

Committee of the Whole (2) Report

DATE: Wednesday, October 14, 2020

WARD(S): ALL

**TITLE: THREE LINES OF DEFENCE: AN INTEGRATED APPROACH TO
FIRE PROTECTION SERVICES**

FROM: Sunny Bains, Acting Deputy City Manager, Community Services

ACTION: FOR INFORMATION

Purpose

It is Vaughan Fire and Rescue Service's (VFRS) responsibility to enhance its understanding of the needs of its growing city. The fire service seeks forward-looking analytic techniques to create greater value for citizens and the community through data-driven decision-making. Quantifying the level of fire risk and response challenges present in communities, has been at the forefront. This report highlights the challenges and opportunities as they relate to improving the strategic optimization of the Provincial "three lines of defence", which include: (1) Public fire safety education; (2) Fire safety standards and enforcement; and (3) Emergency response in the City of Vaughan.

Report Highlights

- In May 2019, Council adopted the Master Fire Plan (MFP) 2018-2028 Implementation Strategy;
- Developed in consideration of the municipality's legislative requirements, adoption of the MFP Implementation Strategy outlines the priorities of a growing community as it relates to emergency response and public education;
- VFRS continuously pursues forward-looking analytic techniques to create greater value for citizens and the community through data-driven decision-making; and
- In order to continue its work in data analytics, VFRS has partnered with a number of internal and external bodies to gain additional emergency response insight.

Recommendations

1. That this Report be received for information.

Background

Legislated Responsibilities

Subsection 2.(1) of the *Fire Protection and Prevention Act* (FPPA) states:

“Every municipality shall:

- a. Establish a program in the municipality which must include public education with respect to fire safety and certain components of fire prevention; and
- b. Provide such other fire protection services as it determines may be necessary in accordance with its needs and circumstances.”

The intent of Section 2.(1) establishes municipal responsibility for fire protection and makes fire prevention and public education mandatory. It serves to clarify the role of municipalities in providing fire services and establish the minimum level of fire protection *without* imposing significant costs on municipalities.

The Three Lines of Defence

Within the Province of Ontario, the delivery of fire protection services is guided by the FPPA, including the strategic optimization of the three lines of defence, which include:

- Line one: Public fire safety education;
- Line two: Fire safety standards and enforcement; and
- Line three: Emergency response.

We understand that if we enhance our first two lines of defence, there will be less reliance on the third line of defence. We have bolstered our fire prevention by including NFPA 1031 *Standard for Professional Qualifications for Fire Inspector and Plans Examiner* in our firefighter recruit curriculum, in 2018. The firefighters who achieve this qualification are able to contribute to our enhanced fire prevention inspection program, identifying fire code violations in existing buildings. Firefighter recruits also achieve NFPA 1035 *Standard on Fire and Life Safety Educator* and are able to assist with public education initiatives.

VFRS prides itself on being highly visible in the community and takes every opportunity to engage and educate the public on fire safety. Advocating for fire safety in our community is about taking action; and through innovative ideas and programming, VFRS strives to provide the highest service delivery everyday. As our first line of defence, there has been an increased focus on fire prevention outreach and proactive

fire safety education across all divisions, with the goal of preventing fires before they occur. VFRS has close to 40 fire prevention and public education programs, which includes Alarms for Life, After the Heat, Adopt-a-School, home escape planning, summer camps and library programs, distributing fire safety educational materials to residential owners and occupants, releasing public service announcements through media initiatives, and connecting with residents through social media. (See Attachment 1, Figure 1.0 and 2.0)

Using Geographic Information Systems (GIS) and Analytics in the Fire Service

Some of the most important tools for fighting fires include advanced protective gear and state-of-the-art suppression equipment. Given that we live in an age of growing communities, density issues, and complex urban and rural landscapes, one of the most valuable tools in firefighting is data.

Based in the City of Vaughan with a population of more than 335,000, Vaughan Fire and Rescue Service strives to operate as efficiently and effectively as possible, while maintaining what is most important: the safety of firefighters and those who live in, work in, and visit the city.

As a leader in the industry, it is VFRS's responsibility to enhance its understanding of the needs of its growing city. The service seeks forward-looking analytic techniques to create greater value for citizens and the community through data-driven decision-making.

Setting the Direction

There is an increasing burden upon decision makers, such as city managers and fire chiefs, to demonstrate the efficiency of their services, and in the case of fire departments, to validate their performance. A persistent issue has been quantifying the level of fire risk and response challenges present in communities while taking life safety and property protection into consideration. The difficulty facing many communities is determining what "optimal" protection means from the perspective of matching the limited resources of a community to its fire risk from a life safety and property protection standpoint.

In February 2018, VFRS hired Dillon Consulting to develop a Master Fire Plan (MFP) and city-wide risk assessment to set the direction of the service for the next ten years. The detailed plan contains maps, charts, and data; however, there were some gaps in using the data to fully understand the future development of the City and the resources required to keep pace. This indicated a need to develop tools that could properly determine and forecast operational capacity.

To address this issue, VFRS partnered with the Regional Municipality of York (York Region), York University, the University of Calabria, Universidad Autónoma del Estado de México, and the University of Genoa to undertake a project in innovation that would:

- Use shared data to create community profiles to understand risks within the City and the vulnerability index;
- Map a future state of the municipality and current resources to develop predictive analytics;
- Model and simulate VFRS's response to emergencies to gain an in-depth analysis of response times and other key performance indicators; and
- Use data-driven, evidence-based decision-making to determine fire station locations and allocation of resources.

Using Data for the Future

Quantitative fire risk analysis is critical to the decision-making process required for resource allocation in mitigating the effects of fire. VFRS worked with our municipal partner, York Region, to learn about the techniques and tools that could drive insight from data. The difficulty was; gaining access to the various data sources, evaluating its accuracy, and then making sense of how it all fit together into a model. Ultimately, an interactive decision support tool was created. This was achieved by looking at historical response-time data, building permits, population data, present road networks and planned road extensions. From there, travel-time models for each fire station were generated using different scenarios. The response coverage for each scenario factored in the number of properties and population that could be reached as well as other key criteria, including vulnerable populations and areas that have been identified as difficult to access. The tool has become a vital resource and has helped VFRS make decisions about station placement, resource allocation, and road network improvements.

Evaluating Performance through Simulation

For the second part of their project, VFRS partnered with York University's Advanced Disaster, Emergency and Rapid Response Simulation (ADERSIM) team in the School of Administrative Studies, in collaboration with the Modelling and Simulation Center - Laboratory of Enterprise Solutions (MSC-LES) of the University of Calabria. This part was two-fold: to conduct a statistical analysis of the VFRS incident database (covering records since January 2009), and to undertake modelling and simulation of VFRS's response to emergencies. VFRS sought to answer these questions:

- Is the current assignment of apparatus/crews operationally adequate and efficient?
- Is there a need to increase responding units at any station or to reallocate existing ones to other stations?
- Would it be appropriate for VFRS to consider building additional fire stations?

The modelling and simulation framework involved two different simulation models running on separate platforms: an Incident Generation Engine, which simulates the arrival to emergency incidents, and a Response Simulation Model, which is an agent-based simulation model that receives inputs from the first model.

The objective was to use modelling and simulation technology to evaluate the expected operating performance and efficiency of the VFRS system (stations, vehicles, and firefighting crews), taking into consideration the uncertainties of emergencies (e.g. time and geographic location of the event, type of incident, alarm processing, vehicle turnout time and on-scene time, among other relevant variables).

Gaining Insight from Data

VFRS worked with York University for 18 months on the modelling and simulation. The service provided historical data and operational procedures/protocols, as well as reviewed the simulation model and preliminary results with the researchers and offered input into required adjustments. In particular, VFRS validated some of the basic assumptions made in the model and the initial simulation results. This enabled the researchers to better identify statistics and operational parameters to build and refine the model as needed.

Interpreting and using data are necessary for fire service management. Decisions on a wide range of critical issues such as funding, apparatus purchases, station placement, and staffing, are validated using data obtained from a wide variety of sources. VFRS has developed predictive, spatial, and prescriptive methods to segregate, organize, and model the data to draw conclusions and identify patterns. We use math, statistics, and modelling along with creativity and skepticism to ask the right questions, explore data and distill it down to insights that support their most critical decisions while reducing costs, improving efficiencies, and mitigating risks.

The modelling and simulation tools were used to examine response performance. Results from the simulation have led VFRS to better evaluate community risks and consider improvements in its operations. The modelling has allowed VFRS to determine optimal unit availability and ideal station location and truck placement.

Award-Winning Work

The completed project, titled “Igniting Insight: Using Geographic Information Systems (GIS) and Analytics in the Fire Service,” received the bronze 2019 Innovative Management Award from the National Institute of Public Administration of Canada (IPAC). Launched in 1990, the Innovative Management Award recognizes government organizations that have shown exceptional innovations that address the wide variety of issues facing society today. It celebrates the ability of public servants across the country

to transform public administration, advance knowledge of management systems and structures, and improve transparency, accountability and responsiveness while increasing public participation.

The simulation model received international attention when it was presented at the 9th International Defence and Homeland Security Simulation Workshop, in Lisbon, Portugal, September 2019 in a presentation titled “Agent-Based Simulation of a Fire Department’s Response to Emergency Incidents.”

Commitment to Innovation

Public service agencies, such as fire departments, are capitalizing on the synthesis of big data in an effort to enhance its capabilities as well as protect its personnel and the citizens it serves. VFRS’s use of data and smart technology aligns with the City of Vaughan’s overall commitment to innovation and continuous improvement. In January 2016, Vaughan became the second municipality in Canada to be World Council on City Data ISO 37120 Platinum Certified and will be the first city to pilot the new Smart Cities standard ISO 37122.

Vaughan Fire and Rescue Service continues to elevate its reputation as a trusted and sought-after Smart City technology leader. VFRS uses data to identify the impacts of any resource allocation or infrastructure change on performance and response times – two factors that are paramount when responding to an emergency. Employing data analytics for fire prevention, suppression, and response allocation will help ensure the fire service is strong, resilient, and well-positioned for the future.

Since the Office of the Chief Information Officer (OCIO) hosted a Digital Day in early 2020, the focus of which was data and analytics, data has been receiving growing attention across the City, especially as a key component of evidence-based decision making. A number of data-related initiatives are underway that are aligned with this goal in mind, including the collaborative sharing of knowledge and experience with developing departments, such as VFRS. Data is being collected corporately that informs Corporate Performance Measures and Objectives & Key Results (OKRs).

The OCIO has initiated a small data services group that provides some data and analytics capabilities in general, and with VFRS in particular, both in the context of EOC Emergency Management during the COVID pandemic, and also collaborated operationally with VFRS directly, before, and during the pandemic.

The OCIO has helped VFRS develop an initial data and analytics capability and facilitated access to incident and medical data sourced from Firehouse.

Specifically, the OCIO has assisted VFRS in the following ways:

- Provided analytics software to VFRS staff;
- Provided guidance and support to VFRS staff for using analytics technology;
- Built a Firehouse-sourced data-mart and enabled access to VFRS staff;
- Built a performance metrics dashboard with the goal of hosting publicly on our web page; and
- Delivered EOC-focused analytics and reporting for senior EOC and VFRS staff particularly for incident and medical metrics during the COVID-19 pandemic.

VFRS has developed a dashboard which tracks performance metrics, key point indicators, and other strategic data points, which will simplify complex data sets and provide users with intelligence and actionable insights to help inform an evidence-based decision making processes on a regular basis.

Vaughan Fire and Rescue Service Operational Performance

Fire department operational performance is a function of three considerations: resource availability/reliability, department capability, and overall operational effectiveness.

Resource Availability/Reliability is the degree to which the resources are ready and available to respond. (Attachment 2, Figure 3.0)

Department Capability is the ability of the resources deployed to manage an incident.

Operational Effectiveness is the product of availability and capability. It is the outcome achieved by deployed resources or a measure of the ability to match resources deployed to the risk level to which they are responding.

Response time objectives are divided into several distinct segments. The call processing time is the elapsed time from when VFRS receives an emergency call at the communications centre until emergency response information begins to be transmitted to the responding fire station-truck(s). The turn-out time is the elapsed time from the start of the notification process until the responding truck is en route to scene of the emergency. Travel time is the elapsed time from when the first responding truck is en route to when that truck arrives at the incident location. The total response time is the elapsed time from when VFRS receives the emergency call to the arrival of the first truck at the incident location. The chart in Attachment 2, Figure 4.0 outlines the VFRS response times from 2016 to 2019; and Figure 5.0 is the map of the station location.

Our focus has turned to identifying the barriers and challenges to improving response times. Performance metrics are intended to assess department's response availability, optimize its capability to arrive and mitigate an incident, and evaluate effectiveness of on-scene operational performance. We seek optimal performance in every deployment thereby leading to positive outcomes for firefighters, civilians, and any property/environment involved. Performance measures can be used to learn, improve,

and optimize fire department operations. Consistent data, realistic response goals, and optimizing staffing to maximize efficiency, are all critical factors we consider.

The development of the MFP and city-wide risk assessment is consistent with the City's vision that includes strategic initiatives focused on organizational excellence, staff excellence, and service excellence. Incorporating a risk assessment, a resource deployment overview and an analysis of current performance, the strategic plan outlines the resources needed to address the service demands of the community as the City continues to develop over the next ten years.

The MFP outlines three major challenges to response times, including road networks, congestion, and fire station placement. VFRS is committed to improvements in our response performance and are continually researching, analyzing, building and integrating robust systems and processes to support routine and emergency operations.

Pre-emptive Technology

Traffic congestion is a problem and is increasing, particularly in an urban area impacting the travel time of emergency response vehicles. Factors such as existing road networks with increasing congestion are impacting the response times of VFRS.

During an emergency, the primary goal is for the emergency response units to arrive as quickly and as safely as possible. Utilizing an adaptive pre-emptive system allows the fire apparatus to control signalized intersections remotely so they can request a green light well in advance of the emergency vehicle approaching the intersection. This clears the intersection prior to its arrival so the fire truck can move through and avoid the more dangerous and chaotic approach relying on honking horns and blazing sirens to urge drivers to move out of the way.

In 2019, VFRS partnered with York Region on a pilot program that upgrades pre-emptive traffic technology from infrared to GPS technology that will send the signal and be received in a radius, rather than line of sight only. This allows traffic lights to remain green, in emergency situations, until the emergency vehicle has passed the intersection. The system not only protects firefighters, but also the people in the community by clearing traffic for emergency vehicles and moving motorists through congested routes. We are currently expanding the project to install the pre-emptive technology on all front run apparatus by 2021. Pre-emptive systems can decrease response times and provide safer travel for emergency vehicles.

Emergency Services as Critical Inputs for Infrastructure Prioritization

VFRS is working collaboratively with the Regional Municipality of York's Transportation Services, adding emergency response time as a critical input for the prioritization of projects within the 10-year Roads and Transit Capital Construction Program budget.

Adding response time as a critical input and selection criteria for infrastructure prioritization will help address road networks issues.

Investment in Infrastructure

In the past, a common solution for decreasing response time was to increase the number of fire stations and strategically locate them across the City. This entails building new stations, hiring more firefighters, and purchasing new equipment. Over the past decade, VFRS has spent approximately \$27 million on capital infrastructure related to new builds to ensure public safety in the City of Vaughan and hired 90 new staff. In 2020, land for station 7-12 and 7-11 will be secured. Over the next six years, VFRS will build station 7-12 and 7-11 in 2023 and 2026 respectively and relocate one fire station, with an estimated projected cost of \$28 million for the three projects. Additional staff will need to be hired for the new fire stations, increasing current operation costs, which is funded 98% through taxation. With the build of fire station 7-12, the data scientist has modelled an improvement in overall response times of 5%, at a cost of \$8M for the infrastructure build in addition to approximately \$120,000 for the operating costs of the new fire station (annually) and close to \$2.8M increase in labour cost annually. While the investment in infrastructure and new hires are effective in improving response times, as stated earlier; data, GIS and technology solutions need to be considered and employed in improving efficiencies as well.

Citizen Satisfaction

The 2018 Citizen Satisfaction Survey is a proven tool that tells us what citizens think of the services we provide. This survey shows that a remarkable 97 per cent of citizens are happy with their quality of life here in Vaughan and give high satisfaction ratings for everything from libraries and recreation to waste collection and value for taxpayers' hard-earned dollars. Vaughan Fire and Rescue Service enjoys an unprecedented 100 per cent satisfaction rating.

Previous Reports/Authority

[Vaughan Fire and Rescue Service 2018 Annual Report](#)

[Vaughan Fire and Rescue Service 2019 Annual Report](#)

[Item 2, Report 7 – FAA, May 14, 2019 – Master Fire Plan 2018 – 28 Implementation Strategy](#)

Analysis and Options

The Provincial “three lines of defence” model (public fire safety education; fire safety standards and enforcement; emergency response) has proven to be an effective strategy in reducing the number of fire related fatalities and injuries and reducing the overall impacts of fire while enhancing the safety of firefighters.

The options and recommendations presented within the Master Fire Plan are intended to optimize the use of this model in providing the most effective and efficient level of fire protection services, with the most value to the community.

Vaughan Fire and Rescue Service continues to pursue forward-looking analytic techniques to create greater value for citizens and the community through data-driven decision-making with the use of geographic information systems and analytics, gaining insight from data, the use of pre-emptive technology, evaluating performance through simulations and its commitment to innovation, while complying with legislative requirements,

Financial Impact

There is no financial impact associated with this report.

The Acting Deputy City Manager of Community Services and the Chief Financial Officer have reviewed the report and agreed with the financial impact information.

Broader Regional Impacts/Considerations

There are no regional impacts.

Conclusion

The ability to meet the demands of a rapidly growing city while responding to various incidents is a testament to our commitment to ensuring that every citizen receives the highest quality of service.

For more information, please contact: Fire Chief Deryn Rizzi (905-832-8585 ext. 6301)

Attachments

1. VFRS – Fire Prevention & Public Education
 - Figure 1.0: 2019 Fire Prevention Initiatives
 - Figure 2.0: Description of Current Public Education Initiatives
2. VFRS – Operational Performance
 - Figure 3.0: 2019 Unit Utilization
 - Figure 4.0: 2016-2019 Response Time Data by District
 - Figure 5.0: 2020 Fire Station District Map

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