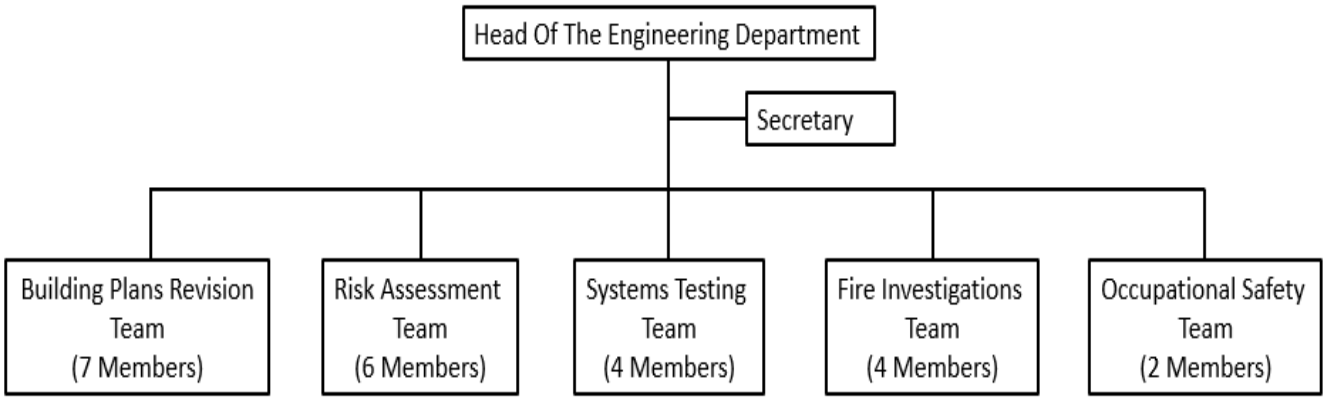

Figure 1: CBCR's existing organizational structure

The Building Plans Revision Team, a team of seven engineers, reviews the plans for new buildings. They do not examine existing buildings, but rather analyze the plans for buildings to be constructed. In 2014 this team reviewed 4566 building plans of soon-to-be constructed properties. Additional attention was given to 200 of these plans because they posed high risks. This team also performs on-site inspections when they see fit. In 2014, this team performed on-site inspections for 80 out of the 4566 building plans the team reviewed. This team decides which buildings they will go to inspect on-site based on the building type and occupancy. They focus on inspecting public buildings that pose the most risk to the public. The buildings that they inspect include health care facilities, malls and hotels. This team does not have the authority to enforce any changes or punishments. This is to say that compliance with their recommendations is not obligatory. For example, of the 80 buildings inspected in 2014, 70 did not make the changes requested by this team (R. Leiva, personal communication, March 20, 2015). If they notice serious issues, the Building Plans Revision Team can refer the situation to Authorities Having Jurisdiction, such as the Department of Health and hope these authorities will take action (R. Leiva, personal communication, March 20, 2015).

The Risk Assessment Team consists of six members, all of who are located in the headquarters of the engineering department in San José. They mostly work on public properties like hospitals, industrial facilities, and schools. This team examines general fire risk factors in a building, such as functional exits, egress, windows and other constraints within the building with regards to fire protection. The Risk Evaluation team bases its inspections off of several NFPA standards[1] (F. Bermudez, personal communication, March 20, 2015). All of the work done by this team is upon voluntary request of the building owner and the team has no authority to demand compliance from business owners. The team can also perform inspections upon request of the Ministry of Health. The engineering department charges the building owners $40/hr. for the time it takes to complete the inspection and $40/hr. for the time it takes the inspector to write up the report. The prices mentioned above are less expensive than getting inspection recommendations from a private contractor, because the Engineering Department encourages inspections to be made. It is optional for the property owners to implement the recommendations suggested by this

[1] These NFPA Standards Include 1, 10, 13, 14, 20, 22, 24, 25, 30, 54,58, 70, 72, 101, 600, 704, 780 and 1600

team. However, if the Ministry of Health requests the inspection, they will require the owners of the building to comply with the recommendations in the report prepared by the Engineering Department. The Ministry of Health only requires owners to have these inspections if they notice, during their own inspection, that a building poses an extreme danger. The Risk Assessment Team oversees approximately 150 inspections a year, but about 80-85% of those business owners do not move forward with the inspectors' recommendations (F. Bermudez, personal communication, March 20, 2015).

The Systems Testing Team checks the sprinklers and automatic fire protection systems in buildings. This team consists of four members, and all of these members are located in San José in the engineering department. Similar to the Risk Evaluation Team, this team only performs inspections upon voluntary request of the building owners. There is a fee associated with the inspection although it is significantly higher compared to the risk assessment inspections at $1,000. The high cost of inspections motivates the building owners to comply more frequently with the recommendations of the Engineering Department, even though implementation is voluntary. (U. Cornejo, personal communication, March 19, 2015).

The Fire Investigations Team investigates the causes and sources of fires that have occurred. As the team only consists of four members, they are not able to investigate all fires. The team works in pairs for each investigation. They travel to any fires that result in injuries or casualties, and they also go to the scene if requested by the police. There are only four members of the investigation team for the entire country, therefore investigating outside of San José is time consuming. Since the focus of our project is to prevent fires rather than investigate them after they happen, less focus will be given to this team. However, this team can provide useful information to the Risk Evaluation Team about the most frequent causes of fire, so that the Risk Evaluation Team can adapt their inspections accordingly (H. Morales, personal communication, March 19, 2015).

While the structure of the engineering department is adequate for voluntary inspections, the structure lacks aspects of four key components seen internationally in developed regulatory fire inspection programs. The need for this project is to identify the aspects that the Engineering Department are lacking in order to move the organization towards regulated inspections. These aspects include improved record keeping systems, organizational structure, education programs, and legislation properties. In the next section, we will discuss the different programs that exist internationally and provide details of the aspects necessary from these four supporting components that all of these programs entail.

2.3 Key Components of a Developed Regulatory Fire Inspection Program

In this section, our team explores globally existing regulatory fire inspection programs. Using a combination of research and journal articles, inspection handbooks, and interviews, we provide detailed information on the four components of a successful regulatory fire inspection program accepted globally: Organizational Structure, Education and Training, Record Keeping and Legislation. We also provide an overview of how each of these components differ by countries, and sometimes even at a department level within a country. This information, tailored to the research in Costa Rica, will provide possible models for components of a regulatory fire inspection program for Costa Rica.

2.3.1 Organizational Structure

Fire Inspector and Fire Marshal positions are widely accepted around the world as the foundation of regulatory fire inspection programs. In this subsection, we explore the positions established by the NFPA and FPA.

The NFPA Fire Marshal method is widely accepted within the United States, but is modified to meet the needs of each individual department. The major difference in the Fire Marshal framework is the organizational structure of the Fire Marshal's Office. This structure can vary state-to-state (NFPA Handbook, page 1-82, 2014). Our team used this information to acknowledge that there is no set perfect structure, but rather there are options that can be chosen depending on the available resources and legislation in Costa Rica.

There are three important positions that are part of the organizational structures defined by the NFPA: **1)** Fire Inspector[2], 2) Fire Investigator[3], and 3) Fire Marshal[4]. The first two are discussed and compared below because they are the two positions most applicable to the Costa Rica, followed by an explanation of where the position of Fire Marshal fits in. According to the information provided by the United States Department of Labor, a fire inspector examines buildings to detect fire hazards and ensure that federal, state, and local fire codes are met. The same source also states that a fire investigator determines the origin and cause of fires and explosions. A major difference between an inspector and an investigator is that a fire inspector analyzes the scene *before* any incident happens, and a fire investigator analyzes the scene *after* an incident has happened. While these positions have an important underlying difference, they assist each other through their differences. The fire investigator collects past data to help the fire inspector identify areas to focus on when inspecting. In certain organizational structures, they work on the same team to maintain good communication (Bureau of Labor Statistics, 2014).

A Fire Marshal is the entity that oversees both of these positions. Usually, fire investigators and fire inspectors report to a Fire Marshal, who enforces changes suggested during inspections and manages the legal aspects based on the findings of the fire investigators. According to the NFPA standard, the Fire Marshal will develop and manage the investigation and inspection programs to ensure that all legal mandates and jurisdictional requirements are followed by Fire Investigators and Fire Inspectors (NFPA 1037, standard 5.8.6, 2012). Overall, based on these standards, the Fire Marshal acts as the expert with reference to the code and standards during investigations and inspections, and ensures that the work completed is reviewed and prepared to be used, if needed, by a legislator, in a court of law (NFPA 1037, standard 5.8.2,3, 2012).

In the United Kingdom, the United States Fire Marshal position translates to Assistant Chief of Fire Safety. They are also called "Enforcing Authority". This position manages the fire prevention program from the headquarters, where the highest levels of experts are located to inspect complex properties. Regional inspectors carry out majority of the inspections and some

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[2] Fire Inspector – Personnel who go to buildings to check for compliance of fire prevention standards.

[3] Fire Investigator – Personnel who inspect the scene of a fire for reasoning's behind the fire happening.

[4] Fire Marshal – An enforcing figure that oversees all the fire preventative actions.

re-inspections can be carried out by the firefighters. Headquarters staff sets the policy to be carried out by the field inspectors, including the frequency of inspection and the training for the inspectors. (Legislation.gov.uk, 2005) (International Concepts in Fire Prevention, 1993)

Canada also has a Fire Marshal position that is outlined in the Fire Safety Act of Canada. The powers and responsibilities of the Fire Marshal in Canada includes promoting practices of fire prevention, managing investigations of fires, making recommendations in the guidelines of fire prevention and enforcing compliance with the regulations in the arena of fire protection and the fire code (Fire Safety Act, 2002).

Given the prevalence of the Fire Marshall position around the world, it would seem obvious to try to import this model into Cost Rica. It is important to note, however, that the structure of Costa Rica's regulatory fire inspection program will be different from the programs in the United Kingdom, Canada and the United States because CBCR does not have the legal authority to enforce inspections. The organization is not given the enforcement authority by the government, nor does it want this authority. Therefore, the structure for the organization needs to be designed to effectively communicate and work alongside the Ministry of Health, who has this authority and thereby serves as the "Authority Having Jurisdiction". In order to design this structure we will use the roles of the Fire Marshal positions discussed above and integrate them into the current structure (without establishing a new position) to help the Engineering Department to take a step towards standardized inspections for the entire country.

2.3.2 Education and Training

Training

Adequate training of the personnel within the program can support an effective regulatory fire inspection program. Through our research, we were able to determine which topics the fire prevention professionals are typically trained in, the timeframe of such trainings, and how the professionals are tested at the end of trainings. The education component of a regulatory fire inspection program varies by country, since every country has its own laws, culture, and unique Authorities Having Jurisdiction. All countries teach incoming inspectors about fire prevention, but requirements and duration of the trainings can vary immensely. In this section we will only provide general information on how educational programs are managed, using the information from the CBCR's Engineering Department, NFPA models, and countries throughout Europe as examples.

New personnel need training in order to be certified to conduct fire inspections properly. This training can be for either inspections based on NFPA codes or other international standards. According to Ken Willette, the Division Manager for Public Fire Protection at NFPA, there are three main ways that the training can be done. The first way is to send new personnel to training programs in another country that uses these standards. The second is for the Fire Department to become certified to teach the standards to new personnel. The third option is to contract out to a certified third party to teach the standards to new personnel (personal communication, February 26, 2015). The questions from the interview with Mr. Willette can be found in Appendix A of this document.

Training in all the researched countries varies in length being anywhere from 15 weeks in Scotland to 2 years in Hungary. Most countries stress on-field training, accompanied by courses

and exams within a training location such as a National Fire Academy. Some training programs researched go beyond new inspector training and also have programs in place to develop experienced inspectors. The UK is one of these countries that contain a program of this type. (Schaenman, July 1993)

Public Education

All the aforementioned components of organization, training of inspectors, record keeping and legislation focus on the internal improvement of the Engineering Department to support a regulatory inspection program. For sustainability, efficiency, and to save money public education has importance around the world. As stressed by the Worcester Fire Department, the education of the society is important in successful fire prevention programs. In order to solve the compliance issues from the root, it is important to create educational programs in the area of fire safety and prevention to promote the importance of fire prevention. NFPA literature also stresses the importance of public education programs on fire prevention as part of the regulatory fire inspection programs. The target audiences seen throughout other countries for these public education outreach programs are children, adults, and other important authorities in the community.

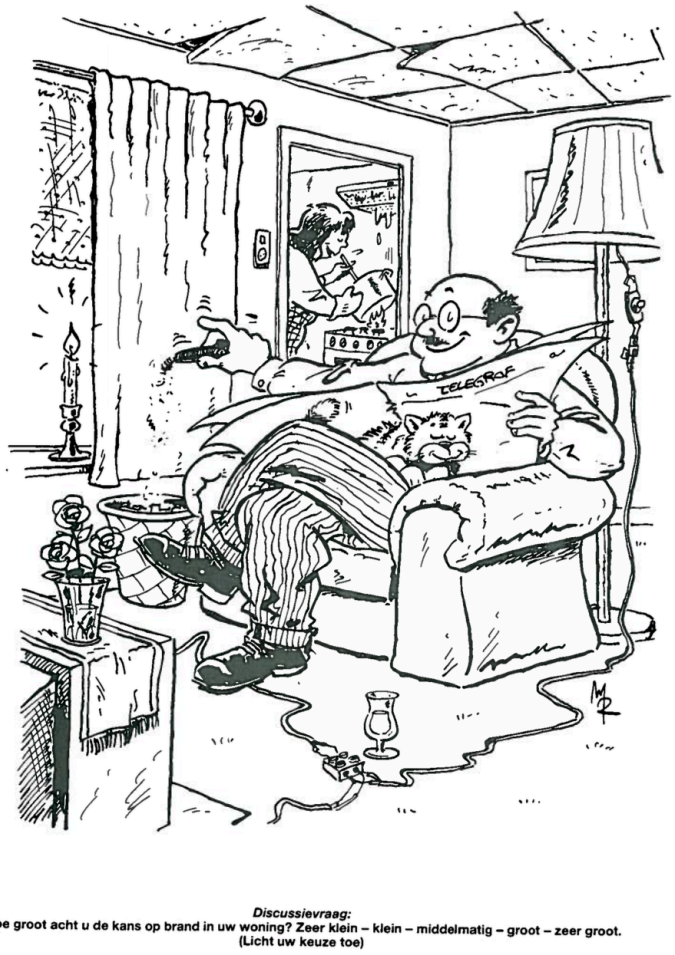

Figure 2: Cartoon used in New Zealand to educate children on fire prevention.

Preschool children, ages 3-5, are the most impressionable ages. Therefore, school fire safety prevention curriculum starts at this young age. Children are taught about fire safety through activities such as practicing "stop, drop, and roll", fire evacuation, cartoon picture books, and visits to fire houses (Schaenman, July 1993). Some examples of these are seen through observing countries such as New Zealand. The cartoon seen is an example of one that children would encounter in school curriculum. As it can be seen, the cartoon depicts a very unsafe fire situation for students to identify the problems with the picture. Around the world programs like this help to develop a generation that will grow up to support fire safety and prevention.

Countries are also shown to educate the adults to promote compliance and lower fire risk, which in turn saves time and money. This is due to inspectors not having to do long and detailed inspections to check for noncompliance as most of the buildings hopefully comply. With

more efficient inspections it takes less time for inspectors to inspect more buildings diminishing the need to hire more personnel, thereby saving money. This education can be seen the around the world often times as a responsibility. The adults are held responsible to make fire safe changes and to teach their children about fire safety. (Schaenman, July 1993)

Around the world there is a focus on educating other important groups within the community in an effort to gain support amongst other authorities. This can be seen to support a sustainable and enforceable regulated inspection program. (Schaenman, July 1993)

Our research of other countries suggests that educating children, adults, and enforcing authorities throughout the community supports a more sustainable program. This more sustainable program in turn increases compliance and not only lowers the number of fires but the inspection times. The decreased inspection times saves money because inspectors can move quicker through buildings dissolving the need for a greater number of inspectors. Ultimately, education adds to the overall goal of a regulatory inspection program, which is *to save lives*.

2.3.3 Record Keeping System

Record keeping is an essential component to a successful regulatory fire inspection program. This section will establish how a record keeping system functions in a successful program and provide some specific technologies and software that are commonly utilized by developed regulatory fire inspection programs throughout the world.

With the investigations, inspections, education, and other tasks implemented by a Fire Marshal and the fire prevention team, record keeping plays an important role. Keeping records on all actions taken by the fire prevention teams is a key component of code administration. These actions include inspections, violation notices, certificates issued, and variances or modifications, and therefore can all be considered as legal documents. In addition to using these records as legal documents, the fire department can use the records Complete and accurate records are needed to assess the effectiveness of existing fire prevention techniques. Using the records the fire department can identify fire risk and compliance patterns, which can help the fire departments' inspectors prioritize what they look for in an inspection The National Fire Protection Agency recommends creating a file for each property, including information regarding the premises and any fire protection related reports. All existing building plans should be included in this file so that they can be easily reviewed prior to inspections.

Computer technology has become increasingly useful as a way to maintain and update records and to create management reports for a regulatory fire inspection program. According to NFPA, the following components are recommended for a management report: "The occupancy inspected, the location, the time of day, the date, and the name of the inspector. The code violations that have been corrected, filed by type and number, and kind of occupancy. The manner in which the fire department used its resources to accomplish fire prevention program objectives" (NFPA Handbook, page 1-89, 2014). The NFPA claims that, "These systems save the inspector time and provide data in a form useful for decision making by operational management. Because they contain a current inventory of occupancies, the systems can provide information for fire protection fiscal and long-range master planning" (NFPA Handbook, page 1-89,2014). Therefore, record-keeping systems can be used in creating systematic methods for decision-making and managing inspections and investigations. For voluntary inspections the

Engineering Department utilizes word, excel, and pdf files to store each team independently. The records are not integrated between teams meaning that records for buildings can be in multiple locations. While this system of record keeping may be adequate for voluntary inspections, the increased amount of inspections when the inspections are standardized will create the need for a new software system.

2.3.4 Legislation

Along with an organizational structure, record keeping system and training component, a regulatory inspection program will need to operate within the Law. Through our research, we have identified trends among legislative processes. Although the legislative processes vary in severity of punishments, they follow a similar framework when confronting noncompliance. In an inspection, the inspector examines the area for any violations that would cause a threat to fire safety. An order is filed in the event that a fire system or prevention device does not meet compliance. An order is a notification to the owner that there is a problem requiring abatement and what the fix will be. Orders can be classified in all different ways such as alterations, enforcement, prohibition notice, or appeals depending on the scope of the problem (gov.uk, 2014). Some factors to consider when giving out the order is the threat the flaw presents, the length of time to fix the problem, the availability of resources and willingness of the owner and fire department to take action, the compliance history and number of people at risk. This will help when determining to what extent the compliance order will be and how many days the owner will be given to fix the problems (Ontario, 1997). If orders are not complied with, the enforcing authority may choose to penalize the property owner. These penalties can include fines or closure, depending on the severity of the case.

Currently, CBCR does not have enforcement authority like other researched fire departments do. If an inspector of the Engineering Department were to notice noncompliance with the Law 8228 of the Assembly of Legislature of the Republic of Costa Rica (Law of CBCR), the inspector is expected to make recommendations for the owner on what fixes should be made. If a property is noncompliant with CBCR's regulations, it is the responsibility of an authority having jurisdiction and not CBCR to enforce that the property reaches compliance and does not risk the safety of its occupants. Therefore, the inspector must forward noncompliance problems to an Authority Having Jurisdiction, which is the Ministry of Health in most cases. The Ministry of Health, as do all other Authorities Having Jurisdiction, has the capability to grant properties with operating licenses, implementation of activities, course of trade, patents, approval of plans and other similar tasks. These properties are to have the technical requirements needed to comply with the provisions of the Law of CBCR (Rica, 2008).

With the existing voluntary system, the Engineering Department can only perform inspections upon the request of a property owner, upon the request of an Authority Having Jurisdiction or when the Engineering Department detects that a building is at high risk and in imminent danger to its occupancy. In the case of an event where they are denied entrance, an inspector of the Engineering Department can become a "competent authority" in order to verify and conduct the necessary inspections at the site of interest. CBCR's Engineering Department is able to become a "competent authority" to ensure that business owners are not withholding properties with fire safety risks from the inspectors. This conversion into becoming a competent authority is outlined in Chapter III, Article 17 of Law 8228 of the Assembly of Legislature of the Republic of Costa Rica (Law of CBCR):

> Artículo 17. —Inspecciones. Para corroborar la adecuada disposición de los medios de detección de incendios indicados en el artículo anterior y el cumplimiento de las reglas de la normalización técnica en la materia, el Cuerpo de Bomberos podrá realizar las inspecciones necesarias en el sitio de interés. Para el procedimiento de verificación, el personal capacitado en la materia pasará a ser autoridad pública.
>
> Si el propietario o encargado del inmueble no permite el ingreso de los inspectores del Cuerpo de Bomberos u obstaculiza la ejecución del procedimiento, la autoridad judicial competente será la encargada de autorizar el ingreso de los inspectores, una vez que se justifiquen las razones o presunciones para ejecutar el procedimiento de verificación.
>
> En una situación específica de emergencia, el personal del Cuerpo de Bomberos, debidamente identificado, sin realizar trámite especial y sin restricción de horario, queda facultado para ingresar a las áreas de las instalaciones, obras, infraestructuras e inmuebles afectados por la emergencia, con el fin de ejecutar las labores necesarias de socorro y salvamento. (Rica, 2008)

A "competent authority" power allows the Engineering Department to verify and conduct the necessary inspections at sites of interest. The above article confirms that this power is available to the Engineering Department. They gain this authoritative power by the approval of an Authority Having Jurisdiction. A judge, the relevant ministry, or the area's municipal office in Costa Rica currently authorizes this power of authority. In the case of an emergency, previously designated members of the Engineering Department are empowered to enter properties in danger in order to implement the necessary relief and rescue.

The Engineering Department can ask the Ministry of Health for help in enforcing compliance or the Ministry of Health can ask the Engineering Department to check a building's compliance. The Ministry of Health may refer business owners to seek aid from Engineering Department after completing a certification check. For example, the Ministry of Health suggested that the Ángeles Custodios children's daycare contact the Engineering Department. In this case, the

business owner reached out to the Engineering Department because they chose to. The Engineering Department came in to inspect the property and provided recommendations on emergency evacuation plans. However, the Engineering Department will not know whether these changes were made to meet compliance because there is a current lack of communication between themselves and the Ministry of Health.

As one can see, there are two ways in how the Engineering Department and the Ministry of Health are supposed to get in contact with one another. As discovered during interviews with inspectors of the Engineering Department, this communication is not always carried out. The Engineering Department has been refraining from contacting the Ministry of Health for enforcement because they would rather avoid the difficulty that comes with the process. On the other hand, the Ministry of Health does not believe they need the Engineering Department's assistance, as they have inspectors themselves (Personal Interview, Solis, 4/24/15). One way of repairing this disjunctive relationship between the two entities is by researching United States' and international legislative processes with regards to fire safety enforcement. By doing this, we will provide the Engineering Department with the knowledge necessary for suggesting solutions for communicating to the Ministry of Health.

2.4 Conclusion

Fire Prevention is a critical matter by which a society can reduce the threat of fires. Firefighter communities around the world try to prevent fires rather than merely fight them. Flagship organizations worldwide show us that the enactment of a Regulatory Fire Inspection Program depends on four components: an Organizational Structure, a Record Keeping System, Education and Training, and Legislation. All of these components are currently embedded within the Engineering Department at some level. The goal of this project will be to create standardized procedures to regulate the fire inspections performed by the Engineering Department. In forming this program, our team will help the Engineering Department improve the fire safety in Costa Rica.

3.0 Methodology

This project developed and proposed a mandated regulatory fire inspection program to assist the Benemérito Cuerpo de Bomberos de Costa Rica's (CBCR) Engineering Department in the field of fire prevention. To achieve this goal, we developed the following objectives:

1) Gain insight into existing regulatory fire prevention programs and fire marshal models around the world.
2) Gain insight into existing techniques used by the Engineering Department and identify methods by which they can be improved.
3) Propose and refine an improved model for the Engineering Department.

In this chapter, we describe the methods that our team developed to address these objectives. The end goal is to initiate long-term (2-3 years) course of action for the Engineering Department to improve safety in public buildings through fire prevention.

3.1 Objective 1: Gain Insight into existing regulatory fire prevention programs and fire marshal models around the world

Our first objective was to understand existing regulatory fire inspection models throughout the world. To address this objective, we researched and reviewed the established programs through literature analysis and identified similarities between them. We compared the written documents and identified the key components that we encountered consistently in every program. This comparison allowed us to divide the regulatory fire inspection program into the four major components that we discussed above: an organizational structure, a record keeping system, an education system, and legislation. Through interviews and research we sought further information on these four components and their applicability in the United States and around the world. The methods we used to investigate each component will be explained in the following sections.

3.1.1 Gaining insight into United States Regulatory Fire Inspection Programs

We studied the United States' National Fire Protection Association (NFPA) to understand how the four components were integrated into its model for a regulatory fire inspection program. We chose the NFPA because they are regarded worldwide as a leader in fire safety regulations. To understand the Fire Marshal model in the United States we researched NFPA codes and standards as well as individual fire department documents. In addition we interviewed experts to further understand these documents and their application in the field.

Organizational Structure

We researched the organizational structures of the regulatory fire inspection programs developed in the United States. This included roles of fire prevention personnel and graphics showing the information flow within the organizational structure. We gained insight on the organizational structure and the roles of a Fire Marshal prior to conducting interviews. We reviewed the NFPA's Handbook as well as the organization's website to find relevant information such as labor force needed in an organizational structure and the dispersal of roles.

No clear record exists of organizational structures in the United States, and the descriptions of the fire marshal's roles are too generalized to be immediately applicable. This generalized information stems from a lack of consistency of organizational structure and fire marshal responsibilities on the state or even city level. We interviewed expert fire personnel to get more specific information on certain departments regarding their organizational structures.

We interviewed three expert fire personnel on this topic. First, we spoke with Steve Sawyer, the Secretary of International Fire Marshal Association, for his knowledge about international structures. We sought information on general aspects of organizational structure and their similarities to international structures. Our interview questions posted to Mr. Sawyer can be found in Appendix B. To get more narrow information on the organizational structure and the roles of an existing department, we interviewed Dan Downes, a Syracuse Fire Department Lieutenant. We chose Lieutenant Downes because he has close to 25 years with his department working a variety of positions. These interview questions can be found in Appendix C.

To obtain a specific departmental example of an organizational structure, we interviewed the Public Education Lieutenant AnneMarie Pickett from the Worcester Fire Prevention Department (WFD). We sought information on specific duties of a fire marshal, fire inspectors, and the

organizational structure in the Worcester Fire Department. These interview questions can be found in Appendix D**.** We then compared these duties with those of the Syracuse Department to identify similarities and differences. We had intentions to go on an inspection with this department, but this was found to be unfeasible due to time constraints. Furthermore, we wanted to interview additional fire departments having similar demographics as Costa Rica. However, we did not hear back from these other departments and time restrictions limited the number of departments we were able to contact.

Education and Training

To understand fire prevention education systems in the U.S. we researched the National Fire Protection Association's criteria for fire inspectors or Fire Marshals[5]. Although the NFPA codes are unified for the U.S. as a whole, there can be differences in the application of the codes within different fire departments. A limitation we discovered through our research was that educational training varied based on jurisdiction and were not formally documented. To obtain this information, we interviewed professionals from two different departments who had expertise in fire safety education.

One of the interviews we conducted was with Ken Willett, a Division Manager for Public Fire Protection at the NFPA. The combination of Mr. Willette's experience working with NFPA standards, his actual experience in the Fire Department, and his experience in training and teaching convinced us that he would be a valuable resource on the topic of training and education. We sought information on the skills and training needed to fulfill the role of a Fire Marshal in the United States.

While Mr. Willette offered fire department training information, we sought public education information from the Worcester Fire Department (WFD). We chose the WFD because we were more familiar with the target population that this department educates. In our interview with the Public Education Lieutenant of the WFD, AnneMarie Pickett, we asked her questions regarding her role in education and outreach. We spoke on the topic of fire safety education within the community. This topic led us to consider utilizing surveys to assess the importance of Costa Rican citizens' perspectives on regulating fire inspections.

Record Keeping

Our team reviewed the NFPA requirements on record keeping in the NFPA 20th-edition handbook to identify, which practices make a successful record keeping system and what information is critical to collect. Since the information in the handbook was clear and extensive, our team did not see the need to spend time conducting interviews about NFPA literature.

Although our team did not utilize interviews to clarify NFPA literature, we looked into the operations of a functioning record keeping program at the Worcester Fire Department by asking questions regarding this matter to Lieutenant Pickett in our interview with her. The questions focused on the record keeping software that Worcester Fire Department uses and their process of creating and maintaining records. Learning that some fire prevention software can be area-

[5] An inspector is the person who completes the on-site inspections. A fire marshal is an overseer of all the inspectors and reviews any reports produced.

specific (as is the case of Massachusetts) we refocused our efforts and researched different technologies to record information from fire inspections that could be manipulated to meet the recording needs of the Engineering Department.

Legislation

Even with a functioning organizational structure, there is a need for a legislative component so that the prospective regulatory program can be effective at communicating with enforcing authorities. We gathered information on existing legislative techniques in the United States' fire prevention programs, as they have established structures behind enforcing non-compliance. As part of our research, we investigated which authorities in the United States have jurisdiction and what the process is for authoritative actions.

In our research, we saw trends between departments on the procedural aspects of enforcement, but noticed that specifics within the systems varied. We focused on the structure and procedures of these systems to provide the Engineering Department with a similar framework to communicate to the enforcing authorities. There is great variation among city-level legislative systems in the United States. For this reason, we chose to examine specific cities that have different aspects to their legislation guidelines. We chose to study the city of Los Angeles, California, as the climate of this location was similar to Costa Rica's. Municipal documentation from this city provided in-depth information on the enforcement procedures behind brush fires. Los Angeles' legislative process was outlined as a step-by-step process that included enforcement penalties and deadlines. While our project is aimed towards the prevention of structural fires and not forest fires, the outlined legislative courses of action in Los Angeles were still applicable for building prevention. The legislative courses of action were applicable because our project intends to solely adapt the United States' legislative frameworks to Costa Rica's current programs as opposed to the United States' legislative content.

Information about Los Angeles' legislative processes provided us with background research and allowed us to create questions on legislation for potential interviews. We chose to meet with Worcester Fire Department because of the city of Worcester is similar to San José in terms of size, in that it is a large city with older buildings throughout. Worcester also has many older buildings, which may have had to be updated in order to reach jurisdictional compliance. These similarities in size and building types would translate well when adopting a legislative model to Costa Rica. In our interview with Lieutenant Pickett, we also asked questions about how lenient the Worcester Fire Department was with enforcement among older properties as the inspectors may or may not take a building's historic value into consideration. Lieutenant Pickett's responses allowed us to instruct the Engineering Department on how to properly and reasonably recommend enforcement penalties to the enforcing authorities. We aimed to integrate the information from this interview into the legislation behind a prospective regulatory fire inspection program in Costa Rica.

The variety of legislative systems among cities in the United States proved challenging in this research, as we did not have time to explore more departments in order to obtain a well-rounded understanding of how a regulated inspection program is enforced. However, the way the United States provides guidelines and how municipalities adopt them to fit their culture provided insight

on the ability to adapt legislative techniques to Costa Rica for the Engineering Department and the enforcing authorities.

3.1.2 Gaining Insight into International Fire Marshal Regulatory Fire Inspection Programs

To gain a broader understanding of developed programs, we focused not solely on the United States but also expanded our literature review to include international systems. We researched government webpages and interviewed individuals familiar with international fire prevention programs. Since Costa Rica's primary language is Spanish and secondary language is English, we limited the focus on the international research to countries that provide documents in these two languages. This section, similar to the previous section, focuses on each component individually by providing the methods we used to gain insight on each component specifically.

Organizational Structure

We obtained information on the international models of successful fire inspectors, through research on a variety of countries. We focused our research on the United Kingdom, Canada, and New Zealand as they all have developed organizational structures that allow them to complete inspections in a timely manner

We chose United Kingdom because it offers an alternative Fire Marshal model to that which exists in the United States. In the United Kingdom, the Fire Marshal and Fire Inspector have different roles compared to the United States. The Fire Marshal is considered the on-field contact for emergency situations rather than an entity focused on prevention, and the inspectors have enforcing authorities that are usually reserved for fire marshals in the United States. This alternative model provided an approach that focuses on fire inspectors for fire prevention rather than the Fire Marshal. Since CBCR would like the roles of the fire inspectors in developed regulatory fire inspection programs to be integrated into their structure, the United Kingdom model provided insight on alternative ways these roles can be integrated.

Education and Training

Our team gathered information on international training and education of Fire Marshals but did not find information that varied from that of the United States. However, through interviews with members of different fire departments we realized the importance of public education, and obtained further information on the elements necessary for educating the public to create a sustainable regulatory fire inspection program. CBCR could use the program to educate Costa Rican citizens. Therefore it is imperative that both citizens and fire prevention personnel are educated regarding fire prevention and how the regulatory fire inspection program will work. The information we sought about public education included education in developing communities, low-income communities, and acceptance to change in cultures that may not be used to these technologies. We intended to use this information to seek for ways the CBCR can utilize public education to improve the outcomes of their prevention program.

As part of our interview with Lieutenant Dan Downes of the Syracuse Fire Department (SFD), we asked about how to implement a program in a developing country because of his experience implementing fire prevention programs in developing communities. Although the interview was focused on the processes and structure of his investigations within the United States, we questioned Lieutenant Downes further on how to implement such a program internationally. He

shared information on how developing countries could be educated using strategies similar to those that the SFD was implementing in low-income neighborhoods of Syracuse. This introduced to us the idea of how a Fire Department can phase in changes to a regulatory fire inspection program to ensure public acceptance and subsequent success of the program. Using a phasing process meant that changes will be made slowly and in a step by step process rather than all at the same time. Since neither Costa Rican citizens nor CBCR's Engineering Department is accustomed to a regulatory fire inspection program, we decided that using a phasing process would produce optimal results for the newly implemented regulatory fire inspection program. This introduction to phasing drove us to revise the interview questions we had developed for fire departments in Costa Rica.

We conducted another interview with Professor Angel Rivera of Worcester Polytechnic Institute's Humanities and Arts Department because he is a native of Puerto Rico, one of the countries our team investigated due to its demographic similarities with Costa Rica. The demographic similarities included the population, natural geography and Latin American culture. Professor Rivera has also previously advised at the Costa Rica Project Center, working with the CBCR. During this interview we focused on the perception of a fire inspector in Latin America, as well as how informed the people of Puerto Rico and Costa Rica are in terms of fire safety and prevention. We used the results from the interview to create a surveying tool to obtain more data regarding Costa Rican public opinion on a regulatory fire inspection program. The interview questions asked of Professor Rivera can be found in Appendix E. Even though demographic similarities presented a basis for creating the surveying tool, we still had a limitation since we based our survey questions on information from a Puerto Rican citizen rather than a Costa Rican national. To overcome this limitation, we reviewed the survey questions with the Engineering Department to ensure that the questions were relevant and worded according to the Costa Rica context.

Record Keeping

Our team reviewed the record keeping processes used internationally by countries having developed regulatory fire inspection programs that indicated a decrease in the overall number of fires. Keeping proper records is often simple, but very time intensive. New Zealand assigns a standardized list of fire protection items to be inspected and recorded by a responsible person. The fire department is then able to go collect this standard set of records and evaluate what buildings need further inspections. We sought to understand how this system saves the fire department time and allows them to make assessments based upon a standardized set of records received from the responsible person. Our team researched how to combine these records with the technology in the United States to further increase record keeping efficiency. The viability of this alternative approach to gathering and maintaining records was determined using the focus group described in section 3.3.1.

Legislation

Acknowledging that other countries enforce regulatory fire inspection programs in ways different than the United States, we investigated international legislative frameworks that the Engineering Department can potentially utilize. The three regions we researched were Canada, Puerto Rico, and the United Kingdom. We were limited to only doing research for these selected regions due to accessibility of contacts within the regions. The international information learned

can be adapted to Costa Rica's current procedures and improve communication between the Engineering Department and enforcing authorities.

We chose to research Canada because it is divided into larger provinces rather than states. This style of division resembles the regional divisions in Costa Rica, with the legislation differing according to provinces. We specifically selected to Ontario's legislation because its provincial government outlined the process officials go through to prosecute a non-compliant property owner.

We explored the United Kingdom's legislative actions because they do not have a standard system similar to other developed regulatory fire inspection programs. Foreseeing that their differences in organizational structure would affect legislative procedures, we chose to investigate this program further. We examined gov.uk, the United Kingdom's official online government webpage, to obtain information on the types of notifications Fire Brigades present to business owners in order to make them aware of their non-compliance. This information from the United Kingdom can be seen as a good indication of how legislative processes are achieved.

Furthermore, we researched government documents pertaining to the Cuerpo de Bomberos de Puerto Rico for structural legislative information. Studying Puerto Rico's fire department is relevant due to similarities with Costa Rican demographics: comparable size and climate as well as shared Latin American culture. We considered the effect of these factors on implementation of legislative action. We examined the punishment process and deadlines for implementation of fire prevention systems.

Through this international research of legislation we obtained options for legislative enforcement to fit varying climates, cultures, building types, and organizational structures.

3.2 Objective 2: Gain Insight and Analysis of Existing Costa Rica Processes

The second objective involved an analysis of the existing methods of the Engineering Department with regards to the four components uncovered in objective 1. This includes gaining insight on (1) the education and training processes, (2) the organizational structure, (3) the legislative enforcement, and (4) the record keeping system that currently exist in Costa Rica. All of these components are essential for ensuring the success of a regulatory fire inspection program. Additionally, we investigated the factors in Costa Rica that can affect these components, including budgetary constraints, legal constraints, and firefighter and citizen perspectives. Our team conducted a focus group with members of the Engineering Department to ensure that any solution provided to the organization was not only rational but also applicable.

Organizational Structure

Our team conducted interviews to understand the organizational structure of the Engineering Department since written documents outlining these roles do not currently exist.

In an interview with a member of the Plans Review team within the Engineering Department, Rolando Leiva Ulate, we sought general information about the organizational structure of the department and each team. We used this general information to create questions for the interviews we conducted following this meeting with the other teams of CBCR's Engineering Department. As Mr. Leiva is part of the Plans Review Team, we sought information on the roles

this team and his thoughts on whether the number of employees in this team were adequate (R. Leiva Ulate, personal communication, March 20, 2015). Questions posed to Mr. Levia can be found in Appendix F.

Similarly, we conducted interviews with team leader of the Risk Evaluation Team, Mr. Francisco Bermundez Solano and the team leader of the Systems Testing Team, Mr. Ulises Cornejo Quintana, to obtain information on the roles of members of these teams and adequacy of the number of employees. These teams performed the voluntary inspections that we were looking to regulate. We sought information on their current employment capabilities in order to perform the resource analysis about any extra employees that these teams would need with the implementation of a regulated program. Questions for the interview with Mr. Bermudez can be found in Appendix G and Mr. Cornejo in Appendix H. in Appendix. In this way we determined how we could optimize the department with the existing teams and with the addition of more employees as the program develops. The resource analysis was important, since changing the organizational structure to increase capacity would include adding employees to the organizational structure, and the resource analysis helped decide the amount of employees to be added to each team in the new structure depending on their roles.

We had a personal conversation with lead investigator Henry Morales Navarro to learn about the responsibilities of a member of the Fire Investigations Team and his thoughts on the current availability of resources. Due to time constraints and the Fire Investigations Team being outside the scope of our project, we found this personal conversation method to be adequate to obtain the aforementioned information that we were looking for.

To explore opinions from different regions in Costa Rica about the perception of a Fire Inspector and a Fire Marshal position in a regulatory fire inspection program, we intended to survey firefighters in Costa Rica. Since we only needed general perspectives from a wide geographical range of firefighters, surveying was the best method to obtain this information. We wanted to determine the percentage of voluntary firefighters versus permanent firefighters to explore options of integrating both into our organizational structure. Although interviews may have provided more detailed information, only a limited number of these stations were accessible from our headquarters in San Jose. We created the survey questions, but due to the complexity of the review procedures mandated by CBCR before distributing the survey to fire departments, we were not able to send out this survey.

Education and Training

To understand the current education and training programs used by the Engineering Department, we conducted several interviews with each team in the engineering department and surveyed some business owners of Costa Rica. Data collected from these surveying tools were used to design a framework of the education and training programs needed for new inspectors and the Costa Rican community.

We interviewed with each of the teams in CBCR's Engineering Department. We decided to conduct both formal and informal interviews with people from these teams because they are the ones who would need to undergo or teach any proposed training. We asked them about requirements they thought necessary for an ideal inspector. They were able to provide us with

information on exactly what type of training, background qualifications, and certifications are needed to work their positions.

In addition to interviewing the teams in CBCR's the Engineering Department, we shadowed the teams in the engineering department on inspections of risk assessment, systems testing, and plans review in different buildings. We did not want to solely depend on information provided in the interviews. Therefore we supported the information from the interviews on how new people would need to be trained by observing the practices of the Engineering Department as they conducted inspections. Since regulated inspections mean an increase in the number of buildings that need to be inspected, new inspectors will be needed to complete these inspections. The inspection processes needed to be uniform across the country in order to ensure that records are standardized for enforcement. Understanding these practices were critical in the development of the training program objectives for new inspectors.

In addition to developing education for the Engineering Department's inspectors, we needed to determine how to better educate the public to improve fire safety. We did this through a five-step process outlined by the NFPA. The first step in the process is a community assessment survey. This was done to gain insight on the demographics that we were reaching out to. We completed this step through surveys given to business owners. The citizens' survey asked questions regarding their thoughts on the current fire situation in the country. This was to gain a perspective on how educated the community was with regard to fire safety and its effects on the country. The reason for citizens' surveys was to understand if the citizens see the urgency behind fire prevention, which would make compliance more likely. Another topic discussed through the citizen survey was the capability for a business owner to comply with a possible regulated inspection in terms of having the budget and time to make changes. Through the surveys we hoped to obtain results on what business owners thought about regulated inspections and gain clarity on the resistance that may be encountered. A copy of this survey can be found in Appendix I. Step two was analyzing the survey results and understanding where the community was most lacking in knowledge or possibly resources. This lead into step three of setting the goals and objectives of educating the public. We got these goals from the identified problems in our survey results. We set goals on how to fix the problems and the objectives behind public education. These goals and objectives were the deliverables from our team to CBCR as we did not have the time to complete the fourth and fifth step of intervention, planning and testing and implementation and evaluation. These steps could not be taken but the goals and objectives left behind should provide information to understand the success of public education and how it applies to the regulatory fire inspection program and where the program should go with public education (NFPA Handbook, pages 5.136, April 23, 2015).

Record Keeping

In order to understand the current record keeping systems being utilized in Costa Rica, we conducted interviews with a member of each of the teams within CBCR's Engineering Department. The interview questions focused mainly on scheduling, the recording tools used to collect the information, information processing, and how records were stored. This allowed us to gauge both the flaws with the current system and set goals for the improved record keeping system.

Informal interviews were conducted with a few members of the Engineering Department who had previously been firefighters. These participants were selected because they were more familiar with the processes and activities at a firehouse compared to those who have not been firefighters. We chose these firefighters rather than the current active firefighters because they possess knowledge of record keeping as both firefighters and as engineering department officers. Costa Rican firefighters explore their district as a way of gaining awareness of the buildings' risk level to prepare for an emergency. We sought to understand if this information gathered by the firefighters while exploring their district could be used as a way of performing basic fire inspections. This would allow CBCR to utilize their existing labor force and identify buildings in need of a more detailed inspection. Our team wanted to learn if the firehouses kept standardized records while exploring their district as well.

The team sought information on how the Engineering Department currently record their observations during inspections, to what detail fire hazards were documented and how this documentation could be used to enforce compliance. Therefore we decided to use shadowing as a method to observe the practices of each team while they were conducting inspections. We accompanied the Risk Assessment Team, the Systems Testing Team and the Plans Review Team on inspections. The team chose this method to support the information gathered through interviews with information collected in the field.

We reviewed existing records to see the type of information being annotated in the existing recording system. We believed that it was important to review how the existing records were kept so that any improvements to the Engineering Department's record keeping system modeled their existing system in as many ways as possible in order make a simple transition. When reviewing these documents, we faced concerns regarding confidentiality. To overcome this challenge, our team asked the head of the team whose documents were being reviewed to identify the confidential documents that should not be used in any public material of this project.

Legislation

Through our research of the United States and international regulatory fire inspection programs, we gained insight on how building compliance is enforced. Although many of these countries worldwide use the Fire Department as their enforcing authority, in Costa Rica, the Engineering Department need to work with a third-party organization with the power to enforce in order to improve compliance. We employed interviews, research, and surveys to understand Costa Rica's unique third party enforcement system.

We individually interviewed each team in the engineering department to understand the existing connection between CBCR and the Authorities Having Jurisdiction. This was meant to illuminate limitations in the current system and show where the department of engineering hoped to see change to better strengthen the relationship between the two parties. We chose to meet with the heads of the teams for each interview, as we thought they had the best understanding of existing practices. We asked questions regarding the frequency in which they contacted the authorities, how difficult it was to connect with the authorities, and what they would want to see in a future relationship between the two entities. This gave us the Engineering Department's perspective behind enforcement and the challenges and desires for the program to be applied to Costa Rica.

We chose to conduct interviews with the enforcing authorities because our departmental interviews suggested considerable interaction between these authorities on issues of compliance. The authorities can include municipalities, the Ministry of Health, and the Ministry of Environment and Energy. We conducted interviews, with the Municipalidad de Belén and performed research on the two ministries. In these interviews, we sought information regarding existing enforcement involvement and how communication between the two parties could be improved. The questions from this interview can be found in Appendix J. We sought to conduct interviews with all possible authorities, but could not due to difficulties in obtaining clearance from CBCR to interview these officials. For example, unfortunately we could not interview the Ministry of Health, the authority most involved with CBCR to obtain compliance; therefore our knowledge is based only upon documented information on how the Ministry of Health operates. We aimed to use this information to ensure implementation of the most sustainable program possible.

3.3 Objective 3: Regulatory Fire Inspection Program Design and Review

Our third objective was to propose an improved design and refine this design continually to produce the best final product. To do this we prepared a preliminary design and used focus groups to have a discussion on the design and refine it appropriately according to the outcomes. In this section we will describe how we utilized the focus groups to obtain information from different perspectives on the components of our regulatory fire inspection program design.

3.3.1 Focus Groups

In order to establish a program that is best suited for Costa Rica, our team created several potential models for each of the four components that would make up the new regulatory fire inspection program. Our team used the focus groups to discuss the pros and cons based on our analysis of each option as a viable solution for the Engineering Department.

The first focus group was made up of the Team Leaders of the Risk Assessment Team, the Systems Testing Team, and the Plans Review Team, as these teams will be most affected by the implementation of a regulatory fire inspection program. It is important to understand these Leaders' opinions on which models would be the most functional to them. This group will be responsible for the management and collection of information from these inspections and ensuring that it is prepared in a way that allows for enforcing authority to take action.

Through a series of separate interviews, the same focus group questions were posed to Alexander Solís Delgado, the Head of the Engineering Department. Through previous interviews with Mr. Solís, our team believed that, as the Head, his opinions could sway the opinions of the Team Leaders in the department. Therefore, he was not included in this focus group.

Our team also had the intention of conducting a focus group made up of the heads of the firehouses within CBCR because these members would have new responsibilities under the new regulatory fire inspection program. This focus group's opinion was critical to understand whether the added roles for the firefighters under the new regulatory fire inspection program were practical according to the resources they had in their regions. However, existing politics within CBCR limited our team's ability to organize this focus group in a timely manner.

The third focus group that our team intended to conduct was made up of Ministerio de Salud, Ministerio de Ambiente, and representatives of different municipalities. These groups are the primary enforcing authorities in Costa Rica. The purpose of this focus group would have been to establish how the groups would work with the Engineering Department's new organizational structure and legislative processes to regulate these inspections. Our team was only able to conduct interviews with the Municipality of Belén and have email correspondence with Municipality of Escazú. The team did not receive replies from other organizations and thus we were unable to conduct this focus group.

3.4 Conclusion

The information from fire inspector models around the world, along with the understanding of Costa Rica laws and regulations, helped us propose a preliminary program design that will suit Costa Rica's needs and reduce the number of fires in Costa Rica by using regulatory measures.

4.0 Results and Analysis

In this chapter, we explore our findings from the research and surveying tools completed in order to meet our objectives. In order to assist the Engineering Department with the development of a regulatory fire inspection program, our team formed following three objectives, as discussed in the previous chapter:

a. Gain insight into existing regulatory fire prevention programs and fire marshal models around the world.
b. Gain insight into existing Costa Rican techniques used by the Engineering Department and identify methods by which they can be improved.
c. Propose and refine an improved model for the Engineering Department.

We will also analyze how this information relates to our four established components and Costa Rica's current system. These results allowed us to develop a preliminary phase of a prospective Regulatory fire inspection program for the Engineering Department.

4.1 Organizational Structure Findings

After our team studied successful organizational structures of developed regulatory fire inspection programs and the current structure of the Engineering Department, we identified three problems to focus on for a proposed organizational structure component. The findings were the following:

a. The current organizational structure lacks an enforcement position.
b. To improve efficacy the new organizational structure needs a geographical component.
c. CBCR's Engineering Department needs to calculate the adequate labor force.

a. The current organizational structure lacks an enforcement position.

The current organizational structure of the Engineering Department does not support a regulatory fire inspection program due to a lack of an enforcement position. We found that successful regulatory fire inspection programs have an enforcement position within their organizational structure that is responsible for ensuring compliance. In the United States and Canada, this

position is called the Fire Marshal, in the United Kingdom it is called the Enforcing Authority, and in Puerto Rico the Director of Prevention. No matter what the name is, this position has responsibilities of managing enforcement of fire safety regulations through inspections. This information below, obtained from NFPA literature, provides general responsibilities of a Fire Marshal:

> "A Fire Marshal's responsibilities can fall into all or some of the following categories: code enforcement, fire prevention inspections, plans review, product approval, fire arson investigation, fire data collection, fire legislation development, fire service training, and public fire and life safety education" (NFPA Handbook, page 1-82, 2014).

Our interviews with the Engineering Department stressed the need for an enforcement position. Mr. Solis Delgado, head of CBCR's Engineering Department, stated that there is no one in the fire department with the ability to enforce regulations. The department must defer to outside organizations such as the Ministry of Health or Ministry of the Environment who have the power to close businesses and give out fines (A. Solis Delgado, 3-16-15). While we found that the Head of the Engineering Department lacks the power to enforce, he does manage voluntary inspections, plan reviews for the new buildings, and investigations that happen after fires. These duties of the Head of the Engineering Department resemble the duties of a Fire Marshal. Under the current organizational structure where only voluntary inspections are being performed, the powers of the Head are sufficient: the Engineering Department does not need an enforcement position. Even if the Engineering Department wanted to have this enforcement, the department does not have the legal authority to give out fines and therefore creating an enforcement position would not work for the Costa Rica context.
If CBCR would like to be able to regulate inspection s to ensure compliance, they need a team in their organizational structure to perform inspections in a standardized way and become the point of contact with the related ministries.

Even though we established from the weekly meetings that the Engineering Department wouldn't want a Fire Marshal position, our findings showed that they need a team to perform some of the educational and legislative duties of a Fire Marshal in their organizational structure. After establishing this need, first we analyzed the different ways that an enforcer position called "Fire Marshal" can be added to the current structure of CBCR's Engineering Department. The three options that we considered included making the Fire Marshal head of the Engineering Department, giving the Fire Marshal same power as the head of the engineering department, or making the Fire Marshal work under the head of the engineering department. Each of these options had its advantages and disadvantages. For example, making the Fire Marshal the head of the engineering department would give more control on this position in all of the aspects of the engineering team, giving Fire Marshal the same power would divide the work, but it may create confusion about the authority and who is the deciding factor, which is a common issue seen with organizations that have more than one leader with equal powers. Having the Fire Marshal work under the head of the engineering department would be beneficial because it would make the least amount of changes to the original structure, but it would limit the management abilities of the Fire Marshal because the Fire Marshal would only be assigned to the Inspection Team and would not be able to manage all of the operations.

Since there a Fire Marshal position cannot be utilized in Costa Rica, we were able to eliminate the first two options and focus on the third option of establishing a team, if not a position specifically called "Fire Marshal", which works under the head of the engineering department. This team would perform regulated inspections and have members responsible for communicating with the Authorities Having Jurisdiction or the building owners regarding the next steps to be taken after the inspection. We could create this team in two ways: as an additional team to those that already exist, or to change the structure of one of the existing teams to include the new responsibilities. We also acknowledged that it is not possible to create a fully capable new team in a single step, therefore the structure of Engineering Department needs to be changed using phasing. Phasing means to make small changes step by step to reach the end goal rather than making significant changes at once. To change the structure using phasing, CBCR needs to increase the number of employees and expand the operations of the new team slowly, rather than hiring a lot of new employees all at once. Taking all the information mentioned in our first two findings into account, we created possible alternative structures by either creating a new team or changing the Risk Assessment Team, which is the team that performs inspections, to present in a focus group where the Engineering Department could discuss the alternatives and identify the structures that fit them in the best way.

b. To improve efficacy the new organizational structure needs a geographical component.

The current structure of the engineering department, centralized in San Jose, limits the coverage of inspections and investigations across Costa Rica. During our interviews we found that there are 4-7 members on each team of CBCR's Engineering Department (Risk Assessment, Systems Testing, Fire Investigations, Building Plan Reviews), and all of these members are located in San José. Not having people in different provinces for inspections and investigations forces team members stationed in San José to travel to locations throughout the country (U.Cornejo, personal communication, March 24, 2015). According to the statistics, of the fires that happened in 2013, only 50% of Costa Rica's fires were in San José. While San José area has the majority of the fires in Costa Rica, the other 50% of fires that are happening throughout the rest of the country are not getting adequate attention. This lack of adequate attention is due to travel and coordination difficulties within the centralized engineering department. Mr. Leiva, from the Plan Review Team, stated that Engineering Department are having problems with coordinating inspections in distant regions to perform the inspections at the same region on the same dates. This coordination problem creates the need for multiple visits to distant regions, which lead to inefficiency during the inspection process. Mr. Rolando Leiva also specifically stated that this coordination problem prevented them from being able to inspect as many buildings as they aimed for (R. Leiva, personal communication, March 20, 2015). Therefore the Engineering Department needs a geographical component in their new structure that would allow them to have shorter response time to building owners' inspection requests and quicker visits to inspection sites.

Identifying the need for a geographical component in the structure, we first researched how the fire prevention departments in the United States account for geographical expansion. We could not find detailed information on this matter, but we found that in most states the fire prevention departments in the city level report to a central department in the state level. This showed that the

fire prevention departments are organized in the state level and account for geographical expansion by establishing regional prevention departments in the city level. We also found that the fire prevention departments in the city level further divide themselves according to specialization. For example, the Worcester Fire Department has a specialist Lieutenant responsible for educational facilities, and a specialist Lieutenant responsible for licensing bars and restaurants.

In the United States, we were able to obtain information using interviews, but this wasn't possible for the other countries we looked at. In the international level we researched how international businesses account for geographical expansion. We specifically looked at international businesses because of the lack of information on the organizational structure of fire prevention organizations, as mentioned in our methodology section on organizational structure. We found that businesses expanded by either creating new divisions with a *geographic focus* or with a *product focus*. A geographic focus means that teams that are responsible for managing specific geographical areas are located in the headquarters. A product focus means that teams that are responsible for managing certain products or services provided by the business are located at headquarters. For example, in our research we found that the Procter & Gamble is utilizing a product focus in their headquarters and divided their services into four areas as Personal Care, Family Care, Home Care and Health & Grooming. Wal-Mart is utilizing a mixture of product focus and a geography focus, by having 3 divisions. In their International Stores Division, they have managers responsible for specific regions located in the headquarters, and also regional managers located in the regions. Using the focus types allows both of the companies to grow in a systematic way and focus their strategies according to their goals.

We superimposed this information onto our problem of improving the existing structure of the Engineering Department. In our context, the geography focus would mean a focus on different regions of Costa Rica and a product focus would mean a focus on the building types in our proposed organizational structure and translate as "building type focus", since it is possible to divide the inspection services provided by the Engineering Department by the type of building being inspected. Since both options can succeed depending on the organization's focus, we included both in the organizational structure possibilities that we presented in the focus group for the Engineering Department.

We identified advantages and disadvantages of each model for the Engineering Department to choose the best structure depending on their focus. Important advantages of the geography focus are having quick response times and easier information processing. This can be achieved by using regional inspectors. A regional chief who is located at headquarters in San José manages these regional inspectors. This focus facilitates local responsiveness. An advantage of the building type focus is that there are teams specialized on the building types in the headquarters that perform more complicated inspections and provide expertise about specifics of inspections that vary by building types. However, the building focus creates problems in the reporting structure, since the regional inspectors would have 4-5 teams that they report to depending on the building type being inspected. After analyzing the advantages and disadvantages, we created three different organizational structures to be presented to the Engineering Department in a focus group, which are discussed next briefly. The figures representing the new structure options are

below, and the roles of the restructured teams and a more detailed listed version of advantages and disadvantages of each option can be found in appendices K and L respectively.

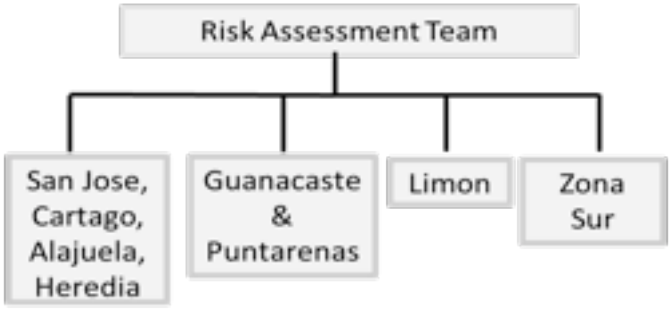

Figure 3: Risk Assessment Team Regional Focus Restructure

Figure 4: Risk Assessment Team Building Type Focus Restructure

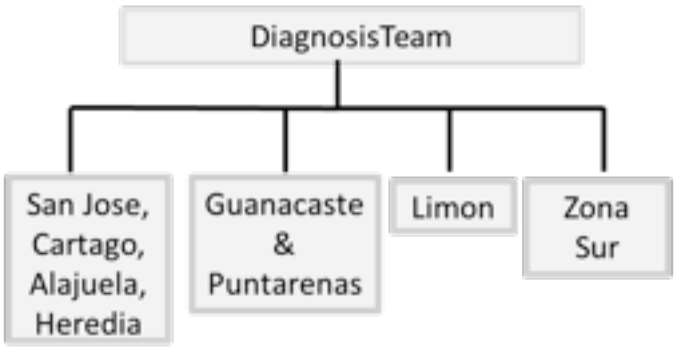

Figure 5: Diagnosis Team Addition Structure

The structures we presented in the focus group to the Engineering Department included 1) a region focus by restructuring the Risk Assessment Team, 2) a building type focus, again by restructuring the Risk Assessment Team and 3) a region focus by creating an additional team that would take some of the basic inspection duties from the Risk Assessment Team. From the discussion in the focus group we found that it is not practical for the Engineering Department to have inspectors specialized in building types, and that they would prefer all the members to inspect a variety of buildings. These discussions about specialization with the focus group lead us to consider the second option as less viable for Costa Rica. Another finding from the focus

group was that structuring teams according to the regions would really help the Engineering Department to coordinate inspections in a better way. We initially considered dividing the inspection team according to the seven regions of Costa Rica. However, during the focus group discussion, we found that it would be much more effective to group some of the regions together as they either have same type of structures or are geographically close to each other. Using the suggestions from the focus group, we narrowed down the number of regional teams from seven to four. Our first option became a regionalized Risk Assessment team with 4 sub-teams that utilizes the current personnel.

The members of the focus group also voiced opinions in favor of the third option, which was creating another team to take up some of the duties of the Risk Assessment team. They liked the idea of having a Diagnosis Team that would have the duties of performing standardized basic inspections in all of the buildings in Costa Rica. These basic inspections would include identifying the existence of protection systems and issues regarding life safety within building. This analysis allows the inspector to assess the hazard level of the building and decide if further actions need to be taken to improve fire safety. Only doing a basic inspection would lower the inspection time significantly for smaller and low priority buildings. Having such a Diagnosis Team would allow the Risk Assessment Team to become a more specialized team that performs detailed inspections on public areas or when the Diagnosis Team reports the need for a more detailed inspection. The members of the focus group also stated opinions in favor of structuring the Diagnosis Team into four different regional teams that was discussed for the first option presented in the focus group. Using the findings from the focus group, we narrowed down our options to create a final recommendation for the Engineering Department, which is discussed in the conclusions section. With the new organizational structure options, the question of having adequate labor force to fulfill the added roles comes up, which is discussed next.

c. CBCR's Engineering Department needs to calculate the adequate labor force.

During our interviews on the utilization of labor force, each team indicated that the current workload is exceeding capacity. This capacity problem was due to having only a handful of members in each team to deal with the workload of Costa Rica as a whole. In the interview with the Plans Review Team we found that they wanted to inspect 200 important projects that were high risk in 2014, but were only able to perform inspections on 80 of them (R. Leiva, personal communication, March 20, 2015). Additionally, the Systems Testing Team was scheduling appointments seven months out as that was the earliest available time for receiving an inspection from this team (U.Cornejo, personal communication, March 24, 2015).

With regulated inspections, the inspection teams would need to inspect significantly more buildings compared to voluntary inspections. During our interviews, we found that the Engineering Department would be able to increase their capacity by hiring additional labor force. Mr. Solis Delgado stated that the Engineering Department has the resources to hire additional four-five people initially and increase its work force even more in the future. The question we needed to answer is how many personnel would be necessary to inspect all uninspected buildings in Costa Rica in the future if the Engineering Department increases workforce. During our research on NFPA 1730 —the code on creating a task force—we found that the amount of

inspectors that the Engineering Department would need to hire also depends on the time frame necessary to complete all the additional inspections that they would have to perform after moving to a regulated program. Therefore, instead of providing them a final number for the future, we found that it would be more beneficial to make suggestions on where the four-five people they hire initially should work and also provide a formula by which to calculate the amount of future inspectors they would need to hire to cover the inspections on older buildings. Plans Review committee is already performing inspections on new buildings, therefore the focus of this formula is to identify the labor force needed to inspect the old buildings that have never been inspected before, as this is what the new teams we create will be doing initially.

NFPA 1730 provided us with the factors that would go into the formula. The first step was to identify services being provided. For the Risk Assessment inspections of the Engineering Department, this was the on-site inspection and the report preparation. The second step was to find the total amount of time spent on these services. Using information on historic data provided to us by the Risk Assessment team, we came up with an estimate of both the on field inspection time and the report preparation time for a building by averaging the data from 40 inspections. By multiplying the time required for one building with the estimate of total amount of uninspected buildings, we found the total service time required by the Engineering Department to complete inspections. The third step was observing required hours for personnel on a weekly scale. For the Engineering Department, this was forty hours per week. The total service time required created the right hand side of our formula. On the left side, we had a multiplication of forty hours/ week times the amount of weeks they want to complete inspections times the number of the employees.

Total Risk Assessment Inspection Hours/building				Estimate Total Number of Uninspected Buildings In CR		Needed # Weeks to Complete Inspections		Total Inspectors Desired/Week		Work Hours/Week
On Field	Reporting	Total								
6	6	12	*	1000	=	50	*	6	*	40

Figure 6: An example calculation for the Engineering Department based on NFPA 1730.

Having the formula, the Engineering Department can easily enter their own numbers to make analysis on cost vs. time in terms of completing inspections. A more detailed version of an example calculation for labor can be found in Appendix M. They would need more inspectors to complete inspections in a shorter time, which would mean more cost. On the other hand, they could complete all the inspections with the amount of inspectors that they currently have, but it would take a longer time to complete the inspections. The example below provides the two ways the formula can be used:

If there are 10 old buildings and it takes a total time of 24 hours to inspect and report each building, the Engineering Department would need 240 hours of work to complete all these inspections. Engineering Department then can enter that they would like to complete inspections with 3 inspectors. With each working 40 hours, these employees can perform 120 hours of inspection per week, so the result the Engineering Department obtains is that they can complete inspections in 2 weeks. On the other hand, they can enter that they would like to complete inspections in 1 week. Since they have 240 work hours, and each employee can work for 40

hours per week, the result they obtain is that they would need 6 inspectors to be able to complete all the inspections in one week.

The numbers that we have provided to the Engineering Department will be estimates, but using historical data and estimates in future resource calculations is common as it is the closest one can obtain to the real data. By using the formula, the Engineering Department can make their own estimations of inspection time and the total buildings that will be inspected. Then they can plug in values to the other side of the formula to see all of their options and decide on an optimal mix that would allow them to complete inspections in a reasonable time frame and with a reasonable cost.

4.2 Education of the Fire Prevention Personnel and Costa Rican Citizens:

By studying the educational systems utilized in developed regulatory fire inspection programs and within the Engineering Department, we arrived at three findings that were further supported by our surveys of Costa Rican citizens:

- **a.** The prevention professionals of advanced regulatory fire inspection programs have standardized training.
- **b.** CBCR's Engineering Departments Training needs to be standardized.
- **c.** Educating the public is important to maintain sustainability and support for Regulatory inspections.

a. The prevention professionals of the advanced Regulatory Fire Inspection Programs have standardized training.

We found that advanced regulatory fire inspection programs have standardized training programs that are usually divided into two types; basic prevention training and experienced prevention training.

Basic prevention training is the training of new inspectors. Some general findings that we found for countries around the world were that for almost all researched countries, inspector applicants were required to have an engineering degree before they were considered. A majority of the countries give high importance to the on-field training and experience to become fire prevention personnel. In some cases this includes 3-4 years of experience. While on field training is important, courses and tests were also involved in training programs. We found that courses and tests mostly focus on the fire safety regulations, and the on-field training focuses on the application of the regulations. While these findings are common throughout the world we found that basic prevention training varies in length. For example in Scotland basic fire prevention training is a 15-week course, 3 weeks of which is focused on fire prevention. Although, an example of a longer course can be seen in Hungary where the inspection-training program lasts 2 years. Throughout the two years, perspective inspectors need to go to the training center for course work training 3 times a month. Otherwise, the rest of the training is done on field.

Once an inspector has gone through basic training they can become more experienced through further training. This further training is for experienced inspectors to expand their knowledge of fire prevention by continuing course work and gaining certifications. The United Kingdom

provides the best example of this as the country is implementing a new type of program for experienced inspectors. In this program experienced inspectors accumulate courses, certifications, and experience to work towards a degree of fire safety engineer throughout their career. With a specific amount of course work, certifications and experience the experienced inspector will have earned a degree of fire safety engineer.

New inspector training was important for us to observe because as we proposed to implement additional work force, these new personnel would need to be trained. In order to train thoroughly and prepare inspectors for the work force the training needs to be standardized. Although, with this program changing from voluntary to regulatory not only will new inspectors need to be trained, but also experienced inspectors will need continued training. For this reason, our findings of experienced fire prevention training could be made applicable to the Engineering Department. (Schaenman, July 1993)

Having this information, we sought to find the details of CBCR's training programs for the Engineering Department to make suggestions on the aspects that can be added, which is discussed next.

b. The training program for CBCR's Engineering Department is not standardized.

Through our interviews within the Engineering Department, we found that they do not necessitate any specific background requirements to be employed as an inspector. This is different from the average requirements of model programs, which typically dictate that applicants must have an engineering degree. Team leaders within the Engineering Department affirmed that an engineering degree requirement would be beneficial to the department. In our interviews, the team leaders discussed that an engineering degree can be beneficial so that inspectors have esteem among the business owners when completing an inspection. For example, if an inspector does not have a technical degree and is making recommendations to an owner about their building, the inspector is sometimes met with adversity. This is because owners do not see the inspector as someone with enough knowledge to be giving them advice on how to help their building meet compliance. (Francisco Bermudez Solano, Personal Correspondence, 4-20-2015)

In addition to investigating the requirements to be an inspector, we also looked at the process after being hired. After the employment process, the Engineering Department delivers courses about international and Costa Rican regulations followed by a test of certification to be able to work in the field. We found that the Engineering Department has existing team members accompany new team members in the field for 6 months of training. Through the inspections that we shadowed, we found that a majority of the training was left to leaders within the department teaching as they inspect. Through our interviews, we learned that while this system of training is satisfactory for the Engineering Department at present, the leaders sought more training. Experienced inspectors already indicated that they are working in full capacity. This means that with a regulated fire inspection program, the experienced inspectors may not always have the time to walk someone through an inspection. This reasoning led us to consider recommending improvements to their recruiting and training programs.

c. **Educating the public is important to maintain sustainable support for regulatory fire**

inspections.

All the components of this regulatory inspection program help the program to function within the Engineering Department. Without the public being educated regarding the urgency of the lack of fire prevention in Costa Rica, the program will not be sustainable. Fire prevention education can lower the number of fires substantially. We found that Japan is a good model of this. Japan is a country that has a strong focus on educating the public on fire prevention. The country cultivates an atmosphere where there is social pressure to be fire safe. Almost the entire population is reached through some sort of public fire education. "The Japanese experience demonstrates that public safety education alone can reduce fire incidence enormously" (Schaenman, July 1993) Some examples of different ways of educating the public are through school programs, public service announcements, fire safety pamphlets or postings in the newspapers, social workers to deliver information to citizens at high risk, and panels of important groups in the community to communicate about the state of fire prevention.

We found Costa Rica could benefit from using these informative methods to educate the public. While CBCR has an education department, we found that their outreach could be improved in the area of fire prevention specifically. This was confirmed when shadowing an inspection of a children's nursery. We found that citizens in Costa Rica were lacking the knowledge of fire prevention safety education. Not only were they unsure of how to increase fire prevention in their buildings but also the citizens weren't entirely understanding of the significance behind fire prevention. We further confirmed proof of the lapse in knowledge through the results of our citizen surveys. The surveys showed us that of the 25 citizens who completed the survey, all underestimated the number of fires annually by almost three times. While citizens were not certain about the number of fires happening annually, citizens did show concern. We found they were aware that fires were a problem and the number of them is steadily rising. To stop the rise in fires, the citizens must be educated. If the citizens have no knowledge of fire safety and prevention, asking them to comply is asking them to do something they don't know how to do. In the citizens survey we found that many citizens wished they had more knowledge to implement fire prevention in their buildings. Equipping citizens with fire prevention knowledge will lower the number of non-compliant building owners who just don't know how to fix their building. Through our research in the NFPA Life Safety 101 book, we found that public education should be targeted separately towards children and adults, as the way they are educated will be different.

Children are the generation that will grow up to change the thought process behind fire safety. Kids are able to retain material through repetition and instruction. (E. Kirtley, NFPA Handbook page 5.9, April 23, 2015). An example of how the children of Costa Rica can impact the entire society is a recycling initiative put in place last year. This recycling initiative was first taught in the schools to the children who then went home to change their families. In an interview with the Municipalidad de Belen's occupational health contact Don Juan Carlos, we found that the recycling program has had great success with children initiating the big change. This means that in a culture where no recycling was done, almost all homes are now employing recycling techniques. He forecasts similar success if fire education is taught to the children first. To help teach children such as those in Costa Rica, the NFPA provides materials written in Spanish to teach fire prevention drills. Developed by the NFPA and National

Association of Hispanic Firefighters, an example of one of these teaching tools is the Learn Not to Burn preschool program that comes with songs and teacher guides. As we learned from that inspection at a daycare, some of the daycare teacher's biggest worries are how to get the kids out of the building should it be burning. The inspectors gave some strategies to the teachers about where to go and what to do should the kids be playing or napping when the building catches on fire. This personalized instruction cannot happen, though, with every school in Costa Rica, so the teaching tools provided by the NFPA may help schools to teach and understand fire safety independent of instruction by CBCR, giving kids the knowledge to bring home to their families.

Educating adults through their children or other forms of instruction can help to instruct the adults on how to make fire safety changes to meet compliance. To teach the adults, we found the NFPA recommends taking into consideration the fact that adults are busy and wanting information to be worth their time and attention. They want to see explanations for why they need something and would rather do an activity explaining it than to be lectured about it (E. Kirtley, NFPA Handbook page 5.9, April 23, 2015). For this reason we found it would be more useful for the inspectors of the Engineering Department to educate business owners on site while performing an inspection. This would put fire safety in the perspective of the owner's own personal building while teaching them the importance of fire safety. This is similar to social workers in other programs around the world, but this relinquishes the need to hire separate personnel to educate the business owners of the community as the inspectors are doing this along the way. The adults, according to NFPA also want motivation to do these fixes, which this motivation can come from feeling safer but also may come from incentives that we talk further about in the legislation section below. According to our citizen's survey, these building owners may not need as much motivation since they already have a desire to comply. The results of the survey showed that 100% of business owners responded positively to inspections being regulated and saw it fit for their buildings to be inspected once a year. Although 100% of these citizens supported the implementation of regularly occurring inspections, 30% thought they needed more knowledge to help their buildings meet compliance. If citizens have the knowledge to fix noncompliance in their buildings and are aware of the reasoning behind these fixes, the inspectors would have fewer hazards to inspect and could move more rapidly through buildings. This will be important when the inspectors have more building inspections to complete.

In addition to the education of the general public, it is also important to educate the other safety groups within the community. These groups would be the ministries and the municipalities. We found through interviews within the department of engineering that there are not always open lines of communication between these entities. In other countries an example tactic used to create more open lines of communication would be through a panel where all of these entities would gather and discuss the situation behind all issues including fire prevention. This will open the communication between all the groups of the community to support one another in programs that will better protect the people.

The more educated the public is, whether it be citizens or the governing authorities, the easier it will be for CBCR and the Engineering Department to implement their regulated inspection program.

4.3 Record Keeping System

The members of the Engineering Department's new organizational structure, who have been trained in how to perform these inspections, will also need to be training in the use of a new record keeping program to improve the efficiency of the regulatory fire inspection program. The current record keeping system utilizes Microsoft Word, Excel, and PDF files stored on individual computers. These files are not shared amongst the teams and are labeled separately and inconsistently among the teams in the engineering department.

After our team studied successful international record keeping systems and interviewed with member of the Engineering Department, we identified three needs for a proposed record keeping system. These needs were the following:

- **a.** A systematic identification system is needed to store information on inspected buildings.
- **b.** The record keeping system needs to be integrated across the different teams in the Engineering Department.
- **c.** The new record keeping system needs to have the capacity to manage the increasing number of records and information from the new mandated inspections.

a. A systematic identification system is needed to store information on inspected buildings.

In order for the Engineering Department to regulate fire inspections, they need to be more efficient with their record keeping. During a conversation with Luis Avila Villalobos, head of the Occupational Safety Team, our team learned that following a hotel fire at the Courtyard Marriott in Escazú on March 18, 2015, Alexander Solis Delgado, head of the Engineering Department, had to form a team of 5 separate members of the Engineering Department to retrieve and review the records. Rolando Leiva Ulate, a member of the Plans Review Team, revealed that each team within the Engineering Department stores their records separately and in different formats (personal interview, 3-19-15). These conversations enlightened our team on the lack of efficiency within the Engineering Department. The excess time spent searching, organizing and writing information, is time that could be spent completing the regulatory fire inspections that the Engineering Department's desires to complete. Additional inspections would only exacerbate this lack of efficiency unless a systematic and standardized record keeping system is developed.

To solve this problem, the a record keeping system would need to be developed to integrate the records of all of the teams within the Engineering Department, thus requiring only one team member to find the required material. Therefore, when a specific building is searched within the system, all of the records related to that particular building would be retrieved. Any edits or additional records added would require a username or password, which would authorize the user to make these changes. This would eliminate unauthorized personnel from making the changes, but would allow all members of the Engineering Department to view the information. If the information were confidential, a separate username and password would be required in order view the information.

The firefighting division of CBCR already uses a system known as SIGAE, which is an integrated Record Keeping System. We considered whether this existing system could act as a

solution for the Engineering Department's record keeping problems. The system is used by the firehouses to report their current activities, observations, and geographic information, so that the administration can manage resources, fire trucks and personnel for example, of the department appropriately. SIGAE allows an individual to make informed and quick decisions regarding the use of resources, which saves time, money and lives. It also functions as a communication tool for the hundreds of employees of the department. Many members of CBCR are able to view the information provided by the system; access and editing capabilities are only provided to those having authorization.

Presently, all the members of the CBCR's Engineering Department have access to SIGAE, but only the Investigations team has authorization to do any type of editing within the system. While SIGAE has many of the conceptual elements needed for the Engineering Department's record keeping system, the program is not designed to store, nor does it have the analytical capabilities needed for, the records kept by the engineering department. The SIGAE software is designed to organize and manage a fire department during an emergency, not manage information from fire department inspections. These software packages are usually separate entities. Having the Engineering Department contract the third party that designed SIGAE to modify it for their needs is not a feasible option because of cost. It would be more cost effective to purchase another technology.

Microsoft Access is a record keeping software that could be utilized by the Engineering Department. The information from Microsoft Access could be linked to Geographic Information System (GIS) technology (mapping software to be discussed further in finding b); thus when a location is selected on a map, it extracts all of the relevant information from Microsoft Access relevant to that particular building within the database. The software is helpful in searching data and pulling subsets for review. Microsoft Access databases are made up of several key components, which include tables, forms, reports, queries, macros, and modules (Microsoft, 2015). Queries mainly function to retrieve the data spread across several tables so that it can be viewed in a single sheet (Microsoft, 2015). Reports summarize the data present in the tables (Microsoft, 2015). Additionally, Access has the ability to store existing PDF and Word files within the database system. Thus, the Engineering Department would be able to insert all of their reports and existing documents into the program without having to change them. Therefore, when a building is searched all existing reports and plans are retrieved.

One-Step-Systems is an alternative software option. The Canadian Company designs the software specifically for the purposes of Fire Inspection. The program has the capabilities to search using both mapping technology and business addresses. According to Gordon Svenson, an employee at the company, the search capabilities of the software can be adapted to search by an identification number, rather than an address (Personal Communication, 4-6-15). The software has the ability to store files such as word files, excel files, and pdf files. All users of the software can view the records. However, a designated inspector who has been approved by an administrator can only enter data. Additionally, administrators control billing information. However, if the Engineering Department chooses to use this software to record the information gathered from inspections, they would need to adapt their recording strategies so that they conform to how the information is recorded within the software.

b. The record keeping system needs to be integrated amongst the different teams in the Engineering Department.

In an interview with Mr. Leiva, we learned about the challenge of retrieving files due to the lack of a standardized street address system. Mr. Leiva stated that, "Upwards of 25 minutes can be spent searching key words in order to locate the files on a specific structure"(Personal Interview, 3-19-15). Since Costa Rica lacks a standardized street address system, an alternative identification system needs to be used, which can be used to recognize the location of a specific property or business. This will become imperative to maintaining the efficiency of the Engineering Department.

According to Mr. Henry Morales, head of the Investigations Team, the coordinate location of each incident attended by the Engineering Department is recorded because these coordinates are unique to every location. This is a potential option for the Engineering Department because it is a standardized system and is a feasible way to search within many databases for information. These coordinates could be linked to Geographic Information System Technology (GIS) where the records could be searched by finding the location on a map.

Geographic Information System (GIS) technology is becoming more widely used in the fire community and is recommended by the NFPA. The supplementary software links tabular data to geographic locations to analyze existing real world situation. The technology allows for manipulation, analysis and display of data (NFPA Handbook, page 12-216, 2014). Data can be turned on and off to visualize fire districts, public occupancies, streets, building locations and more (NFPA Handbook, page 12-216, 2014). Data regarding a specific building can be linked to a specific location on a map. Information can be attached to each point, in this case building location, would be linked to acknowledging qualities of the building. Utilizing GIS along with Microsoft Access is an option in assisting the Engineering Department to locate inspection and other records quickly.

While using a coordinate system would work well with the record keeping software, it is not necessarily the user-friendliest option. Using coordinates would require the user to remember a series of inconsequential numbers that would not vary significantly. Since Costa Rica's current address system is based off of landmarks, to move from using landmarks to [arbitrary?] numbers would be a major shift for the organization, and could increase the amount of time spent searching for records. Using a coordinate system alongside a second identification method would be most practical. The coordinates could be used for the GIS software and another systematic identification number could be developed by the Engineering Department to identify the location. By having the Engineering Department create this identification system they would be more familiar with it.

c. The new record keeping system needs to have the capacity to manage the increasing number of records and information from the new regulatory inspections.

With each of our interviews with the teams in the Engineering Department it became more evident that the Engineering Department is already approaching its maximum working capacity. In order to create a sustainable regulatory fire inspection program, which will involve additional

inspections, the employees of the department need to optimize their time. A more functional record keeping system would reduce the amount of time required for each inspection and thus the Engineering Department could perform more inspections.

Our focus group with the heads of the Risk Assessment Team, Systems Testing Team, and Plans Revision team indicated that having a standardized diagnostic form would help the engineering department manage the large quantity of inspections and quickly evaluate, which buildings will require further attention. For example, Mr. Cornejo stated a simple report of "yes" and "no" answers would help his team prioritize the order in which they would complete more complex follow-up inspections (Personal communication, April 24, 2015). This standardized form will allow the engineering department to have a systematic way of deciding what buildings qualify as passing and failing upon an initial inspection.

During an interview with Ulises Cornejo, head of the Fire Protection Systems Testing Team, we learned that a significant amount of time was spent after each inspection inputting the results of the inspection into the computer; he felt a lot of time could be saved if this inputting could be done in the field (Personal Communication, March 24, 2015). Mr. Cornejo stated that a record keeping system with the capability to complete the inspections via tablets in the field would save his team a lot of time because it would eliminate recording the results twice.

Along with using portable devices, utilizing software that has the ability to schedule inspections would make the Engineering Department more efficient, therefore allowing for more inspections to be performed. Mr. Leiva noted during his interview with our team that the Plans Review Team could perform more inspections if they were coordinated more effectively. Currently, the Plans Revision Team goes to inspect buildings based on owners' availability. If the software was able to schedule inspections based on the similar locations of buildings, travel time could be reduced and more inspections could be completed per day.

Both Microsoft Access and One-Step-Systems technology have the capability to systematically schedule inspections based on locations and times when the inspections need to be completed. These scheduling tools would help ensure that inspections are planned in an orderly manner. Both programs also have the ability to connect remotely to the databases either through Wi-Fi or cellular data. Therefore, scheduling can be entered directly into the system while in the field, saving the Engineering Department the time.

The factors in determining which record keeping system will be more effective for the Engineering Department are cost and the ability to integrate into the existing record keeping system. One-Step-Systems uses a licensing system, which needs to be renewed annually. Each inspector license costs approximately $965 per year and the administrative licenses cost approximately $1500 per year. The number of inspectors will determine the number of licenses, which in turn will determine if this is a feasible option for the Engineering Department. The existing inspection records would need to be re-organized to be utilized most effectively within the software. One-Step-Systems charges a fee, but the company will extract the information from existing records so that the Engineering Department can most effectively use the software (Gordon Svenson, personal communication, 4-6-15). Not only does One-Step-Systems have a high cost, but integrating this software requires a lot of adaptation to the Engineering

Department's current system. Recording data using this system will differ significantly from the Engineering Department's existing systems and would require training for all the users on how to use this new system. Many of the employees of the Engineering Department have been with CBCR for a significant amount of time, meaning they are accustomed to how inspections are performed at the present time, thus the learning phase of conducting inspections using these systems would slow down the Engineering Department's productivity making them less efficient.

Figure 7: One-Step-System prompt screen organizing records

Microsoft Access is an alternative option that would be more affordable, and recording the data from an inspection would be similar to how the organization performs the inspections at present. The Engineering Department already has Microsoft Access on their computers (Rolando Leiva Ulate, personal communication, March 20, 2015). Our team found that purchasing a corporate license, where the most up-to-date software is provided on a yearly basis, would more effective than personal licenses, which would require purchasing new licenses every time the Engineering Department would want to update the software. Purchasing a professional license of Microsoft Office would also allow the Engineering Department to have a regularly updated version of all the other Microsoft Programs that they also use. The license costs a couple thousand dollars every time the license is renewed

Using Microsoft Access would allow the database to be tailored to the exact needs of the Engineering Department and could be easily adapted over time. Additionally, Microsoft Access files can be linked to Geographic Information System (GIS) Technology, allowing the information from Microsoft Access to be analyzed using this mapping technology. Each specific firehouse fire and each specific site file within our model contains a space where the coordinates of the building can be entered. These coordinates will link the location file to a location on the map. Once this is complete a site may be selected in the GIS file, which will then link the user to the information within the Access File. GIS cannot perform analyses unless Microsoft Access database, containing the data is complete. The supplementary GIS software would provide the Engineering Department with information that could be used to improve their records and regulatory inspection strategies in the future. However, using Microsoft Access with GIS would

require IT support to develop the entire database, maintain the database, and answer questions that its users have. GIS is also an additional cost on top of Microsoft Access because it is a separate software. The decision to use either Microsoft Access with GIS or One-Step-Systems will be based on where the Engineering Department believes the money will be better spent and how much they want to deviate from their existing system.

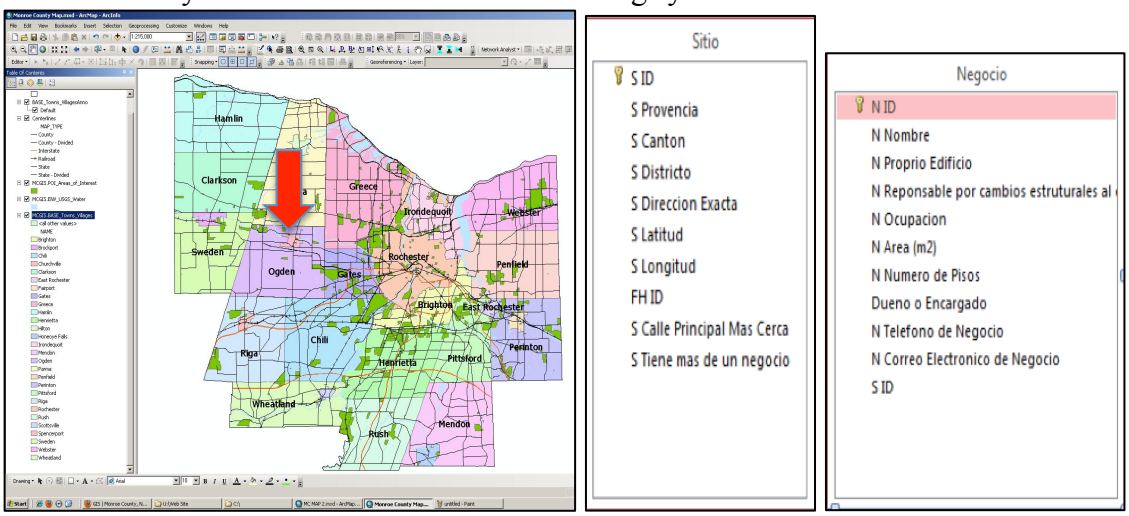

Figure 8: Linking GIS to site data in Microsoft Access

4.4 Legislative Findings

In order to develop a regulatory fire inspection program, in addition to an improved organizational structure and record keeping system, the Engineering Department will need to ensure that they are still operating within Law 8228 of the Assembly of Legislature of the Republic of Costa Rica (Law of CBCR), which states the legal powers available to the Engineering Department in respect to inspections. Therefore, we researched countries with developed standardized inspection programs and analyzed that against the existing system the Engineering Department follow. This led us to the following findings:

a. Developed Regulatory Fire Inspection Programs suggest enforcement power be given to the inspectors.
b. Giving enforcement power to inspectors is not feasible for the Engineering Department at the present time.
c. Working with the Ministry of Health in certifying operating permit is plausible for the Engineering Department.

a. Developed Regulatory Fire Inspection Programs suggest inspectors should be given enforcement power.

Through United States' and international research, we found that fire inspectors and Fire Marshals have the power to legally enforce in a developed regulatory fire inspection program. The Fire Marshal's authority of enforcement includes enforcing the penalties of fines and building closure within different time limits. By analyzing the information gathered from our research, shadowing and surveying tools, we found the following results concerning legislative enforcement aspects in developed regulatory fire inspection programs.

Fining systems are utilized for fire safety infractions in order to legally enforce compliance. In Puerto Rico, a ticket is given out the first time a fault is noticed upon inspection. The ticket will indicate the date by which the fault should be corrected, and if not corrected by then, the property owner will begin to accrue fines. If the offender obtains three tickets and fines, the Chief of the Cuerpo de Bomberos of Puerto Rico has the authority to temporarily close the building. Puerto Rico shows one example of a fining system but is similar to those of other regions we researched.

These fines are given time limits to abate a fire prevention issue before the owner will receive another fine. All regions include time constraints for how long it should take to make corrections, but no time limit is the same between regions. For example when Los Angeles, California (LA) enforces time limits for noncompliance a notice is given to the property owner stating they have fifteen days to fulfill the inspector's counsels. While these fifteen days are accruing, the city takes bids from private contractors willing to fix the property in order to meet compliance. If compliance is not reached by the allotted time, the lowest bidding private contractor is given rights to fix the property within the next two weeks. The property owner is then responsible for the inspection fees, administration fees and contractor fees of this process. Like in other region's legislative enforcement procession, property owners do have the chance to appeal.

Time limits and fines are part of a regulatory fire inspection program for when a property is noncompliant, but does not present immediate risk. Buildings that pose immediate danger have the ability to undergo closure. In researched cases, closure is the most drastic penalty an enforcing authority can command over a building. Each region investigated closed properties when either the space was an immediate danger to occupancy or when corrections of the fire inspector's recommendations were not completed after an allotted amount of time. There were variations in systems as to when to close a property, as each region had a closure procedure dependent on their definition of when a building poses an immediate threat.

From investigating different fining systems and closure protocols, we found that enforcement within CBCR's Engineering Department is presently not feasible option because this concept is not allowed within their law. Opinions on whether fining systems should be implemented varied drastically among inspectors of the Department of Engineering. In an interview discussing authoritative control with Ulyses C., the head of the Testing of Systems team within CBCR's Engineering Department, he stated that giving inspectors more authority in these matters would be great progress for the department. He was in favor of the development of a ticketing system, where inspectors have the ability of giving business owners a ticket of a certain amount at the time of an inspection. He also thought that buildings in great risk should be subjected to closure immediately. This perspective was the polar opposite of Nuria Arce Zamora of the Risk Evaluation team. During an on-site shadowing of an inspection, we asked her thoughts on enforcing an inspector's stipulations through a fining system. In her response, she was against immediate fining in order to motivate improvements in a building. This is because she realized that noncompliance was not a lack of desire, but rather a lack of education and the resources. Instead, she would rather provide business owners with several chances to make improvements on their property. If it is clear that the owner has no intention of complying after a few follow-up inspections, then the inspector should resort to fining. This aversion to fining property owners

immediately was also common among the interviews with Lieutenants Dan Downes and AnneMarie Pickett where they mentioned the importance of education before punishment.

While some inspectors may support the delegation of enforcement power to inspectors, the law does not allow for that right now. At the stage that CBCR is now, the organization would need to demand a change in the law in order to give out fines. This change in the law will affect their current operational procedures. For this reason, the option to give the inspectors of the Engineering Department the authority to give out enforcement penalties was seen as not feasible at the present time. Although this enforcement is backed by support of many inspectors in the department, it is not possible in this implementation phase of a more standardized regulatory program.

b. Enforcement is not feasible for the Engineering Department at the present time.

While we found that most developed regulatory fire inspection programs worldwide showed enforcement power is given to the inspectors, we found this would not work for the Engineering Department in the beginning phases of implementing a regulatory fire inspection program. For this reason, we found that it may be best and most feasible to work within the Law of CBCR. This is not to say that there is not any room for improvement. Even while working within the law, there are still areas where fire inspections can be improved. In the Law of CBCR, the ability for an inspector of the Engineering Department to inspect is stated in article 71 saying:

> Artículo 71. —Inspección. El Cuerpo de Bomberos, está facultado para realizar las inspecciones que considere pertinentes y así verificar el cumplimiento de la normativa aplicable en materia de seguridad humana, prevención y protección contra incendios. (Rica, 2008)

This article says that CBCR has the ability to inspect buildings that they deem a present risk and the owner must facilitate this inspection. The article goes further to state how an inspection should be conducted. We found that an inspector must request that the owner allow an inspection to be done. If the owner permits the inspection, the inspection is conducted and the non-compliances are noted and sent to the Ministry of Health to enforce compliance. Should the owner not allow the inspector in to do the inspection the Engineering Department can request permission to enter from a court judge. Furthermore, if the Authority Having Jurisdiction fails to resolve the problem, the Engineering Department has the right to forward the issue to criminal court, where both the property owner and the Authority Having Jurisdiction are charged This article shows that the Engineering Department have the ability to inspect all buildings they see fit and request compliance through the Ministry of Health.

We found there are two options for improvement for the Engineering Department while working within their current law and keeping procedures similar to how they are now in terms of working independently of the Ministry of Health. The two options we created build on the idea that CBCR has the ability to enter buildings they choose. Although option 1 the inspectors select who to inspect while in option two owner's self select to be inspected after being motivated by

an incentives program. If denied access to inspect a building in either of these options an inspector can be granted access by an Authority Having Jurisdiction.

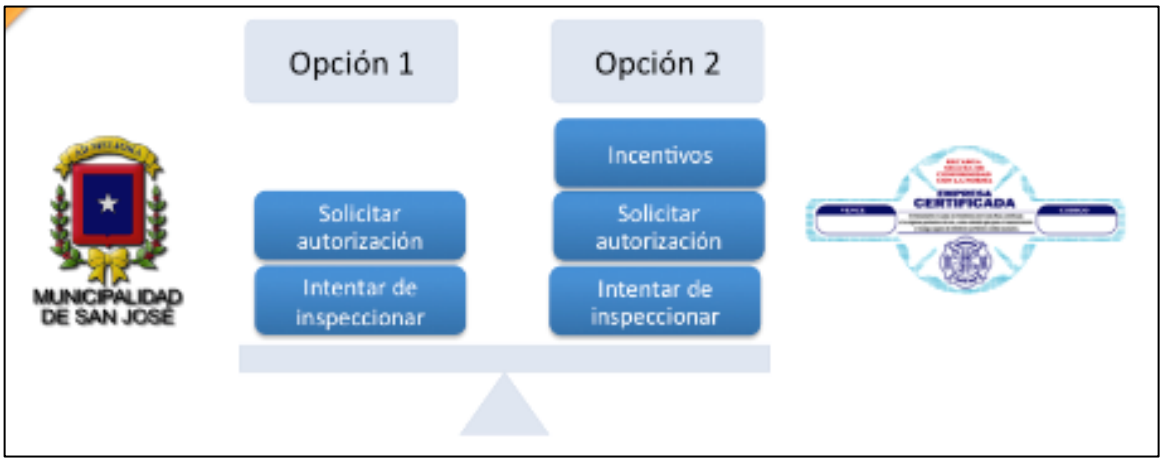

Figure 9: Legislative options 1 and 2

In option 1 the Engineering Department does inspections as they have been doing, but utilizes the Article 17 mentioned in section 2.3.4. This article says that the Engineering Department has the authority to enter any building they think poses a risk to citizen's lives. If denied access to the building the inspectors can become a competent authority with approval by a judge, a municipality, or a ministry, as these are all current Authorities Having Jurisdiction in Costa Rica. This power is currently not being exerted, thus decreasing the number of public properties inspected throughout the country. If they exert this power as option 1 suggests they can make their current system more standardized by going out and systematically inspecting all buildings as a competent authority. The Engineering Department can promote a regulatory fire inspection program if they were to standardize the amount of properties they inspect in an allotted amount of time. If working in conjunction with the other components of this chapter, this can be achieved through the phasing, where inspectors gradually inspect buildings over a certain time.

In the first phases of a regulatory fire inspection program within this first option, the Engineering Department can direct their attention on ensuring that all Type A properties and buildings of high occupancy are reaching compliance. This is to say that inspectors would focus on buildings of high risk and high population first because these properties would be the most dangerous if fire prevention systems and regulations were not present. Schools, malls, nightclubs, museums and hospitals are all examples of places that should be inspected in the first phase of this program. Seeing as these buildings are public, the changes in their fire prevention systems would call greater public attention and possibly educate the public at the same time. If a fire inspector were to examine a property that was not in accordance with the CBCR's regulations, they should proceed with their existing procedures and notify the according Authority Having Jurisdiction of this noncompliance

The second option we found that could help the Engineering Department move to regulated inspections can be used in conjunction with the first option, but instead of the Engineering Department selecting whom to inspect an incentive program is put in place for owners to self-select inspection.

The Engineering Department would gain motivation for owners to have their buildings inspected through the implementation of an incentives program. The Department of Engineering has

already begun doing some preliminary drafting of how this program should run. They have not been able to make any progress in developing this program due to time constraints.

Implementing an incentives program would be useful because it would entice business owners to voluntarily request for their property to be inspected by the Engineering Department. Although owners currently have their properties inspected voluntarily, this number will increase with the implementation of incentives. This increase in inspections through the incentives program should be standardized. This can be achieved by first targeting businesses that are Type A properties and those of high occupancy due to their high risk if fire prevention regulations were not in place. The Engineering Department should offer recognition through the means of a certification or label. This certification can be used as way to promote fire safety throughout the country and to attract customers to businesses. If the owner did not comply the Ministry of Health would be informed as is done now. Building types of moderate to low risk can be targeted through this incentive program in further phases of this Regulatory fire inspection program. (Salud, 2015)

Taking into account the time saved from utilizing the other suggested options explored through the other components of this chapter, the Engineering Department should be able to direct more time into the establishment of this program.

These two options provide ability for Engineering Department to work within their law, but will not necessarily allow them to most effectively complete their regulated inspections. In both options the Engineering Department are trying to build their own network of buildings to inspect. The first option, in which properties are chosen by the Engineering Department, could make for a long process should owners not be willing to let the inspectors inside their buildings. It could take a while to obtain a warrant from an Authority Having Jurisdiction to enter the property. The option where an incentives program provides motivation may allow them to inspect more properties, but may take a longer time to gain publicity and traction within the community. These options provide a first step for the Engineering Department to work within CBCR's law, but a bigger change may be necessary in order to regulate fire inspections successfully.

c. We found working with the Ministry of Health in certifying operating permit is plausible for the Engineering Department.

In order to standardize the amount of properties inspected, the Engineering Department should become an essential part of the Ministry of Health's system when it comes to assessing fire risks in Costa Rica. This is to say that when noncompliance within a property was detected, the Engineering Department forwards the issue to the Ministry of Health. If done, this option will allow the Engineering Department to inspect more buildings and to work better with the Ministry of Health. We found that it is possible for the Engineering Department to work alongside the Ministry of Health. The Ministry of Health works to certify buildings through an "operating permit." This is to say that as an Authority Having Jurisdiction, the Ministry of Health has the power to grant or deny patents, licenses and permits to function. This certification allows a building to operate for a given amount of time. The certifications need to be renewed every one year to every five years depending on the risk level of the building, type of occupancy, and activities that the building solicits. Within the process to certify a property, a business owner must have their place inspected for safety risks if their property is considered to be risk Type A or Type B1. We found that the Ministry of Health does simple inspections to check for fire safety risks using their own inspectors. In an interview with the Head of the Engineering

Department, we discovered that these inspectors are somewhat unfamiliar with what they are looking for, as their training is not based of the Law of CBCR. Because of this, we found it would be helpful if the Engineering Department could perform inspections when necessary to ensure that accurate and dependable inspections are being performed.

CBCR's Law states that the Ministry of Health can refer to the Engineering Department for help in inspecting. Article 73 states:

> Artículo 73. —Autoridades competentes. Las autoridades competentes para otorgar permisos de funcionamiento, realización de actividades, ejercicio del comercio, patentes, aprobación de planos o diseños y otros semejantes, podrán solicitar al Cuerpo de Bomberos el criterio técnico referente a prevención de incendios y de situaciones específicas de emergencia, cuando este permiso vaya a ser utilizado o se refiera a concentraciones masivas tales como: iglesias, discotecas, estadios, gimnasios, redondeles populares y otros centros de reunión pública de similar naturaleza. (Rica, 2008)

This article says that the Authority Having Jurisdiction, in this case the Ministry of Health, can contact the Engineering Department when revising operating permit. We found it would be helpful for the Engineering Department to have the Ministry of Health consult with them more often in order to establish standardized inspections in these buildings. This would help Engineering Department to inspect more buildings while strengthening their cohesiveness with the Ministry of Health and keeping an eye on fire safety risks in a regulated manner.

5.0 Conclusions and Recommendations

The following sections will address our team's third goal, mentioned in chapter three, of proposing and refining an improved regulatory fire inspection program model for the Benemérito Cuerpo de Bomberos de Costa Rica's (CBCR) Engineering Department. In this section our team will outline our final determination of what we believe will be the best approach for the Engineering Department to develop a regulatory program based upon best practices around the world and the existing resources and capabilities within the organization. These conclusions were devised through a series of interviews, on site observations, an analysis CBCR's Law, focus groups, and a review of best practices. This section is meant to serve as an initial investigation and guide for the Engineering Department as they begin this two to three year process of establishing a regulatory fire inspection system. Included within this section are a series of recommendations about the next steps in this development process.

5.1 Create a New Diagnostic Team to Perform Regulated Inspections.

Using our research, findings and the focus group discussion, we concluded that the organizational structure option that will work best for the Engineering Department is creating a Diagnostic Team of 4-5 people to ensure every building in Costa Rica passes from a standardized basic fire safety inspection. This team would focus on covering existing uninspected buildings by performing less detailed inspections and identifying the buildings of major concern for the Risk Assessment Team to re-inspect.
The team would be located in the CBCR's headquarters, but be divided into four sub-teams that focus on 4 regions as shown below:

a. Cartago, Heredia, Alajuela, San Jose (2 members)
b. Puntarenas, Guanacaste (1 member)
c. Limón (1 member)
d. Area of South (1 member)

The team would perform the regional inspections with a representative of the firehouse that covers the area being inspected. This way, the local firefighters are familiarized with all the buildings in the area and learn how to perform the basic inspections with the goal of taking the responsibilities of performing these inspections from the Diagnostic Team in the future. In the future after the firefighters are trained to perform the basic inspections, the diagnostics team can become a team in the headquarters that would manage these basic inspections rather than performing them and continue teaching the firefighters on fire-prevention. It is also possible for this team to become an Enforcement Team in the future if the Engineering Department is given the legal authority to enforce the results of the inspections.

This Diagnostic Team achieves the goals of regulating inspections while still working with the current legal circumstances in Costa Rica. Adding this team does not change the structure or number of people in any of the other teams, it only decreases the responsibilities of the Risk Assessment Team to focus on more complicated inspections. By creating regional groups for the Diagnostic Team, we solve the problem of CBCR's Engineering Department being too centralized. This option works within the current limitation of the Engineering Department of only being able to hire four to five more people.

We recommend the Engineering Department to start with creating this Diagnostic Team and providing them the necessary tools to perform the diagnostic inspections and teach the firefighters. We also recommend the Engineering Department to move at least one or two members of the current Risk Assessment team to the new Diagnostic Team. This way, the new Diagnostic Team will not consist of completely inexperienced members who are not familiar with inspections.

Adding the new team with four or five people partially solves the problems of the Engineering Department, but we also recommend that they seek ways of obtaining funding and increase the capacity of their workforce to be able to perform more inspections in a shorter time frame. After they increase capacity, they can consider inspecting every building in Costa Rica for more specialized fire prevention systems. To decide how much they can increase their capacity while still working with their budget, we recommend the Engineering Department to use the excel formula we provided them for calculating the time-frame and the number of inspectors needed to

complete inspections. The formula will not change, but the data that go into the formula might change as the nature of inspections change over the years.

5.2 Teaching the Public and other Organizations about Fire Prevention

Using the findings from our research on developed regulatory fire inspection programs and the citizen surveys in Costa Rica, we concluded that the CBCR should increase their educational activities about fire prevention. This would involve two separate categories of training the inspectors and educating the public about fire prevention, which are discussed next respectively.

a. CBCR's Engineering Department needs to improve training of their personnel.

With a new Diagnostic Team and a regulated inspection procedure, training of both new and existing employees is important. We concluded that with an improved training procedure for both types of inspectors, these inspectors would be able to do a thorough and efficient job with regulated inspections.

To train new employees, like the Diagnostic Team, the training program should be longer to give new inspectors more time to gain knowledge and experience. We recommend that the Engineering Department model their training after Hungary's training program. Hungary's training program is longer in duration than the Engineering Departments, however both programs stress field training more than course work.

Due to the evolving nature of fire inspection regulations and procedures, the Engineering Department will need to train their existing employees as well. We concluded, based on our findings, that the Engineering Department should train existing employees through accruing courses, certifications, and through field experience gained throughout their careers. To do this, we recommend using a program modeling the UK's training program for experienced inspectors. In the UK's program, accomplished inspectors expand their knowledge and remain up-to-date on codes, regulations, and procedures.

Lastly, we recommend that all inspectors be required to have an engineering degree to be able to join the Engineering Department as inspectors. This will allow for an inspector to be respected by business owners when providing recommendations on compliance.

b. CBCR's Engineering Department needs to improve fire prevention educational programs for the public and organizations

If the Engineering Department would like to have a successful program where the results of the inspections are complied with, the organization needs to introduce educational programs for the public about fire safety and prevention. The public will be more likely to comply with inspections if they understand the results and the importance of making the changes. If the public complies with changes, not only are they well educated, but also they are saving the Engineering Department time and money. This is because owners are complying more frequently making inspections faster as the inspectors are not denoting many flaws. This saved time allows the Engineering Department to not have to hire as many employees as inspection

time is less so a smaller number of inspectors can get through a larger number of buildings. With less time and people inspecting buildings the CBCR Engineering Department is saving time and money. To do this though, three target audiences must be educated. These three are: the business owners, the children, and the governing authorities.

For business owners we concluded that the Engineering Department should spend time after the first inspection in a building to educate the owner about fire safety. During an inspection, the inspector can spend time to highlight specific protection issues relevant to the building. Then after the inspection the Engineering Department can provide standardized fire safety brochures, booklets or video tutorials to the business owners in order to teach the basic concepts of fire prevention. In the future, fire prevention packets specific to building types can be prepared to send to building owners for review before opening the building for operation.

Not only should the business owners be taught fire prevention and safety, but also teaching the children impacts the next generation to be fire safe. As of now, the Costa Rican schools are lacking any educational programs regarding fire. As shown by the inspection of the children's nursery school, emergency evacuation procedures aren't even taught to the children by the teachers. Therefore, we concluded that the CBCR should initiate educational programs for fire safety in schools. Materials, such as the Learn Not To Burn educational tools offered by the NFPA should be used in the Costa Rican schools to deliver information to students.

The third target audience is the Authorities Having Jurisdiction. With the current Law of CBCR, the Engineering Department has no authority to enforce any inspections and must ask an Authority Having Jurisdiction to enforce compliance with an inspector's recommendations. With a regulatory fire inspection program, there will be a greater number of buildings to inspect and possibly a larger number of noncompliant buildings. For this reason, we concluded that panels should be held where the Engineering Department, the ministries, and the municipalities gather to discuss fire safety. These panels will improve communication between all of the entities and educate one another on each other's practices.

We understand that some of these changes will not be within the power of the Engineering Department and will lie within CBCR's Department of Education. We recommend that the Engineering Department speak with CBCR's Department of Education regarding how to more effectively educate the public and other organizations about fire prevention.

5.3 Develop a Microsoft Access Database

After conducting our interviews and focus groups our team found that the best option for the Engineering Department to complement our recommended organizational structure and training suggestions would be to utilize Microsoft Access This software it is a more cost effective solution and can be edited and tailored to meet the needs of the regulatory fire inspection program that the Engineering Department is developing. The software has the ability to be linked to a network allowing the inspection forms to be completed on a tablet in the field and be saved to the database. The program also has stronger analytical capabilities then other Microsoft Products the Engineering Department is currently as it contains a search tool known as a query—a search that can be designed by the user in order to find relevant information within the database.

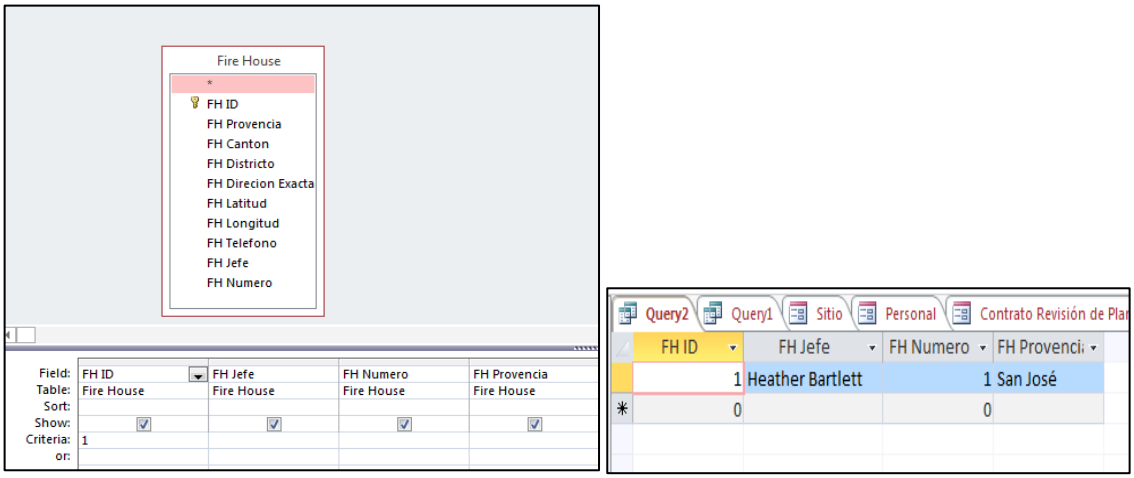

Figure 10: Microsoft Access "query" with its results

Our team developed a model of Microsoft Access, which utilizes a series of identification numbers to indicate the firehouse responsible for the building, the location of the building, the businesses within the location, and any inspection or contract related to a particular building. Using a framework like this means a specific business on the site can be searched systematically within Microsoft Access, eliminating the existing trial and error methods currently used. The software also has the ability to store all existing word, excel, pdfs and photos for all the existing buildings worked on by the entire engineering department of the Engineering Department. As a result, all of the information is stored based on a business' unique identification number. Finally, this system also eliminates duplication of information such as addresses and names, which could be entered incorrectly.

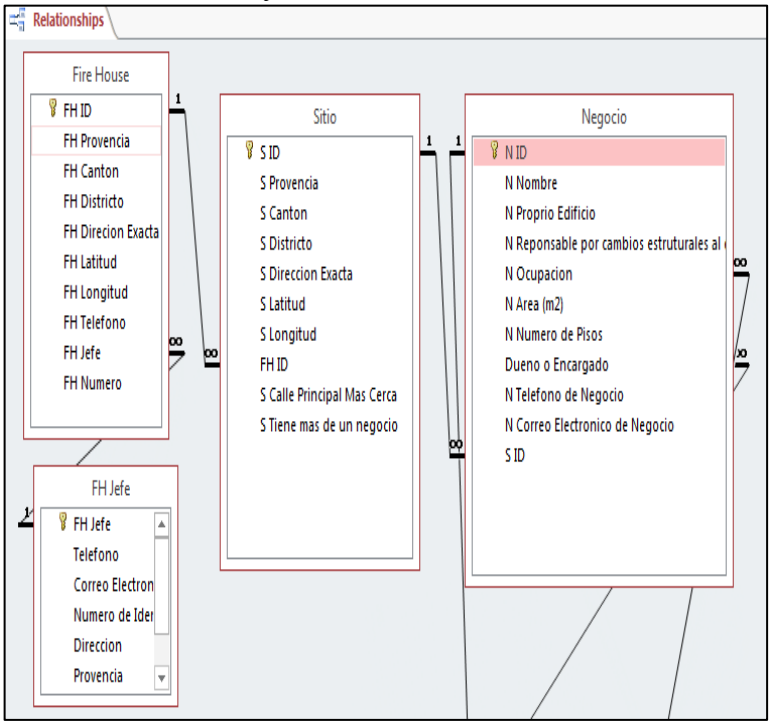

Figure 11: Organization of information in a Microsoft Access file

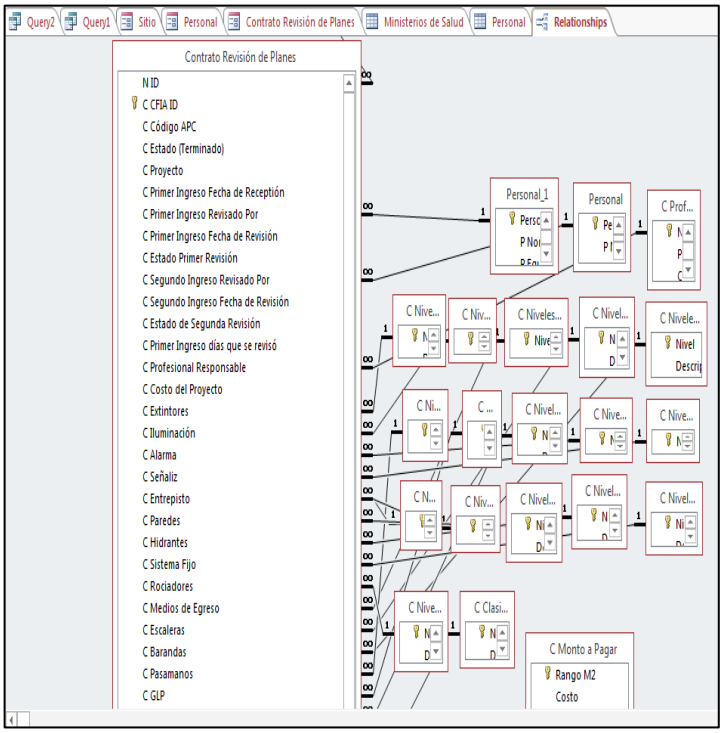

Figure 12: Microsoft Access file adapted to Plan Revision Team's existing Excel file

In order to meet the Engineering Department's goal of inspecting every building in Costa Rica, our team designed a standardized report in Microsoft Access. The report was based upon NFPA-101 Life Safety Code, El Manual de Disposiciones Técnicas and the responses from our focus group. These conditions include the means of egress for the building, compartmentalization, fire barriers, the presence of fire protection equipment, building interior finishes, contents, furnishing, and emergency action plans. This standard form will allow inspections to be completed more efficiently. This report can then be either utilized to generate a letter for Ministry of Health due to non-compliance, stored to be used for a later compliance inspection or the report can be sent to the Engineering Department indicating a more thorough inspection is needed for this particular building.

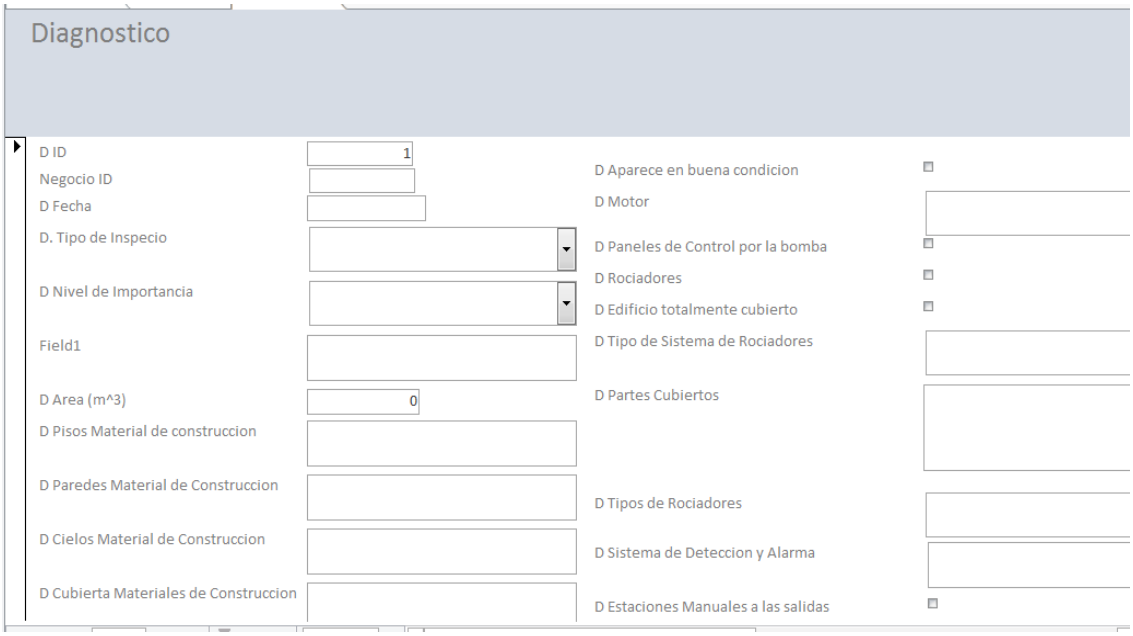

Figure 13: A portion of the Diagnostic Team's report in Microsoft Access model

Using a record keeping system like this will allow the Engineering Department to obtain inspection reports on all buildings and more effectively communicate to either the Ministry of Health issues of non-compliance and to the other teams in the Engineering Department when a building requires a more detailed inspection. Standardizing the information flow will allow the Engineering Department to become more efficient. The next phase of this design would be to work with the Risk Assessment Team and the Systems Testing Team to develop the database so that their future records could be stored within tables in Microsoft Access because they have stronger analytical techniques. The Microsoft Access framework we designed also isn't linked to a network that can be accessed by multiple computers and used remotely. Once the engineering department's existing information is entered into the database it will need to be exported to a network that can be accessed by all of the members of CBCR's Engineering Department. Finally, our team recommends that the database be complete and that the Engineering Department likes the functionally of this record keeping tool and finds it sustainable prior to investing in this technology

Our team found that the most effective way for the Engineering Department to communicate with appropriate ministries is through a standardized letter. This letter would contain a list of non-compliances from the diagnostic report in Microsoft Access. At the present time, the Engineering Department would be working with the Ministries to enforce the findings of an inspection. In our focus group, the heads of the teams within the Engineering Department believed that the decision on what sanctions should be taken for non-compliance, should remain with the appropriate ministry. Therefore the Engineering Departments recommendations should not be included in the letter. The current procedures defined in the Reglamento a La Ley del Benemérito Cuerpo de Bomberos should be followed if the ministries do not take action. Recommendations for how to fix each issue should not be included in the letter because there are many ways to fix non-compliance and this would complicate matters for the Ministry of Health.

5.4 The Engineering Department be can integrated into the Ministry of Health's System

Through our research, interviews, focus group discussion with fire experts and findings, we concluded that the best option is for the Engineering Department to work alongside Costa Rica's Ministry of Health. This will ensure that properties in Costa Rica are free of fire risks. This option also coordinates well with the other components' conclusions of this proposal as discussed in this section.

We recommend that if CBCR were to add inspectors to its Engineering Department, these inspections would be performed through the Ministry of Health's licensing process. The Diagnostics Team as discussed in the Organizational Structure section of this chapter could perform these inspections. Having the extra members to perform the inspections allows the Engineering Department to cover more properties than what they are currently inspecting. The members of this team can make preliminary inspections to either grant or deny fire risk assessments as part of an operating permit certification. If noncompliance within the property is detected, they will then notify the Ministry of Health as well as the corresponding team within the Engineering Department. A proposed flowchart of the process if the Engineering Department is asked to be part of the operating permit process can be found in Appendix O. The Engineering Department can standardize and increase the amount of inspections they perform by working with the Ministry of Health and performing inspections to look for compliance.

Ideally, a property would need to be in compliance with the CBCR's codes and regulations in order to be permitted to function by the Ministry of Health. One way of ensuring this happens is by requiring the designated fire inspector from the Engineering Department to sign off on the certification in order for it to be approved by the Ministry of Health. This step is currently not required by the Ministry of Health. Both entities, the Engineering Department and the Ministry of Health will work together as two separate units that can be of resource to one another. By being involved, these entities will become more effective and efficient with regards to communicating and inspecting well. In order to officially become a part of this process, we recommend that the Head of the Engineering Department to meet with the Ministry of Health and present the severity of this need. This option would allow for all properties in Costa Rica to be subjected to fire inspections at least once every five years in order to be permitted to function. This would help Engineering Department to strengthen their cohesiveness with the Ministry of Health and improve building fire prevention systems in a regulated manner.

5.5 The Most Sustainable Framework for an Improved Regulatory Fire Inspection Program

The above conclusions for each of the four components we believe will provide the Engineering Department with the most sustainable program for their organization. These conclusions will work effectively with the available resources and the existing CBCR's Law. The addition of a Diagnostic Team to the engineering department will standardize inspections and allow for more buildings to be inspected. This team allows for the engineering department to train other members of the organization and allows for further growth within the program. By working alongside the Ministry of Health to certify operating permit, the diagnostic team will improve communication, thus educating the Ministry of Health and citizens with regards to fire prevention. The combination of enforcement from the Ministry of Health and the education of

the public will more effectively promote fire prevention compliance in the Costa Rican Community. The increased number of inspections and more frequent communication with the Ministry of Health will be made possible through improved records keeping system using Microsoft Access. The components will work cohesively to provide the Engineering Department with an improved regulatory fire inspection program, which will save lives.

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Appendix A - Interview Questions for Ken Willette, Division Manager for Public Fire Protection at the National Fire Protection Association

1. How do you go about writing a job description for a position such as a Fire Marshal? What types of research and background work is done?
2. What kinds of changes are made when the new additions to documents like 1037 are written? What types of concepts are frequently discussed to be adopted into the code?
3. How do you find these codes to be most frequently modified when an Authority Having Jurisdiction adopts them?
4. What are some of the topics that come up with regards to 1037 when going through the technical meetings, who are involved in this particular case? What are the arguments that you most frequently see?
5. What are some recommendations that you have if there isn't someone who has all of these qualifications? What skills would you want to look for in a person in order to fulfill these roles?
6. What are some recommendations that you would have for us if we have to create our own job descriptions for these roles to fit into the existing programs in Costa Rica?
7. May we send you an email or contact you if there is further development after meeting with our sponsor in Costa Rica?

Appendix B- Interview Questions for Steve Sawyer, the Secretary of International Fire Marshal Association

1. Tell us about your role within the International Fire Marshal Association. What is your role and what are some of the tasks that you do?
2. Tell us about the International Fire Marshal Associations most recent achievements or those that are most noteworthy in your opinion?
3. Can you inform our team a little bit about your experience as a Deputy Fire Marshal? What were some of the tasks that you handled in particular?
4. Going back to your time in that role, if you were to design the job description or the tasks for that particular position, what roles and responsibilities would you have created and/or changed?
5. Tell us about the different Fire Marshals that you deal with. I know that your website mentions that you work at a state and local level. Can you give us some examples of the different groups that you have worked with?
6. What types of international fire marshals or organizations do you work with?
7. Tell me about some of the biggest variations between these Fire Marshal programs that you deal with. Specifically with regards to their structure and how they handle certain situations?
8. In your opinion, which Fire Marshals and/or their programs are the best designed with regards to how they function?
9. One of the International Fire Marshal Associations tasks deals with the union of officials that work to fight fire. How does this group go about actually doing this? We are going to be incorporating this "Fire Marshal" Model into an existing government and existing governmental authority.
10. How does involvement of many Fire Marshals in the codes and standards enhance the codes in your opinion? We are dealing with the adoption of some NFPA codes, but many buildings may not be up to those standards developed by the code. How do you make this transition?
11. Having trouble right now getting information in exactly how each Fire Marshal Functions at different levels? Where do you recommend going in order to get information regarding specific fire marshal's processes?
12. May we send you an email? As we speak more with our sponsor in CR we may develop a few follow up questions?

Appendix C - Interview Questions for Dan Downes, Syracuse Fire Department Lieutenant

1. Who is the Fire Marshal in Syracuse?
2. Is the Fire Marshal part of the Fire Department in Syracuse?
3. Do you know what the fire marshal's district entails?
4. What roles does the fire marshal play?
5. What is the difference between what inspections you do as a fire fighter and what inspections that the Fire Marshal does?
6. Do you know if the city has written information about the job (job description)?
7. Are the records that the fire marshal or the firemen do part of public record? If so do you know where they list that stuff?
8. Do you know where the fire marshal is based within the city?
9. Where are the judicial differences between the responsibilities of the fire marshal and the firemen?

Appendix D - Interview Questions for Maryanne Pickett, Lieutenant in the Worcester Fire Department

1. What is your role in the organization?
2. How do you educate your fire inspectors in what to do out on the field?
    -Is there both theory and practice aspects to this education/ training program?
3. Do you use a specific checklist when inspecting buildings that is common to all buildings?
    -With this what is your recording mechanism to keep track of the inspections?
4. Is there a reporting structure for the results of a fire inspection?
5. How do you make sure that building owners follow the results and recommendations? Are there any laws or punishments in place to ensure compliance?
6. Are there any differences in inspections when it comes to different types of buildings such as a hospital, school, hotel or shopping mall? Are these considered High Risk areas?
    -Are there any exceptions for old buildings?
7. What department does the prevention team in Worcester fall under?
8. For the Worcester population how many fire inspectors do you have?
9. What is the organizational structure of your fire prevention organization?
    -What would you recommend for a department to focus if they are recently implementing a prevention structure?

Appendix E - Interview Questions for Professor Angel Rivera, Professor in WPI Humanities and Arts Department

1. What were your perceptions when living in Puerto Rico of citizen perception when government established some new types of mandate or regulation?
2. What is your perception of how people feel with regards to fire protection/safety?
3. If you were looking to understand public perception on an issue such as fire safety how would you go about doing it? Would you stop and talk to business owners?
4. In general, would you think that people would be willing to invest in order to make their properties safer? In the perception of Puerto Rican culture what would be considered an acceptable amount of time to make these changes?
5. Are there any other societal perceptions or culture comments that we should be considering?

Appendix F - Interview Questions for Rolando Leiva Ulate, Engineer in the Plans Review Team of the Engineering Department of the Cuerpo de Bomberos de Costa Rica

1. **Estructura Organizacional:**
    1. ¿Me podría aclarar cuántas personas están trabajando en este equipo en este momento? ¿Recibe ayuda de otras personas?
    2. En promedio, ¿cuántos planes revisa anualmente? Mencionaste 2000 para el año pasado. ¿Esto es típico o existe una tendencia creciente? ¿Cree que el número de personas que trabajan en el equipo es suficiente para revisar todos estos planes?
    3. Aproximadamente cuánto tiempo se tarda en revisar un plan de construcción en términos de horas?
    4. ¿Cuál es la estructura de su equipo? Usted pertenece al departamento de ingeniería, pero ¿a quién reporta? ¿Hay un administrador para el equipo? ¿Con cuáles otros equipos trabaja usted regularmente?
    5. ¿El equipo de revisión del plan realiza inspecciones? ¿Cuál es el criterio que se utiliza para decidir si un plan de construcción requiere una inspección en el sitio? (¿Cómo seleccionó los 80 planes del año pasado cuando habían 2000?)
    6. ¿Cree usted que la cantidad actual de las inspecciones in situ es suficiente? ¿Qué porcentaje es una meta realística para inspecciones in situ?
    7. Aproximadamente, ¿qué porcentaje de estos planes que se revisan anualmente se encuentra en San José? ¿Qué porcentaje se encuentra fuera de San José? ¿Puede darnos estadísticas basadas en los tipos de construcción y la geografía?
    8. Cuando usted va a las inspecciones in situ, ¿estos lugares están ubicados mayormente en o cerca de San José? ¿Usted va a inspecciones en otras regiones también? ¿Puede darnos estadísticas basadas en los tipos de construcción y la geografía?
    9. ¿Cree usted que las restricciones de transporte son un obstáculo al tener acceso a otras regiones y la realización de inspecciones in situ en las regiones?

2. **Educación y Entrenamiento:**
    10. ¿Qué conocimientos técnicos se necesitan para llegar a ser un miembro del equipo de los planes de construcción y revisiones?

11. ¿Cuáles son los pasos educativos que usted toma para poder adquirir estas habilidades técnicas? ¿Por cuánto tiempo? El proceso de educación se basa en el salón de clase o es basado por el trabajo en situ?
12. ¿Usted toma cursos anuales después de completar su educación inicial?
13. ¿Un bombero voluntario sin experiencia será capaz de adquirir estas habilidades pasando por la misma formación y podrá revisar estos planes o asistir a las inspecciones en las regiones más alejadas de la ciudad? ¿O se requiere cierta experiencia anterior para el trabajo?

3. Sistemas de Grabación:

14. ¿Nos puede mostrar un ejemplo de un documento que se crea después de completar una revisión?
15. ¿Se mantiene un registro de estos documentos completados? En caso afirmativo, ¿en qué forma los guardan?
16. ¿Se mantiene un registro de cambios hechos a la revisión del plan después de recibir sus recomendaciones?
17. ¿Qué tan efectivo es el sistema de registro actual que se utiliza? ¿Es suficientemente detallado que podría ser utilizado en una corte de justicia?

4. Legislación:

18. ¿Qué tipo de problemas ha observado Ud. In situ que Ud, puede referirse a otra entidad que tiene jurisdicción como el Ministerio de Salud o la policía?
19. ¿Cuál es el proceso que usted seguiría si tuviera que hacer esto? ¿Puede darnos un ejemplo?
20. ¿Cómo se forman estas conexiones con el Ministerio de Salud y el departamento de policía?
21. ¿Usted quiere tener un empleado de su departamento que será capaz de hacer cumplir las sanciones jurisdiccionales, o usted prefiere tener más recursos contactos que implementa el sanción judicial por usted?
22. ¿Usted anticipa enfrentar cualquier oposición a o dificultades con estas revisiones?
23. ¿Cómo son compensadas las inspecciones in situ que usted realiza ? Par las inspecciones voluntarias de edificios, entendemos que las personas llaman y están dispuestos a pagar por ello, pero para las

revisiones de edificios, usted revisa todos los planes. (Cuota del permiso?)

24. ¿Usted hace algún tipo de revisión a los edificios existentes?

Appendix G - Interview Questions for Solano Bermudez, Chief of the Risk Assessment Team of the Engineering Department of the Cuerpo de Bomberos de Costa Rica

a. **Estructura Organizacional**, **Educación y Entrenamiento y Preguntas Generales:**
    1. ¿Cómo usted describiría su posición? ¿Cuáles son sus papeles y responsabilidades? ¿Usted tiene un documento escrito para esta descripción de las funciones?
    2. ¿Cuál es el proceso educativo que usted hace para adquirir estas habilidades?
    3. -¿Crees que usted necesita algunos cursos para mantenerse actualizado?
    4. -¿En que te gustaría entrenamiento adicional si nos trasladamos a las inspecciones asignadas a ser mandatas? (multas, leyes)
    5. -¿Usted tiene miembros del equipo especializado para examinar diversos tipos del edificio?
b. 3. ¿En promedio, cuántos edificios examina usted anualmente en total? ¿Es el número de la gente en este equipo actualmente adecuada para todos éstos?
    1. -¿Qué edificios usted visita lo más frecuentemente que han pedido una inspección?
    2. -¿Qué porcentaje está en San José y qué porcentaje está fuera de San José?
    3. -¿Hay restricciones del transporte para las inspecciones al exterior de San José?
    4. -¿Las estaciones de bomberos le divulgan información aplicable o asisten a su equipo de alguna manera?
    5. ¿Cuáles son los costos asociados con las inspecciones voluntarias? ¿Varía con el tipo de edificio?
    6. -¿El gobierno u otra organización suple algunas de estas inspecciones o provee los dueños de los edificios con incentivos?
    7. -¿Usted piensa si las inspecciones estuvieran gratis más gente pedirían ser examinadas y realizar los cambios?
5. En una inspección, cuáles son los tipos de cosas que usted busca?
6. ¿Cuántas horas duras en sitio examinando y cuántas duras en la oficina para una sola inspección?
    8. -Qué edificios son lo más complejo y desperdiciador de tiempo para usted?

9. -¿Cuál es el proceso si un problema se encuentra en un edificio con una inspección voluntaria?

7. ¿Usted encuentra desperfectos en un tipo de edificio más que los otros?
8. ¿Usted siente que bombero (voluntario o entrenado) podría realizar las partes más básicas de su inspección?
9. ¿Pueden los dos equipos voluntarios de la inspección trabajar en conjunción? ¿Hay habilidades que no se traducen entre ambos equipos?

c. Sistemas de Grabación:

10. ¿Usted sigue reglas específicas del NFPA o de otras organizaciones internacionales o domésticas al terminar estas inspecciones?
11. ¿Usted utiliza una lista de comprobación?
12. ¿Cómo se parece un reporte de una de sus inspecciones ¿Cómo usted anota estos informes? ¿Cómo?
13. ¿Usted tiene una base de datos de toda la información que usted recoge? ¿Cómo trabaja? ¿Usted desea que podría hacer cualquier cosa que no hace presentemente?
14. ¿Usted preferiría tener su propia base de datos o uno que es para el departamento de ingeniería entero?
15. ¿Usted solo puede llenar el reporte en la oficina o tiene un método portable para accesar la base de datos en sitio?
16. ¿Cómo usted mide si hay una disminución del riesgo de fuego con estos esfuerzos?

d. Legislación:

17. Como las inspecciones son voluntarias pero le pagan a usted para este servicio, usted le reporta problemas a cualquier autoridad del exterior?
    1. -¿Quién? ¿Qué tipos?
18. Piense en una situación donde había un problema de incendios en un edificio. ¿Cuál sería su proceso a reportar o arreglar este evento?
19. ¿Usted tiene un abogado o una organización que le ayuda cuando hay problemas con los edificios?
20. ¿Generalmente, la gente reciben sus recomendaciones y los cambios de buena manera? ¿Hay partes de las recomendaciones con que se conforman con más que otros?
21. ¿Qué los está parando de cumplir con los arreglos?
22. Aunque exista un problema o no, ¿crees que estos edificios públicos deben demandar que mejoren sus sistemas regularmente?
23. ¿Tiene la gente los recursos a conformarse si estas inspecciones sean mandatas?

24. ¿Mandando inspecciones mejoraría la seguridad total de los edificios? o la población todavía no cumpliría con los cambios?

Appendix H - Interview Questions for Ulises Cornejo Quintana, Chief of the Systems Testing Team of the Engineering Department of the Cuerpo de Bomberos de Costa Rica

1. **Estructura Organizacional**, **Educación y Entrenamiento y Preguntas Generales:**
    1. ¿Cómo usted describiría su posición? ¿Cuáles son sus papeles y responsabilidades? ¿Usted tiene un documento escrito para esta descripción de las funciones?
    2. ¿Qué habilidades técnicas se requieren para ser un miembro del equipo voluntario de la inspección?
    3. ¿Cuál es el proceso educativo que usted hace para adquirir estas habilidades? ¿Cuánto tiempo? ¿Salón de clase o experiencia?
    4. ¿Usted necesita algunos cursos para mantenerse actualizado? ¿Cursos anuales?
    5. ¿En qué te gustaría entrenamiento adicional si nos trasladamos a las inspecciones asignadas a ser mandatas? (multas, leyes)
    6. Estructura del equipo. ¿El equipo tiene un líder? ¿A quién usted le reporta y con quiénes trabaja de cerca con?
    7. ¿Usted tiene miembros del equipo especializado para examinar diversos tipos del edificio?
    8. ¿En promedio, cuántos edificios examina usted anualmente en total? ¿Es el número de la gente en este equipo actualmente adecuada para todos éstos?
    9. ¿Qué edificios usted visita lo más frecuentemente que han pedido una inspección?
        i. -¿Qué porcentaje está en San José y qué porcentaje está fuera de San José?
        ii. -¿Hay restricciones del transporte para las inspecciones al exterior de San José?
    10. ¿Las estaciones de bomberos le divulgan información aplicable o asisten a su equipo de alguna manera?
    11. ¿Cuáles son los costos asociados con las inspecciones voluntarias? ¿Varía con el tipo de edificio?
    12. ¿El gobierno u otra organización suple algunas de estas inspecciones o provee los dueños de los edificios con incentivos?
    13. ¿Usted piensa si las inspecciones estuvieran gratis más gente pedirían ser examinadas y realizar los cambios?

14. ¿Caminamos por una inspección y cuáles son los tipos de cosas que usted busca?
15. ¿Cuántas horas duras en sitio examinando y cuántas duras en la oficina para una sola inspección?
16. ¿Qué edificios son lo más complejo y desperdiciador de tiempo para usted?
17. ¿Cuál es el proceso si un problema se encuentra en un edificio con una inspección voluntaria?
18. ¿Usted encuentra desperfectos en un tipo de edificio más que los otros?
19. ¿Usted siente que bombero (voluntario o entrenado) podría realizar las partes más básicas de su inspección?
20. ¿Pueden los dos equipos voluntarios de la inspección trabajar en conjunción? ¿Hay habilidades que no se traducen entre ambos equipos?

2. Sistemas de Grabación:

21. ¿Con que frecuencia encuentra usted que los edificios tienen sistemas de prevención contra los incendios? ¿La existencia varía con el tipo de edificio o por la localización geográfica?
22. ¿Qué se requiere tener con respecto a la prevención contra los incendios?
23. ¿Sea que algunos edificios se requieren tener más sistemas de prevención que otros? Hospitales por ejemplo.
24. ¿Usted hace las recomendaciones para que sistemas adicionales sean añadido?
25. ¿Cuáles sistemas encuentra que son los más críticos para la protección en Costa Rica?
    i. Rociadores contra incendios
    ii. Detectores de humo y calor
    iii. Sistemas de notificación
    iv. Cerramiento automático de las puertas
26. ¿Usted tiene documentos o instrucciones escritos para hacer estas inspecciones?
27. ¿Puede enseñarnos un reporte de resultados?
28. ¿Generalmente, en qué condiciones están los sistemas de alarma en los edificios?
29. ¿Crees que es práctico que todos los edificios públicos sean requeridos a tener sistemas de protección?
30. ¿Qué tipos de registros guarda su equipo y qué reporte le da al dueño?

3. Legislación:

31. Como las inspecciones son voluntarias pero le pagan a usted para este servicio, usted le reporta problemas a cualquier autoridad del exterior?
    i. Quién? ¿Qué tipos?
32. Piense en una situación donde había un problema de incendios en un edificio. ¿Cuál sería su proceso a reportar o arreglar este evento?
33. ¿Usted tiene un abogado o una organización que le ayuda cuando hay problemas con los edificios?
34. ¿Generalmente, la gente reciben sus recomendaciones y los cambios de buena manera? ¿Hay partes de las recomendaciones con que se conforman con más que otros?
35. ¿Qué los está parando de cumplir con los arreglos?
36. Aunque exista un problema o no, ¿crees que estos edificios públicos deben demandar que mejoren sus sistemas regularmente?
37. ¿Tiene la gente los recursos a conformarse si estas inspecciones sean mandatas?
38. ¿Mandando inspecciones mejoraría la seguridad total de los edificios? o la población todavía no cumpliría con los cambios?

Appendix I – Survey on Public Education and Fire Prevention For The Citizens of Costa Rica

The survey below was administered to 28 building owners in Costa Rica. Not all 28 answered all of the questions. We had an average of 16 responses per question. The numbers of people that choose certain options are provided in parenthesis next to the options with the questions.
(Grupo encuestado: Ciudadanos costarricenses y dueños de negocios)
Gracias por su participación en esta encuesta. Por su privacidad, por favor no incluye su nombre en las repuestas. Las respuestas estarán destruidas después de revisarlas.

1.) ¿Crees que los incendios en edificios son un problema en Costa Rica?
a. Sí (11)
b. No (5)

2.) ¿Cuántos incendios en edificios cree que suceden en Costa Rica cada año?
a. 0-400 (10)
b. 400-800 (4)
c. 800-1.200 (2)
d. 1.200-1.600 (0)
e. 1.600+ (0)

3.) ¿Recuerda usted de algún incendio importante en Costa Rica? En caso afirmativo, cuándo y dónde sucedió el incendio?
a. No (4)
b. Sí, Fecha:_____ Lugar:_____ (11)

4.) ¿Crees que el número de incendios en Costa Rica han ido aumentando o disminuido en los últimos años?
a. Creciente (10)
b. Decreciente (6)

5.) En una escala de 1 a 5, ¿que tal seguro se siente usted en los siguientes edificios?

a. Hospitales;	Inseguro	1 2 3 4 5	Seguro	(Average 3)
b. Centros Comerciales;	Inseguro	1 2 3 4 5	Seguro	(Average 3.8)
c. Hoteles;	Inseguro	1 2 3 4 5	Seguro	(Average 3.27)
d. Edificios de oficinas;	Inseguro	1 2 3 4 5	Seguro	(Average 3.27)

e. Escuelas; Inseguro 1 2 3 4 5 Seguro (Average 2.8)
f. Iglesias; Inseguro 1 2 3 4 5 Seguro (Average 2.93)

6.) ¿Se sentiría más seguro si los edificios fueran inspeccionados para asegurarse de que cumplen con la normativa de protección contra incendios?
a. Sí (16)
b. No (0)

7.) ¿Le resultará beneficioso aprender cómo llevar a cabo una inspección de prevención de incendios en su hogar?
a. Sí (16)
b. No (0)

8.) ¿Cree usted que si las inspecciones de incendios fueran obligatorias, se reduciría el número de incendios que se producen en Costa Rica cada año?
a. Sí (14)
b. No (1)

Por favor, conteste las siguientes preguntas si usted es propietario de un negocio o eres dueño de una propiedad donde se dirige un negocio.

9.) ¿Alguna vez ha pedido que su lugar de trabajo sea inspeccionado en seguridad contra incendios? ¿Con qué frecuencia?
a. Sí, _____ (2) (Una vez al ano)
b. No (11)

10.) ¿Cree que las inspecciones de incendios deben ser obligatorias?
a. Sí (13)
b. No (1)

11.) ¿Está dispuesto usted a recibir las recomendaciones hechas por el Cuerpo de Bomberos?
a. Muy dispuesto (12)
b. Algo dispuesto (2)
c. Sin opinión (0)
d. No estoy dispuesto (0)

12.) ¿Qué preocupaciones tendrías si se requieren inspecciones de bomberos en su negocio? Puede marcar más de un ítem.
a. Conocimiento - No sé cómo hacer los cambios requeridos. (7)

b. Tiempo - Estoy demasiado ocupado con mi trabajo para dedicar tiempo a hacer estos cambios (5)
c. Financiera - Yo no sería capaz de hacer los cambios. (7)
d. Trabajo - No tengo mano de obra disponible para físicamente hacer estos cambios. (3)
e. Propiedad - No creo que nadie deba tener control sobre lo que se hace en mi negocio. (0)
f. Necesidad – No creo que mi propiedad necesita una inspección (1)
f. Otros - (Por favor explique)
_____

13.) Si su negocio tuviera que ser inspeccionado por el Cuerpo de Bomberos, ¿cree usted que su negocio sería considerado inseguro?
A. Sí (2)
B. No (8)
C. No sé (2)

14.) ¿Su edificio tiene los siguientes? (Círculo todas las que correspondan)

A. Sistema fijo contra incendios	Sí (0)	No (13)
B. Extintores portátiles contra incendios	Sí (11)	No (2)
C. Hidrantes	Sí (1)	No (12)
D. Dispositivos de alarma de incendios	Sí (3)	No (9)
E. Sistemas de detección de incendios	Sí (2)	No (11)
F. puertas de salida de emergencia	Sí (8)	No (6)
G. Sistemas de ventilación de humo	Sí (4)	No (9)
H. Iluminación de emergencia	Sí (3)	No (10)
I. Señalización de salidas	Sí (7)	No (3)
K. Plan de Emergencias	Sí (7)	No (4)

15.) ¿Con qué frecuencia cree que sería apropiado que su empresa sea inspeccionada por el Cuerpo de Bomberos?
A. Sólo una vez (0)
B. Una vez al mes (4)
C. Una vez al año (9)
D. Una vez cada 5 años (1)
E. Una vez cada 10+ años (0)
F. Nunca (0)

16.) Si la inspección encuentra incumplimientos o riesgos, ¿cuánto tiempo es adecuado para hacer ese cambio?

a. Nunca - Yo no debo ser obligado a hacer cambios (0)
b. 1 Semana (0)
c. 1 Mes (6)
d. 6 Meses (5)
e. 1 Año (2)

17.) ¿Qué consecuencia debe ser aplicada por incumplir la normativa de protección contra incendios?

a. Multa (6)
b. Multas recurrentes hasta el cumplimiento (2)
c. Tiempo en la cárcel (0)
d. Cierre del negocio (2)
e. Ninguno (3)
f. Otro: (Explique) _____

18.) ¿Le preocuparía si un inspector de incendio que usted no conoce entra a inspeccionar su negocio?

A. Sí (8)
B. No (6)

19.) ¿Estaría más cómodo con las inspecciones de incendio si conociera al bombero que inspecciona su negocio?

a. Sí (12)
b. No (0)
c. No sé (1)

20.) ¿Crees que pagando por las inspecciones contra incendios o la instalación de sistema de protección contra incendios crearía problemas financieros para su negocio?

A. Sí (10)
B. No (2)

21.) Si incentivos como exenciones fiscales fueron disponibles para usted como dueño de un negocio, ¿estaría más inclinado a invertir en sistemas de protección contra incendios? (pensar en primas de seguros)

A. Sí (8)
B. No (2)

22.) Si una certificación de incendios estuviera disponible, ¿estaría más dispuesto a invertir en sistemas de protección contra incendios?
A. Sí (9)
B. No (2)

Appendix J - Interview Questions for Juan Carlos Cambronero Barrantes, Salud Ocupacional y Atencion de Emergencias, Municipalidad de Belen

¿Conoce usted la Ley 8228 (Ley del Benemérito Cuerpo de Bomberos de Costa Rica) y lo que indica el artículo 15, sobre las autoridades competentes de otorgar permisos y patentes?

Artículo 15. —Autoridades competentes. Las autoridades competentes, en el momento de verificar los requisitos para otorgar permisos de funcionamiento, realización de actividades, ejercicio del comercio, patentes, aprobación de planos o diseños y otros de similar naturaleza, revisarán si el administrado cumple lo dispuesto en el artículo anterior.

1. ¿Cuál es su opinión al respecto?
2. ¿Estaría su departamento en condición se exigir el cumplimiento?
3. ¿Este departamento revisa la aplicación del reglamento de seguridad humana y protección contra incendios? (Multas, cierre, eliminación de patentes…)
    -¿Cómo qué?
    -¿Hay reportes que van junto con éstos procedimientos?
    -¿Quién tiene la capacidad de dar multas?
    -¿Hay una manera de cómo este municipio recupera los costos de i inspeccionar los edificios?
4. ¿Ustedes (municipalidad) coordinan con el Cuerpo de Bomberos?
    -¿Bajo qué circunstancias o que temas?
    -¿Con los bomberos locales o con el departamento de ingeniería?
        i. ¿Cuantas estaciones tiene en su municipio y con qué frecuencia trabaja con ellas?
        ii. ¿Con quién trabaja en el departamento de ingeniería?
5. Conocen ustedes (en la Municipalidad, cual es la función preventiva del Cuerpo de Bomberos de Costa Rica.
6. ¿Hay oposición de los ciudadanos en éste municipio para cumplir con sus recomendaciones de la normativa de protección contra incendios?
    -¿Que opina de que el Cuerpo de Bomberos haga que las inspecciones de incendios sean obligatorias?
        i. ¿Cómo esto afectaría o beneficiaría el trabajo de la municipalidad?
        ii. ¿Cuál podría ser la forma más efectiva de hacer que las personas cumplan con las inspecciones de incendios en este municipio?

-¿Su departamento tiene incentivos para promover el cumplimiento de la normativa de protección contra incendios dentro del municipio?

Appendix K – Roles of the teams in each of the Organizational Structure alternatives provided for the Cuerpo de Bomberos

Alternative 1- Risk Assessment Team Regional Focus Restructure:

-Perform inspections within the regions they are responsible for
-Complete reports that are sent to the head of the department
-Prepare a basic report for the building owners and the Ministry of Health
-Suggest adaptations to fix the problems they have found in a more detailed report if requested
-Maintain a personal relationship with their perspective ministries and understand how best to work with them
-Provide re-inspections for the Ministry of Health as requested
-Complete inspections strategically by starting with the buildings of more concern to the public

Meetings:
-Bi-weekly or monthly meetings
-Discuss major findings, buildings of concern, actions taken by the ministries in their area
-General adaptations being suggested

Alternative 2- Risk Assessment Team Building Type Focus Restructure:

-Perform inspections for their respective type of buildings
-Complete reports that are sent to the head of the department
-Prepare a basic report for the building owners and the Ministry of Health
-Suggest adaptations to fix the problems they have found in a more detailed report if requested
-Contact the other teams in the engineering department for expertise
-Provide re-inspections for the Ministry of Health as requested

Meetings:
Bi-weekly or monthly meetings
Discuss major findings, buildings of concern, actions taken by the ministries about their building type
General adaptations being suggested

Alternative 3- Diagnosis Team Addition Structure:

Diagnosis Team Roles:

-This team covers less important existing buildings with a basic diagnosis inspection.
-Refers buildings of major concern encountered during the diagnosis inspection to the Risk Assessment Team
-Works with the goal of providing every building in Costa Rica with some type of inspection
-Works with and educates the local fire houses on how to perform the diagnosis inspections
-Maintains relationships with the Ministry of Health and send basic reports to the ministry and to building owners about the results from the diagnosis inspection
-Ensures that the local fire houses become familiar with the important buildings of concern

In the future, this team potentially becomes education and enforcement team if the Cuerpo de Bomberos gain enforcement authority.

Risk Assessment Team Changed Roles:

-Covers inspections of important public buildings of concern
-Performs more detailed inspections in the buildings that the team inspects
-Performs inspections on buildings that are referred by the Diagnosis Team after a diagnosis inspection

Appendix L –List of Advantages and Disadvantages of each of the Organizational Structure alternatives provided for the Cuerpo de Bomberos

Alternative 1- Risk Assessment Team Regional Focus Restructure:

Advantages:

-Changes to the original structure of the Engineering Department of the Bomberos is kept minimum, only the Risk Assessment Team is restructured.
-There is a team of experts located in the headquarters to deal with complicated inspections on certain structure types.
-In the future regional inspector teams can be introduced to have easier access to regions, quick response times and maintain a close relationship with the local ministries.
-If the regional inspectors are introduced, the specialized team can focus on education of new inspectors and complicated inspections in the future.
-With 5 different building type teams, and 2 in each, requires 10 people initially, which is only 4 more than the current employees in the risk assessment team.

Disadvantages:

-If the regional inspectors are introduced, they will have to group their inspection information and send it to respective building type team in the headquarters. Therefore, technically each inspector will have 5 bosses that they report.
-Regional inspectors will not have a designated "Head" in the headquarters
-Regional inspectors, rather than a higher authority will maintain relationship with ministries, which may create problems related to a lack of higher rank authoritative figure when communicating with ministries
-It is not designated which person from the headquarters should attend to the regional meetings. As each region technically have 5 teams they report to, a member from all 5 teams may need to be present in the regional meeting rather than only 1 person
-Inspectors in Costa Rica are expected to have knowledge about all prevention systems and type of buildings. Therefore, building specialization may not be beneficial for inspectors.

Alternative 2- Risk Assessment Team Building Type Focus Restructure:

Advantages:

-Changes to the original structure of the Engineering Department of the Bomberos is kept minimum, only the Risk Assessment Team is restructured.
-There is a team of experts located for each region in the headquarters to deal with complicated inspections in the regions
-One person from the region teams in the headquarters becomes the authoritative figure for the region and therefore can be in contact with the ministries as an authoritative figure responsible for the region.
-Regional inspector teams are utilized to have easier access to regions, quick response times and maintain a close relationship with the local ministries.
- Having information organized according to regions shows the differences among the regions and therefore teams are able to shift their focus with the varying nature of inspections among regions. This shows resemblance to the structures used internationally.
-With 4 regional teams, the new structure requires 11 people initially, which is only 5 more than the current number of inspectors in the risk assessment team.
-When the regional inspectors are introduced in the future, the reporting structure will be simple and direct, as each team will have its designated leader in the center.
-Creates the basis for future regional division, which is the type of division structure that is most utilized around the world in regulatory fire inspection programs
-In the future when regional inspectors are introduced, this team becomes the link between the regional inspectors and headquarters. Therefore, each region has at least 1 representative in the headquarters.

Disadvantages:

-Specialization in the headquarters is focused on regions, which may result in not capturing the differences that may come up in inspections due to different building types.
-The authoritative contact for the regional ministries is located in the headquarters in San Jose, which may decrease the quality of communication. Making regional inspectors the primary contact can solve this.
-The regional inspectors go to all building types, so there is no division in terms of building type. However, in the future it is possible to have a specialist for each type of building located in the region.

Alternative 3- Diagnosis Team Addition Structure:

Advantages:

-Separates the detailed Risk Assessment inspections that are performed on the buildings from the basic diagnostic inspections.

-Since there are a lot of old buildings in Costa Rica that are not inspected at all, releases pressure from the Risk Assessment team by taking basic inspection duties from that team. The diagnostic team can focus on making sure every building in Costa Rica is inspected at least once, while the Risk Assessment team can focus on the detailed inspections in important public buildings.

-Adding this team creates a formal procedure for following up the results of the inspections with ministries and the building owners, which was a weak aspect in the current structure.

-This team has the tools and abilities to work with the building owners towards progress on their own safety, which will result in better compliance whether it is with or without enforcement.

- This team fulfills the communication duties with building owners and the ministries, which is really important in order to show both parties the importance of fire prevention and the risks associated with non-compliance.

- The regional component is still added to this team to have the focus of covering entire Costa Rica with the basic diagnostic inspections.

-The team consist of 4-5 members, which is the current capacity that the Cuerpo de Bomberos can hire additional to the current workforce.

-In the future, this team will have the technical capabilities to assume enforcement responsibilities if enforcement power is given to the Cuerpo de Bomberos of Costa Rica.

Disadvantages:

-The team is a brand new team with brand new responsibilities that the engineering department is not familiar with, so there will be a learning process.

- The authoritative contact to follow up the regional ministries is located in the headquarters in San Jose, which may decrease the quality of communication. Stationing the Diagnosis Team in the regions may change this.

-With this structure, there are no designated regional inspectors for the detailed inspections that the Risk Assessment Team will be performing on buildings. The Risk Assessment Team will still have travel time and coordination issues when performing the detailed inspections. To solve this, two of the suggested structures can be merged to create both a new structure for the Risk Assessment Team and add a Diagnosis Team. However, since Risk Assessment Team will only be performing detailed inspections, the regionalization is not essential for the Risk Assessment Team with this structure.

Appendix M – Labor Force Requirements Calculations and Excel Sheet Formula Screenshots

A.Calculating Number of Weeks Needed to Complete Inspections

Total Risk Assessment Inspection Hours/building				Estimate Total Number of Uninspected Buildings In CR		Needed # Weeks to Complete Inspections		Total Inspectors Desired/Week		Work Hours/Week
On Field	Reporting	Total								
6	6	12	*	1000	=		*	6	*	40

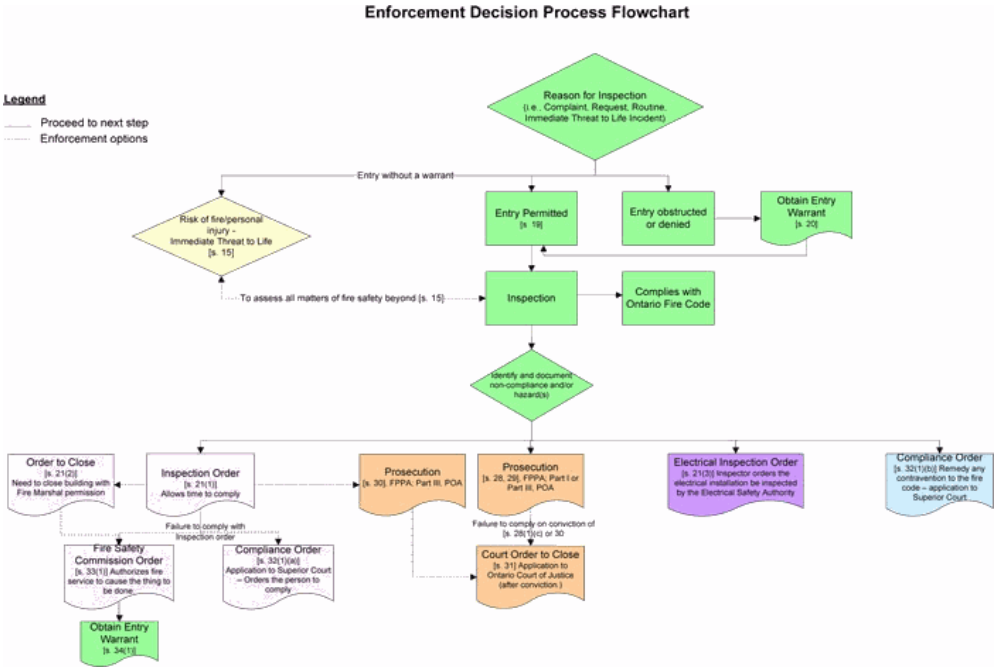
Total Risk Assessment Inspection Hours/building				Estimate Total Number of Uninspected Buildings In CR		Needed # Weeks to Complete Inspections		Total Inspectors Desired/Week		Work Hours/Week
On Field	Reporting	Total								
6	6	12	*	1000	=	50	*	6	*	40

B.Calculating Total Inspectors Needed per Week

Total Risk Assessment Inspection Hours/building				Estimate Total Number of Uninspected Buildings In CR		Needed # Weeks to Complete Inspections		Total Inspectors Desired/Week		Work Hours/Week
On Field	Reporting	Total								
6	6	12	*	1000	=	25	*		*	40

Total Risk Assessment Inspection Hours/building				Estimate Total Number of Uninspected Buildings In CR		Needed # Weeks to Complete Inspections		Total Inspectors Desired/Week		Work Hours/Week
On Field	Reporting	Total								
6	6	12	*	1000	=	25	*	3	*	40

Appendix N – Enforcement Decision Process Flowchart International



Appendix O – Legislative Flow Chart to Work with the Ministry of Health