

**Improving Volunteer Firefighter Personnel Management with Database Systems**

(Technical Paper)

**An Analysis of the Volunteer Firefighter Shortage in the United States**

(STS Paper)

A Thesis Prospectus Submitted to the  
Faculty of the School of Engineering and Applied Science  
University of Virginia • Charlottesville, Virginia  
In Partial Fulfillment of the Requirements of the Degree  
Bachelor of Science, School of Engineering

**Daniel Lysinger**

Spring, 2020

Technical Project Team Members

N/A

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Signature \_\_\_\_\_ Date \_\_\_\_\_

Daniel Lysinger

Approved \_\_\_\_\_ Date \_\_\_\_\_

Professor Daniel Graham, Department of Computer Science

Approved \_\_\_\_\_ Date \_\_\_\_\_

Kathryn A. Neeley, Associate Professor of STS, Department of Engineering and Society

## **Introduction**

Emergency responders have a long history of service in the United States. Many work long hours for low pay in order to ensure the safety of their communities. However, few are as respected as those who volunteer their time and effort to work for this same end. Volunteer firefighters are one of the most overlooked groups who risk their lives for the protection of others. It should come as no surprise that their numbers have steadily declined in recent years, forcing career firefighters to work more and longer shifts. In 2019, National Fire Protection Agency (NFPA) estimates, outlined in their semi-annual fire department report, place the number of volunteer firefighters at 680,000 nationwide, down from nearly 800,000 in 2015 (pg. 4). This apparent lack of engagement in such a critical service should be cause for concern. Research done by Linardi and McConnell (2011) only compounds this, as they discovered that the number of people who decide to leave an organization grows once others have been seen to leave. These findings, coupled with the statistics published by the NFPA (2019) regarding fire loss in 2018, which indicates that the monetary losses incurred due to fire in the U.S. amounts to \$25.6 billion (pg. 10), exacerbate the situation even further.

This project attempts to address the numerous difficulties that are associated with managing volunteers with varied backgrounds, starting technically with a database management system. While such a solution only addresses a small issue in the broader picture, perhaps it can be but the beginning of a greater effort to support and sustain local volunteer fire departments. Additionally, for my STS topic I will be investigating the causes of the shortage of volunteer firefighters nationwide, with hopes to better understand the issue at hand while developing a solution for the local difficulty of personnel management.

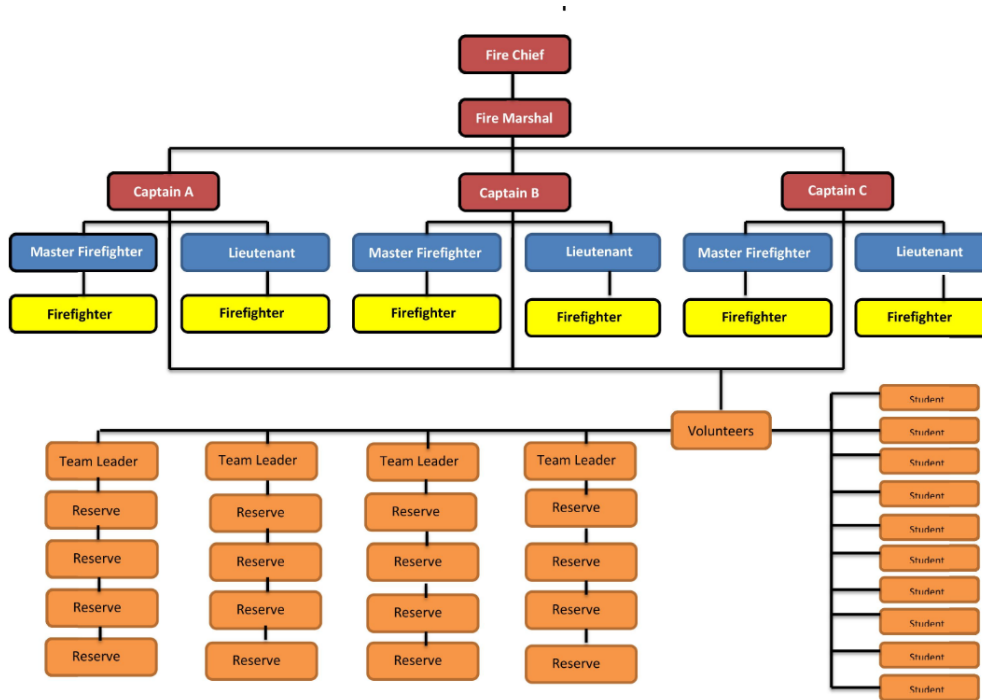
## **Technical Topic: Improving Volunteer Firefighter Personnel Management with Database Systems**

Using database systems to keep track of the individuals within an organization is hardly a new idea. Indeed, it is relatively easy for private entities such as commercial stores or other such companies to put into place such systems. Moreover, the application of these systems within the context of emergency response has proven to be helpful to emergency responders. In 2019, Valecha, Rau, Upadhyaya, & Sharman noted that such data analysis and management “helps in resource assignment, responder accountability, and other emergency operations” (pg. 48). If it is true that data management is alleviating the problems associated with response time and effectiveness, the effects it might have on something as seemingly mundane as personnel management are no doubt even greater.

The current system which is responsible for personnel management relies heavily on the human resource manager, a position which is unenviable in any volunteer fire department, but especially in smaller local departments. Due to the large amount of responsibility that is hefted onto the shoulders of this individual, it can often be stressful and difficult to use current scheduling software. Putting all of this pressure onto this position can lead to perceived inefficacy of management in the eyes of a volunteer. According to the Volunteer Firefighter’s Insurance Service (2006), “a direct connection can be made between how we manage our human resources, [and] the longevity of our personnel” (pg. 93). Putting these disparate burdens on one single individual is not feasible long term for most communities. However, community volunteer

fire departments such as the one that exists in Charlottesville also rely heavily on individuals within the paid department to manage and respond to emergency incidents that have occurred.

(see Figure 1 below).



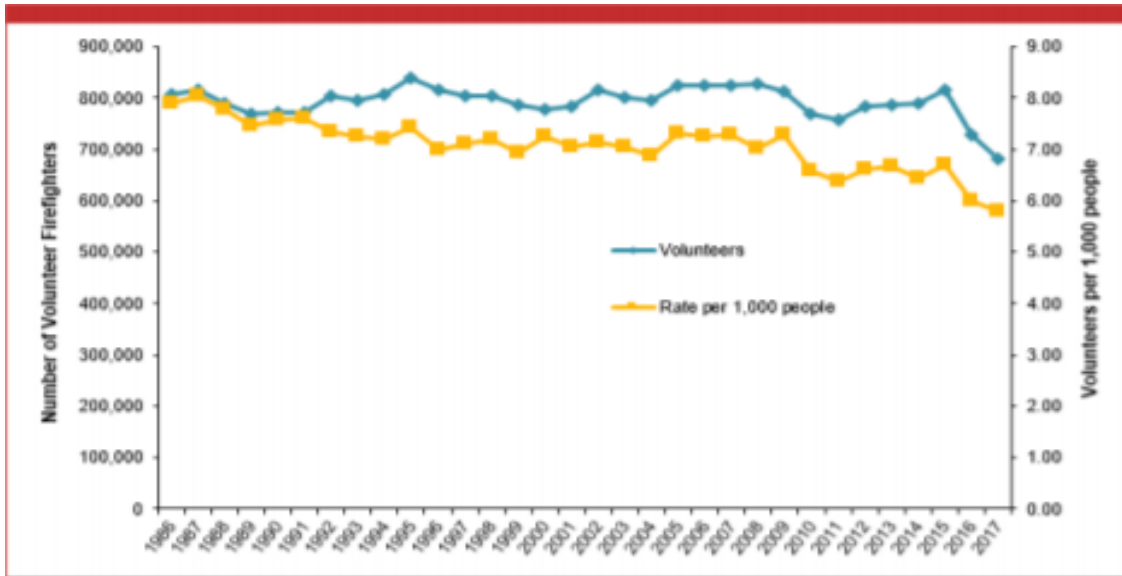
**Figure 1:** An example organizational layout for a local fire department (Created by Author).

The incongruous nature of the responsibilities of the professional and volunteer department can make the volunteer management feel more responsible for any gaps in coverage. As a result, there is enormous pressure placed on volunteers to cover the few times the paid department doesn't handle. This usually ends in the individual needs of some volunteers being jettisoned in favor of a quick response to an emergency. Such a situation makes for long hours for the volunteers, and an increasing amount of hassle for the scheduling human resource officer who bridges the gap between the volunteers and the paid department. As outlined in the figure above, paid departments have significantly more organizational flow with responsibility

distributed among more than one individual. Since such a structure is impossible to practically introduce to a volunteer department, volunteers rely on the scheduling officer and (to a lesser extent) their respective team leaders. This project hopes to ameliorate this situation by implementing a database solution which is designed specifically to aid the scheduling officer and to distribute some of the responsibility of scheduling to more than just a single individual within the department. Allowing team leaders and individual volunteers clear and detailed access to the scheduling information would be one step towards helping local volunteers in their endeavors.

### **STS Topic: An Analysis of the Volunteer Firefighter Shortage in the United States**

The number of volunteer firefighters within the United States was at one point a growing number. Public awareness after 9/11 led to a significant increase in the number of volunteer firefighters nationwide. However, in recent years these numbers have begun to drop at an alarming rate. A report published in 2019 by the National Fire Protection Association (NFPA) noted that “this past year the number of volunteer firefighters decreased to the lowest estimate since the NFPA began reporting this statistic” (pg. 3). Current NFPA estimates place the number of volunteer firefighters at 680,000 nationwide, down from nearly 800,000 in 2015 (see Figure 2 below). Such a decline is problematic not just because such volunteers provide a great service to the community, but also due to the increased pressure and workload this puts on the career firefighters.



**Figure 2:** The number of volunteer firefighters per 1000 people (NFPA, 2019, pg. 4)

Unfortunately for those who wish for an immediate remedy to this situation, there are many complex difficulties that have caused such a decline. Some of the most immediate are the health risks that are commonly associated with being a firefighter. Constant exposure to acrid substances, which are ever-present in fires, can lead to a wide variety of lung diseases. Smith et al. (2019) noted that firefighting activities induced marked increases in inflammatory responses, which can lead to cardiac arrest – a malady which accounts for nearly 50% of all line-of-duty deaths among firefighters (p. 617). However, health risks aren't the only discouraging factors behind steady decline in volunteer firefighter numbers. Another significant factor is the time commitment. With the decreasing number of volunteers nationwide, more contributions are expected from the few that remain within both the paid and the volunteer departments. The combination of these factors has led many volunteers to view their volunteer firefighting as a time consuming, dangerous, and thankless endeavor.

Their own lives are not the only ones in jeopardy, however. In fact, recent data from the NFP in a report on the number of fire deaths per state in 2019 indicates that “race and ethnicity are correlates of other factors that may have a greater impact on risk” (pg. 3). Unfortunately, this disparity will only be compounded if local fire departments are continually being weakened across the nation. Strengthening and providing more resources to local departments is the best way to begin to fix this predicament. To this end, many have attempted to dissect the difficulties and challenges that face the volunteer firefighter. Mayr (2017) writes that the motivations that lead individuals to volunteer are varied, but that many hinge on the hope to make a difference in the community. He points out that, if these individuals cannot effectively see the positive impact on others that their actions impart, they will quickly become discouraged with their job and look to find some other occupation. Lack of recognition, coupled with the other difficulties outlined above, has proven to be a challenging obstacle to overcome. These and other reasons provide a strong basis for an analysis that involves more than just a perfunctory glance. To truly understand these circumstances, one will have to dive much deeper in order to properly understand (and perhaps later mitigate) the difficulties that volunteer firefighters face on a daily basis.

It is with this in mind that I will examine current published material regarding the general decline in the number of volunteer firefighters, keeping in mind the difficulties that have been outlined above. Volunteer firefighters are, as a rule, extremely disciplined and caring individuals. It would be a great loss to both the community and the nation if their numbers were to continue to decline at the current rate. Perhaps a more careful and critical analysis of the circumstances and situations that surround volunteer firefighters will yield actionable results that concerned

communities can leverage to ensure that their volunteer departments continue to replenish their numbers.

## **Conclusion**

Successfully managing and developing integral community organizations such as volunteer fire departments is a very difficult challenge for many communities. Moreover, as the data management continues to become more complex, the applications for it will only continue to grow. With this growth comes a large amount of responsibility, not only for local governments, but also for concerned developers to maintain a strong and efficient system for the most critical organizations within the community. Though my technical project might only provide small relief to those in positions of authority within volunteer departments, the increase in volunteer numbers that hopefully will follow can do nothing but help the situation.

The technical aspect of this cannot be alienated from the sociotechnical side, however. While hurriedly pushing out a piece of software might seem like a tempting proposition to any software developer, ensuring that the potential software will fit and integrate nicely with the existing sociotechnical system before actually developing it is an entirely more difficult approach. A detailed analysis into the reasons for the current volunteer firefighter shortage must be conducted, and a careful examination of the individual department must be done prior to any actual implementation.



## References

- Curcio, K., Santana, R., Reinehr, S., & Malucelli, A. (2019). *Usability in agile software development: A tertiary study*. Retrieved from <https://doi.org/10.1016/j.csi.2018.12.003>
- Linardi, S., McConnell, M. A. (2011). No excuses for good behavior: Volunteering and the social environment. *Journal of Public Economics*, 95(1), 445-454
- Loten, A. (2019, June 13). *911 Response times are getting faster thanks to data integration*. Retrieved from <https://www.wsj.com/articles/911-response-times-are-getting-faster-thanks-to-data-integration-11560468747>.
- Mayr, M. L. (2017). Transformational Leadership and Volunteer Firefighter Engagement. *Nonprofit Management & Leadership*, 28(2), 259 - 270.
- National Fire Protection Association. (2019). *U.S. fire department profile 2017* (Report No. 7). Retrieved from <https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/Emergency-responders/osfdprofile.pdf>
- National Fire Protection Association. (2019). *Fire death rates by state*. Retrieved from <https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem/Fire-deaths-by-state>
- National Fire Protection Association. (2019). *Fire loss in the United States during 2018* (Report No 14). Retrieved from <https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem/Fire-loss-in-the-United-States>.
- Smith, D., Friedman, N., Bloom, S., Armero, W., Pence, B., Cook, M., ... Woods, J. (2019). Firefighting induces acute inflammatory responses that are not relieved by aspirin in older firefighters. *Journal of Occupational & Environmental Medicine*, 61(7), pp. 617-622.

Valecha, R., Rau, H., Upadhyaya, S., & Sharman, R. (2019) An activity theory approach to modeling dispatch-mediated emergency response. *Journal of the Association for Information Systems*, 20(1), pp 33-57

Volunteer Firemen's Insurance Service. (2006). *Managing volunteer and combinatorial emergency service operations*. Retrieved from <https://www.msfa.org/content/recruit/file/CEO%20MANUAL%20ARIAL%20-%20disc.pdf>

Homeland Security Systems Engineering and Development Institute. (2014). *First responder big data analytics: roadmap recommendations*, 47-67. Retrieved from: <https://www.dhs.gov/sites/default/files/publications/First-Responder-Big-Data-Analytics-Roadmap-Recommendation-508.pdf>.