

INTERNATIONAL FIRE SERVICE JOURNAL OF LEADERSHIP AND MANAGEMENT



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IFSJLM would not be possible without the financial support of the College of Engineering, Architecture, and Technology and FPP. This support represents a commitment to the continued professionalization of the American fire service.

As a further indication of the support of FPP to the international fire community, all issues of the *IFSJLM*, except the two most recent years, are available for reading **free of cost** at the Journal's website. Please go to <http://www.ifsjlm.org/PastEditions.htm> to read and/or download previous issues of the Journal.



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RESEARCH SYMPOSIUM 2009 (RS09)

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RESEARCH SYMPOSIUM 2014 (RS14)

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RESEARCH SYMPOSIUM 2010 (RS10)

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RESEARCH SYMPOSIUM 2015 (RS15)

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RESEARCH SYMPOSIUM 2016 (RS16)

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RESEARCH SYMPOSIUM 2012 (RS12)

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Fire Protection Engineer
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RESEARCH SYMPOSIUM 2017 (RS17)

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RESEARCH SYMPOSIUM 2018 (RS18)

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Dr. John Granito Award for Excellence in Fire Leadership and Management Research

The Dr. Granito Award

Fire Protection Publications (FPP) and the *International Fire Service Journal of Leadership and Management (IFSJLM)* headquartered on the campus of Oklahoma State University (OSU) are proud to announce the creation of the **Dr. John Granito Award for Excellence in Fire Leadership and Management Research (the Dr. Granito Award)**. The award will be presented at the *IFSJLM* Research Symposium that supports the *Journal* held annually in July at the IFSTA Validation Conference. The award honors Dr. John Granito. John has been one of the premier fire and public safety consultants in the United States. Just a few of his many Fire, Rescue, and Emergency Services research projects include: Oklahoma State University-Fire Protection Publications Line of Duty Death Reduction project (3 years); Centaur National Study (3 years); Research Triangle Institute/National Fire Protection Association/International City/County Management Association project (4 years); Fire Department Analysis Project (FireDAP) of the Urban Fire Forum (13 years); *Combination Department Leadership* project, University of Maryland, Maryland Fire & Rescue Institute (4 years); Worcester Polytechnic/International Association of Fire Fighters/International Association of Fire Chiefs/National Institute for Occupational Safety and Health *Fire Ground Performance Study*. He has participated in more than 400 fire department studies. John also has strong ties to academia. He served in a number of academic positions for almost 30 years, including 16 years at the State University of New York at Binghamton. He is Professor Emeritus and Retired Vice President for Public Service and External Affairs at SUNY Binghamton, which is consistently ranked in the top public universities by *U.S. News and World Report*. John has published numerous articles, chapters, and technical papers, served as co-editor of the 2002 book published by the International City/County Management Association entitled, *Managing Fire and Rescue Service*, and is a Section Editor of the NFPA® 2008 *Fire Protection Handbook*. Dr. Granito was the first recipient of the award that honors him and his service to the fire service and to academia. Each year the recipient of the Dr. Granito Award presents the Keynote Address at the annual *IFSJLM* Research Symposium. The Keynote Address is subsequently published as the lead article in the following year's volume of the *IFSJLM*.

Nomination Form

Fire Protection Publications (FPP) and the *International Fire Service Journal of Leadership and Management (IFSJLM)* headquartered on the campus of Oklahoma State University (OSU) are accepting nominations for the **Dr. John Granito Award for Excellence in Fire Leadership and Management Research (the Dr. Granito Award)**. The award is presented at the Research Symposium that supports the *International Fire Service Journal of Leadership and Management (IFSJLM)* held annually in July at the IFSTA Validation Conference.

The nominee should have made a significant contribution to the advancement of fire leadership and management through his/her scholarly/academic writing. The Dr. Granito Award is not necessarily a life-time achievement award, although such individuals certainly should be in a prominent position to be nominated. The nominee can be a person who,

although early in their career as a practitioner/scholar or academic, has made a seminal contribution to the fire leadership and management literature.

To nominate an individual for the Dr. Granito Award, please submit by 15 November of the current year: (1) this form (or a copy of it), (2) no more than a one-page single-spaced letter explaining why you believe the person is deserving of the award, and (3) a copy of the nominee's resume or curriculum vitae. Please send required materials in hard copy to: Dr. Granito Award, C/O Dr. Robert E. England, Founding Editor, *International Fire Service Journal of Leadership and Management*, P. O. Box 720846, Norman, Oklahoma 73070. Or, if you prefer, scan and complete the nomination form and send all materials electronically to: bob.england@okstate.edu.

I nominate _____ for the **Dr. John Granito Award for Excellence in Fire Leadership and Management Research**. To support the nomination, I have included a letter of recommendation and a resume or curriculum vitae (CV) of the nominee. (A nomination is not accepted without the supporting letter and resume/CV.)

Nominator Name: _____

Address: _____

Zip/Postcode: _____

Contact Information:

Telephone: _____

Email: _____

Message from Dr. Robert E. England

Founding Editor, *International Fire Service Journal of Leadership and Management (IFSJLM)*,
Fire Protection Publications, Oklahoma State
University

Welcome to Volume 12 of the *International Fire Service Journal of Leadership and Management*. Typically, readers should expect to see the annual volume

released no later than October 31. When the issue goes to press, however, is largely dependent on when external reviewers accept three articles for publication. Regardless of the number of articles, a volume will be available no later than the end of the calendar year.

We hope you enjoy Volume 12 of the *IFSJLM*.

Editor's Note: Sixteen months pass between when a Keynote Address is delivered at a Research Symposium and when that Keynote Address is published as the lead article in the next volume of *IFSJLM*. Occasionally, as in the Keynote Address below, an event or events mentioned in the Keynote Address may have transpired during the 16-month time gap.

Tenth Annual Dr. John Granito Award for Excellence in Fire Leadership and Management Keynote Address presented at Research Symposium 2017 (RS 17) by **Fire Chief Ronald J. Siarnicki**, Executive Director, The National Fallen Firefighters Foundation, Emmitsburg, Maryland.

Changing the Conversation: Making Firefighter Health and Safety Personal

Abstract

This Keynote Address will connect what has been learned over the past fourteen years since the National Fallen Firefighters Foundation (NFFF) was tasked with the accepted mission to develop materials and training aimed at preventing line-of-duty deaths (LODDs) and injuries. The roots of this challenge began in 2001 when the NFFF and the entire fire service was overwhelmed with the service deaths associated with 9/11. The attack hit the NFFF with a tsunami-type impact. As the Foundation navigated the complexities of 9/11 with the help of the entire fire-service community, it realized that more benefit would come from adding to the mission of the Foundation working with the fire service to reduce firefighter LODDs and injuries. Out of the soul searching on both a personal and organizational level, the Everyone Goes Home[®] program and the 16 Firefighter Life Safety Initiatives were developed in 2004, and the influence the Initiatives have come to play in the culture of the fire service has continually grown. Safety is truly everyone's top priority as this effort is expressed by individual firefighters, company officers, department leaders, constituent organizations, and the national political leadership. This Keynote Address will highlight the efforts that have been put forth by many to address behavior, leadership, and survivability within the fire-service community.

Keywords: *National Fallen Firefighters Foundation (NFFF), firefighter line-of-duty-deaths (LODDs), firefighter safety*

Introduction

I have been attending *IFSJLM* Research Symposiums for many years and have always left learning so much about leadership and management. As I will explain a little later, there were some growing pains for me as I learned the differences between being a leader and being a manager. Most of us have to do both, and it is through opportunities like this Symposium where we can hone our skills.

The primary objective of attending these meetings is, of course, to learn more about fire-service research and bring what we learn back to our constituent groups and departments. Many times the information presented is new to me, but other times I can see and hear the rise of the safety ethic or, as I like to describe it, the new fire-service conversation, throughout many of the presentations, and I am always glad to think that the National Fallen Firefighters Foundation (NFFF) has played some role in this profound sea of change.

In its short existence, the NFFF has transformed from a small mom and pop shop to a national entity that is involved in many aspects of the American fire-service community. Our growth has been a very poignant exercise for me as the Foundation is celebrating its 25th Anniversary in 2017, having been created by the United States Congress in 1992. A day of celebratory events is being planned for Thursday, October 5, 2017, in our nation's Capital. Those events will be the starting point for the 2017 National Memorial Weekend and Memorial Service where we will add the names of our lost heroes from 2016 to the Emmitsburg Memorial.

And with that in mind: ***I would like to dedicate my presentation today to all the men and women whose names appear on the National Fallen Firefighters Memorial and to those 95 who will be added in October of 2017, and to all who are added in the future.***

The Dr. John Granito Award for Excellence in Fire Leadership and Management

What can I say about being the recipient of the Dr. John A. Granito Award for Excellence in Fire Leadership and Management Research? First, knowing John personally makes it all the more special. I consider John my friend, and he has been a reliable sounding board for me and many others. He's been a steadfast supporter and ally of the NFFF for many years. He is also a beacon for research leadership and an inspiration for those who have yearned for the fire service to take this dimension of knowledge and apply it to everyday experiences.

I especially appreciate that even though John is an esteemed academic, he doesn't talk like one! Moreover, he always finds the energy to stay involved and engaged. Two years ago the NFFF hosted a Research Agenda Symposium, which was mandated by the 7th Firefighter Life Safety Initiative, and we asked John if he would participate as the Lead Judge when it came time to decide which recommendations would move forward. In this capacity, he expertly worked with the Jury to deliver what I believe to be the best and most professional set of recommendations of the three research Symposiums we have hosted since 2005. These recommendations were important to our industry and, as you know, set in motion most of today's competitive fire-service research. If you want grant funding, familiarity with the most current Research Agenda is imperative.

I follow today in the footsteps of many great individuals, friends, and colleagues who have been recognized in the same fashion with this esteemed award:

2008 - Dr. John Granito, himself

2009 - Dr. Denis Onieal

2010 - Dr. Lori Moore-Merrell

2011 - Dr. Edward T. Dickinson, MD

2012 - Daniel Madrzykowski

2013 - Dr. Anne Eyre

2014 - Chief Dennis Compton

2015 - Dr. Denise Smith

2016 - Dr. Sara A. Jahnke

I am humbled to be here and to share this prestigious award with each of them.

Some Personal Experiences and Perspectives

The title of my Keynote Address is intended to bring perspective to the experiences I have had in my fire-service career and at the NFFF with consideration of the motto for the *International Fire Service Journal of Leadership and Management*—Building Theory to Impact Practice.

I would never in my wildest dreams, 43 years ago, when I first started my fire service involvement at the age of 18 with a small 40-person volunteer department in the hills of Western Pennsylvania, have believed that I could be where I am today — and yet, as a third-generation firefighter. I started as a young lad growing up in the fire department that my dad and others chartered to serve the part of the town that we lived in, later transitioning to a career position and ultimately becoming the Chief of that very progressive combination Fire/Emergency Medical Services (EMS) Department; Prince George's County, Maryland — one of the largest combination departments in the United States (US). Then after 24 years of service, being fortunate to take on a new challenge as the Executive Director of the NFFF, it became a real pleasure working with greats like Hal Bruno, Jerry Scannel, Denny Compton, Vina Drennan, Bill Webb, and many, many more. America is indeed the land of opportunity.

Throughout my life I have also been a devoted student, both academically and in day-to-day experiences. I worked to learn all that I could from the occurrences that came my way and, most of all, made the best of what cards I was dealt. I learned early on that there is opportunity when tragedy strikes, and it is necessary to turn things around for the better if at all possible — truly a critical point in changing the fire-service conversation.

As I travel around this great country of ours, I am often asked what I believe to be in store for the future of the American Fire Service. For so many years we have attempted to answer that question, and I am now convinced that we are in a transformational time; and through the efforts of so many researchers, the application of their evidence-based work is serving as our roadmap.

Over the years we have examined the fire problem in America and have documented those findings. The legendary *America Burning* report in 1973 (President's Commission on Fire Prevention and Control) highlighted many issues of concern to the fire service and identified "the indifference with which Americans confront the subject" (p. X), and I believe to some extent that indifference continues today. This document changed the way the fire service looked at the fire problem in America and provided one of the more significant opportunities for change within the profession. As time moved forward, interest waned, and the world became a different place. I believe that much progress was made as a result of this report, and many opportunities were harvested. But times changed, and a continued lack of supportive research and funding brought the progress to a near stop. Yet over time, since *America Burning's* release, fire departments, rescue squads, emergency service organizations, and other first responders have faced expanded responsibilities and broader assignments than just traditional fire response and suppression activities.

In 1999, then Federal Emergency Management Agency (FEMA) Director James Lee Witt attempted to revitalize the progress. Director Witt identified an esteemed group who he felt represented the American Fire Service, appointed them to the new America Burning Recommission Panel, and charged the group with examining this very issue. That Commission reached the following major conclusions:

- The frequency and severity of fires in America do not result from a lack of knowledge of the causes, means of prevention, or methods of suppression.
- We have a *fire problem* because our nation has failed to adequately apply and fund known loss-reduction strategies.
- The primary responsibility for fire prevention, suppression, and response with respect to other hazards dealt with by the fire service, properly rests with state and local governments. Nevertheless, a substantial role exists for the federal government in funding these initiatives and providing technical support to them.

These conclusions set into motion a series of opportunities that again moved the fire service forward and changed many conversations along the way. Specifically, funding and training enhancements that better prepared our industry along with a deeper understanding of the importance of research were identified.

The Assistance to Firefighters Grant (AFG) program was birthed; and as a result of that funding, departments received much needed equipment, staffing, and resources to get their work accomplished. Also, funding became available for firefighter safety, community-risk reduction, and scientific research. To this day, AFG funding is impacting the fire service as a whole and providing the resources needed to carry change, growth, and effectiveness forward.

During this same time period, I was fortunate to be enrolled in the Executive Fire Officer Program (EFOP) at the National Fire Academy (NFA). The four-year program was designed to assist fire-service leadership in meeting the ever-changing needs of the communities they serve and to think more strategically in their process of managing their departments.

On the very first day, I remember during his welcome remarks that Chuck Burkell told my class that if the American Fire Service was ever to be compatible with other professions, we would need to create a methodology to develop evidence-based research and publish works that inform, instruct, and challenge the way we do business as an industry. That was Chuck's way of letting his students know the importance of the research projects that were required as a part of each year's EFOP. Chuck's words stuck with me, even though I did not recognize at the time the significant impact research could have or would have in the future

or that the effort he put forth helped change the conversation on a national level—one EFOP graduate at a time.

But it was not enough, fire deaths in America continued to occur at alarming rates, and the number of firefighter line-of-duty deaths and injuries remained unchanged. I often wonder if we, as the fire-service community, had put more effort into research and validated justifications at that time, would the results have been different? It reminds me of the case of the Firestone Tire Recall.

In 1996, the State of Arizona began to notice a trend with tread separation of Firestone tires on their vehicles. Officials inquired about these observations to the leadership at Firestone and was told that the company found no validation to the reported failures.

A year later, a batch of vehicles that was sent to Saudi Arabia experienced the same types of failures. With its inquiry, supported with evidence-based research that was conducted external to the Firestone Corporation, the National Transportation and Safety Board (NTSB) initiated an investigation and in 2000 ordered a total recall of the affected tires. The NTSB cited that 174 deaths and 700 injuries resulting from the tire failures, leading to \$540 million in damages, warranted its intervention.

My point is that over a four-year period, 174 deaths and 700 injuries resulting from faulty tires caused significant enough concern to warrant intervention to correct a problem; and yet, in the fire service, 100 plus firefighter deaths a year and over 29,000 injuries on the fireground as reported by the National Fire Protection Association® (NFPA®), as a continuum of a 20-year norm, gets painted as being part of the job in this dangerous business. Unfortunately, members of the profession to this day accept that situation.

We need critical evidence-based research to make the connections to the work we perform and invoke change within the fire-service community. Let me put it another way, let's do a little role play. Let's pretend that you work for Exxon-Mobil, and you are the Director of Operations for the US, and you are going to make your annual report to the Board of Directors and Shareholders of the company.

You go into the meeting room and start your presentation by stating the following facts: As being a business with inherent risks, we only lost 95 employees to job-related deaths over the past twelve months and only had 29,000 operational injuries reported. What do you think would happen next? How long would it be before you were escorted to your office to find a couple of empty boxes with a security guard waiting for you to collect your personal belongings and be escorted out of the building? The answer to the question is, you would not have to wait long to be escorted out of the building; I know you get the point. So changing the

conversation and doing things differently should be our order of business. It can happen, and it is possible. Let me give you some examples.

September 11, 2001, changed the world, changed the US, and changed the American Fire Service. The tragic loss of 343 New York Fire Department (FDNY) firefighters, 4 fire-patrol members, hundreds of other first responders and civilians, and now a hundred more individuals dying from Post-9/11 World Trade Center Disease will impact us forever.

As a result of that one day, everyone looks at events and incidents differently now. We attempt to bring closure as we try to establish our new normal level of operations and existence. While this situation is often challenging and will take a great deal of time and new approaches to accomplish, we can persevere. It will be a tough thing to do and will take a great deal of time to accomplish. But, one such example of learning and implementing change that resulted from that tragedy was demonstrated by then Chief of Department Sal Cassano and Safety Chief Alan Hay.

For years, the FDNY utilized a senior firefighter in each firehouse to assist the company officer with day-to-day operations in the station and with crew continuity. It still does that today, but what Chief Cassano and Chief Hay leveraged was the mass exodus of nearly 2,000 senior members from the department because of the pension plans in effect at the time.

The FDNY pension system calculated the two best years of a member's salary for his/her retirement payment, and those calculations did include earned overtime. With the time spent at Ground Zero, many members had to retire due to the economics even if they did not want to. So the senior members left in droves; and through its internal safety-division research, the FDNY validated that the old-timers had been influencing the younger members when they came to their duty assignments right out of recruit school and installing a sense of *How things are really done in the field*. This situation was acknowledged and identified as a causal factor in many of their on-the-job injuries and close calls within the department.

As the older members retired over a 24-month period, the FDNY leadership put greater focus on supporting the company officers and building a more stringent guideline for the senior members to embrace the training that was occurring at the academy. Additionally, the department realized that the new senior members were much younger than in the past, allowing for a better relationship to be established between the senior members and the company officer who were closer in actual age and time in the department, resulting in a 32% reduction across the board in departmental injuries and a marked increase in the proper use of hoods and gloves.

Through these efforts, the FDNY acknowledged the tragedy of 9/11 and turned it into an opportunity for the betterment of the agency. The department did these things in memory and honor of those they lost that day and continue to lose as a result of the aftereffects of the attacks on the World Trade Center.

These actions also led to the creation of several videos produced by the NFFF in conjunction with the FDNY to highlight its new approach to safety and the need to personalize the stories. The videos featured injured, disabled firefighters, well-seasoned and respected officers, and the families of their own fallen members telling the stories of how they saw the need to make changes in the department without jeopardizing their Courage, Honor, or Valor. They also acknowledged the lessons learned from mistakes made. Just as a note, all of the videos, materials, and documents that I have referenced are available on the NFFF website. People are free to use them as they wish.

As the safety dialogue within the FDNY continued along with the reasoning to enhance the overall survivability and well-being of their personnel, other critical issues that had been identified as needing to be addressed came into focus. One issue in particular was about dealing differently with wind-driven fires within the city. Through partnerships with the National Institute of Standards and Technology (NIST) and Underwriters Laboratories (UL) and a great deal of hands-on research and modeling, the FDNY developed protocols to assist with extinguishment of fires, tenability of structures, and survivability of occupants and firefighters. These protocols were put into place and changed the operational conversation within the FDNY.

I totally understand and agree that we should not have to wait until a tragedy occurs to make changes. But if one does occur, we have to seize the moment, change the conversation, and make a positive impact.

The Super Sofa Store fire in Charleston, South Carolina (SC), is a perfect example. Upon learning that 9 Charleston firefighters died that day, the NFFF snapped into action. Working with the SC Firefighters Association, our Local Assistance State Team (LAST) Program responded to assist in any way possible. Upon meeting with city officials, we learned that the fire department needed to make some major changes, and the mayor was willing to do whatever he could to make the department better.

The NFFF met with the mayor's staff, offered to help bring in outside resources, and worked with the City and the Fire Department to assist with the aftermath of the fire and loss of life. Ultimately, these efforts led to the *Routley Report*, which in turn influenced change, rebirth, and growth within the department and, ideally, within city government as a whole. The NFFF is still in the background in Charleston and New York

City providing support, resources, and assistance as needed. It will continue to be there for as long as it is needed.

Behavioral health concerns surfaced as critical issues during 9/11 and were major factors in Charleston. The lessons learned in New York were applied to Charleston and that led to the creation of a state-wide program involving fire departments across the region. Fire associations, government, and industry collaborated to support all first responders throughout the State of SC with the transition of intervention methodologies developed for the military to the fire service. This program included the insertion of Stress First Aid principles and developmental techniques for *The New Normal* by NFFF team members. This program is a true example of turning tragedy into an opportunity.

Shortly after 9/11, NFFF took steps to change the conversation at all levels of the fire-service community in a nonevent response mode. Through the efforts of many, the Everyone Goes Home Program® was born and through the two Tampa experiences before, conversations around the country were influenced and impacted, especially those at firehouse kitchen tables.

Through all of this, the Sixteen Firefighter Life Safety Initiatives had a common thread—the need for more evidence-based research. This common-core element resulted in the creation of a National Fire Service Research Agenda that has been developed and subsequently reviewed and updated every five years since 2005 when the first agenda was created.

Each time the Research Agenda was visited, six core domains were examined: (1) Community Risk Reduction, (2) Health and Wellness, (3) Tools and Equipment, (4) Emergency Service Delivery, (5) Technology and Science, and (6) Data Collection and Wildland Fire Fighting. Do any of these topics sound familiar to some of the research projects you have heard about at the Symposium over the years? ABSOLUTELY! These topics were developed by the NFFF from the root-cause analysis that was conducted upon the review of nearly 3,000 reported firefighter LODDs going back to 1982. An evidence-based research project provided a great deal of validity to the entire Everyone Goes Home Program®.

Collection and analysis of meaningful data are critical in order to address the fire problem in this country with respect to civilian and firefighter casualties and property loss. Analysis of data provides a basis for direction and prioritization of relevant initiatives, available resource deployment, and the expenditure of critical funds utilized to support operations. We know that a large quantity of data exists, and what we need to do is **manage** that data for the greater good of the fire-service community in a way that it is retrievable, beneficial, and most of all relevant to the work we have to accomplish. That relevance is why projects like

those being conducted by the International Association of Firefighters (IAFF) and the National Fire Protection Association® (NFPA®) are so critical to our survival. I applaud them and especially Dr. Lori Moore-Merrill for her efforts to maintain the strategic quality and significance of much of these data-driven projects.

Research on the science of fire, fire behavior, suppression and extinguishing of fire, and fire-service operations is ever increasing, but more is needed. Critical investigations and valuable work are currently being conducted in federal agencies, such as the Consumer Product Safety Commission, NIST, and of course our partners at UL.

In particular, it is interesting to follow the discussions and conversations about the work that UL is conducting along the way. In the beginning of its research work, the fire-service community was not united when it came to points of view. Some embraced it, others condemned it. The discussions went rampant; however, over time as the evidence-based data was released and the actual videos (proof of the work being done) were distributed, the tide turned. As a result, many departments are now evaluating their strategies and tactics that were entrenched long-term in their agencies. A new approach and another potential tool have been added to the fire service delivery system toolbox. This tool is another example of how to effectively use validated facts to debunk the myths and past practices of a profession that was often emotionally driven in decision-making and is now on the tipping point of scientifically-supported leadership methodologies.

Vital research is also ongoing at many of the nation's colleges and universities, and there is also a private-sector component of research looking at fire and emergency service issues that continues to contribute to a national agenda. Many of those institutions have reported at the Symposium and other events around the country. Many are partners with the NFFF and other stakeholder organizations. The work relative to cardiac and vascular issues, firefighter health and wellness concerns, overall survivability of our membership, and utilization of the equipment and technology that is available today is staggering. Even more impressive is the caliber of the researchers who have decided to examine the fire-service needs and have put their hearts and souls into their work. Individuals like Dr. Stefanos Kales, Dr. Denise Smith, Dr. Lori Moore-Merrell, Dr. Sara Jahnke, Dr. Jeff Burgess, Dr. Gavin Horn, Tom Hales, Dr. Dan Madrzykowski, Steve Kerber, Kevin Roche, Dr. Jennifer Taylor, Dr. Kathy Notaranni, and many others have made significant research contributions that have real-world implications for the health and safety of fire-service members. Space restrictions do not allow me to offer a full accounting of all of these scholars and the stellar research they are

doing; but we know who they are, and we say thanks for all they do. I believe their passion and commitment to move the bar further along within their respective fields of study is best represented by the words of Thomas F. Huxley who said: "The rung of a ladder was never meant to rest upon, but only to hold a man's foot long enough to enable him to put the other somewhat higher." Indeed, none of these researchers are resting; they are moving one step further at a time for a better fire-service community.

It is important to also discuss the changing role of the American fire service over time. The responsibilities of today's fire departments extend well beyond the traditional fire hazard experienced in the early days of our industry. The fire service is the primary responder to almost all local hazards, protecting a community's commercial as well as human assets. Firehouses are the closest connections the government has to disaster-threatened neighborhoods. Today's fire service confronts a full range of hazards and risks for America's communities. Emergency medical response to incidents that require medical care has become a dominant role of the fire service as well.

In the last 25 years, EMS, ranging from primary response to advanced life support, has grown to occupy a particularly unique and prominent position in the fire service. Firefighters/paramedics are frequently the *gate-keepers* of today's health and medical services when trauma, other emergencies, or general health care are involved. The EMS field is rapidly changing with new rules and regulations being passed at the federal and state levels. Emergency medical responders (EMRs), emergency medical technicians (EMTs), and paramedics have a greater level of required training than ever before and are as much a part of the health-care environment in a community as they are of the firefighter side of the equation.

The efforts of many individuals and organizations have led to the creation of the Fire-Based Emergency Medical Services Electronic Tool Box, which truly has changed the conversations at many kitchen tables and conference rooms across the fire-service community. Under the leadership of Chief Dennis Compton, and in conjunction with Congressional Fire Services Institute (CFSI), Metro Chiefs, International Association of Fire Chiefs (IAFC), IAFF, National Volunteer Fire Council (NVFC), NFPA® and International Fire Service Training Association (IFSTA), we now have a resource that has added clarity to the national-policy discussions regarding EMS issues. The Fire-Based Emergency Medical Services Electronic Tool Box is a living and breathing document that has positively influenced the way we do business and has proven to be of assistance to many departments and jurisdictions in multiple ways. The work product continues to grow as more research and efforts are conducted and more data and findings are secured.

To date, there has been success in the use of codes and standards as tools to make the fire service safer. However, the success we have seen must be accelerated and intensified. The fire service must be involved in the codes and standards process and must bring to the table justifications and support for the changes and enhancements they recognize as critical to their survivability. The adoption and enforcement of those codes and standards for construction or rehabilitation that affect fire safety, as well as safety for all hazards, must be extended.

Various discussions underway about the use of detection systems continue to flourish throughout the fire-service community. The proper deployment of smoke alarms and carbon monoxide (CO) alarms are on the forefront of many departments and agencies across the US. These devices are a part of the solution, and yet mandatory requirements continue to be met with resistance, as identified years ago in both *America Burning* documents.

Now the bigger challenge we face is over the mandatory installation of residential sprinkler systems, which we know save lives and holds fires in check, but the cost and mandated infringement concerns continue to haunt the process. The conversation has changed in some jurisdictions with the use of video productions, live demonstrations involving side-by-side trailers, and overwhelming evidence of local success stories that are being tracked and recorded. Efforts to change the mindset about the use of sprinklers have been successful in communities across the country. San Antonio Fire has lead the charge in its jurisdiction for the use of sprinklers; and on November 12, 2015, the San Antonio, TX, City Council approved a retroactive ordinance requiring 48 high-rise buildings in the city to retrofit with fire sprinklers. Recently, Governor Scott from the State of Florida (FL) took on the Condo Association and vetoed a bill it had pushed through the legislature to reduce the requirements for sprinklers in high-rise residential units. The fire service is making progress in the use of sprinklers, but the road ahead is long and winding. With a consolidated effort and a unified front, it can and will make a difference.

In order to achieve the overall effectiveness of the fire-service community, there must be a commitment to alter traditional attitudes with respect to the activities that are most important to the fire service. There should be recognition for those leaders and departments that effectively put an end to traditions that limit the forward thinking and development of a diverse fire and emergency service organization.

In an effort to change that conversation, a recent video released by the NFFF captured the personal stories of a group of fire chiefs who all suffered the most tragic loss of one of their own. By making the stories personal, the chiefs were able to better facilitate

changes within their agencies. It took time and resources to create positive effects, but by capitalizing on the needs of the organization and the loss they experienced, forward progress occurred.

Additionally, several videos have been released that capture the stories of the Fire-Hero Families who, after a period of time, were able to recount their firefighter's story and the lessons learned from their personal experiences. Many of the family members spoke on the importance of following safety procedures, understanding the risks associated with being a firefighter, and the ultimate gains that may or may not have been made. These spouses, partners, and loved ones poignantly shared the magnitude of their losses and have significantly stimulated change as a result of their brave actions to get in front of the world and tell their heartfelt stories on video.

There are those in the fire service who suggest that this effort to reduce line-of-duty deaths and injuries diminishes the traditions and culture of fire fighting. Personally, I wholeheartedly disagree. A conscientious approach to fire safety should not be considered disrespectful to the valued traditions that distinguish the culture of fire fighting. Rather, it is an opportunity to raise the bar of the fire-fighting culture. A conscientious approach to safety is also an opportunity to free the profession from the antiquated thinking that injuries and deaths are simply part of the job. To be clear, embracing the culture of fire fighting, as we have always done, and at the same time giving our best efforts to ensure that everyone goes home are not mutually exclusive ideas. In fact, just the opposite is true. Fires must be fought by intelligent men and women who value lives over property and who do it in such a manner that draws admiration from their communities. At the end of each shift, everyone should go home to their other treasured roles as family members and friends.

Currently the two nationally recognized leading causes of firefighter fatalities are cardiovascular events/heart attacks and vehicular crashes. These two things are within our realm to control. The ever-emerging issue that we now face, head on, is that of fire-service occupational cancers. Eventually, a firefighter death due to cancer will be recognized at the national level as a line-of-duty-death. The NFFF is working to support the Fire Service Cancer Alliance, and anyone who wishes to be a part of changing that conversation should plan to attend the National Fire Service Cancer Symposium in Phoenix, AZ, September 7–8 this year. Critical issues on the topic will be addressed at the Symposium, and some of the latest research findings will be presented. Additionally, a Fire Service Occupational Cancer Tool Box is planned to be ready and made available at the Symposium. The Tool Box will address everything from cancer prevention to

diagnosis to long-term care and what members of the fire-service community can do to improve their survivability with these deadly diseases. The Symposium, and others like it that have been made available over the past decade, is intended to raise the awareness and commitment of the fire-fighting community to do the right thing and change health-related behavior.

Accepting personal responsibility for our safety is nonnegotiable, is effective, and saves lives. Over the past 10 years, the number of line-of-duty deaths in the US has dropped to historic lows, from 115 in 2008, to 86 in 2009, and to 75 in 2016. These figures are the lowest they have been in decades. This reduction in fatalities offers hope that the efforts of the NFFF along with our national partners and the fire service as a whole are being successful. I believe this decrease in firefighter fatalities is occurring because we understand that we can do our jobs more effectively by recognizing the risks that we can control and accepting the responsibility to mitigate them. We know that there are risks in this profession. Every one of us must have the courage to face a multitude of risks in order to save lives and protect communities. We must also have the courage to stay safe in potentially dangerous situations and avoid needless risks and tragic consequences. We must be role models for others. We have a responsibility and duty to everyone we know to share our experiences, our training, our research efforts, and our knowledge. We also have a responsibility to be sure that everyone we work with understands that their skills, their experiences, and their actions can affect themselves, their loved ones, their departments, and their communities. It was Gandhi who said, "Be the change that you wish to see in the world."

Each member of the fire service can be an agent for change by making a commitment to themselves, their loved ones, and their communities and by accepting personal responsibility for doing their job safely. Sadly, as much as we would like to put the NFFF out of business, there will always be a role for it to assist families of the fallen. Without a doubt, there are always going to be incidents that are beyond our control. Firefighters will die even when they have done everything right. But by accepting personal responsibility, we are embracing a new culture of fire fighting that ensures that we are doing our jobs safely and to the very best of our abilities while protecting the people we have promised to serve. For all of us associated with the American Fire Service, our charge as we go forward is to continue to carry the torch to stimulate thought-provoking ideas in order to change the conversation and impact positively the survivability of our fire-service community. We all must do our part.

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About the Author

Fire Chief Ronald Jon Siarnicki began his fire service career with the Prince George's County Fire/EMS Department in 1978 and with over 40 years of fire, rescue, and emergency medical services operational experience, he progressed through the ranks to Chief of the Department. In July of 2001, Chief Siarnicki retired from the Prince George's County Fire/EMS Department to take the position of Executive Director of the National Fallen Firefighters Foundation (NFFF). He is a graduate of the Master's Program, School of Management and Technology, at the University of Maryland, University College, College Park, Maryland, and has a Bachelor of Science Degree in Fire Science Management from UMUC. He is a certified Fire Officer IV, Fire Fighter Level III, and State Emergency Medical Technician. Prior to joining the Prince George's County Fire/EMS Department, he served as a volunteer firefighter with the Monessen VFD Hose House #2 and currently serves with the United Communities VFD in Stevensville, Maryland.

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Reproductive Health Concerns Among Female Firefighters

Abstract

There has been little research conducted on the reproductive health of female firefighters. The purpose of this study was to determine whether female reproductive health is a concern among firefighters and to identify key associated issues. Eighty-seven United States (US) firefighters participated in focus groups or interviews. Themes were created using grounded theory with NVivo analysis software and a three-phase coding process. The major finding emerging from the study is that female firefighter reproductive health is a significant concern among firefighters.

Keywords: *female firefighter reproductive health, reproductive health and firefighters, female firefighters, firefighters' health*

Introduction

Females make up 50.9% of the United States (US) workforce (Hulett, Bendick, Thomas, & Moccio, 2008), and this number continues to rise (Bureau of Labor Statistics, 2003). Traditional male-dominated occupations such as the military and law enforcement have female-employment rates of approximately 14% (Women in Military Service for America Memorial Foundation, Inc., 2010) and 13% (US Department of Labor, 2009), respectively. Despite a target of 16–22% representation by females in the fire service (International Association of Women in Fire and Emergency Services [iWomen], 1995), only 3.7% of career firefighters ($n = 12,850$) are estimated to be female (Haynes & Stein, 2017). This representation is remarkably low, especially when compared to other tactical careers or occupations that have similar requirements in strength, endurance, and hazardous work conditions like logging and roofing (Hulett et al., 2008).

A number of reasons are offered for why female representation is so low in the fire service. The firefighter workplace culture has been traditionally unaccepting of females (Bielby & Reskin, 2005). The psychological and physical strains of fire fighting are cited as possible explanations for the low proportion of female firefighters (Hulett et al., 2008). Gender-based harass-

ment has also been suggested as an explanation and is suspected to account for issues in female firefighter recruitment and retention (Hulett et al., 2008; Rosell, Miller, & Barber, 1995).

While these explanations surely account for some of the representation disparity between men and women in the US fire service, *the proposition offered in this article is that the impact of fire fighting on reproductive health may be partially responsible for the underrepresentation of females in the fire service.* To test this proposition, a qualitative study of a national sample of 87 firefighters was undertaken to identify reproductive-health concerns among female firefighters.

The study is organized into six sections. Section one provides an overview of the literature on the reproductive health concerns of fire fighting, with a focus on female firefighters. The second section discusses the methods used in the study. Section three presents the results of the analysis of responses provided by focus groups and interviews with the 87 study participants. A discussion of the findings emerging from the qualitative analyses is provided in section four. Section five outlines limitations of the study. Finally, in section six, conclusions and recommendations are offered.

Reproductive Health Concerns Among Firefighters: A Review of Findings

Female firefighters' reproductive health concerns were first documented over 20 years ago (Federal Emergency Management Agency [FEMA], 1996). Improper fit of personal protective ensembles/equipment (PPE), including the possible effect of improper fitting equipment on reproductive health, was female firefighters' second largest concern about their occupation, with the stress of fitting into a nontraditional occupation being their first concern (FEMA, 1996).

A survey conducted by the International Association of Women in Fire & Emergency Services (iWomen), the largest organization of female firefighters in the US, echoed these early concerns. Survey findings found that 58% of female firefighters reported ill-fitting PPE (iWomen, 1995). Fourteen percent of the females specifically cited ill-fitting self-contained breathing apparatus (SCBA) and face pieces that protect firefighters against potential toxic particles in the air. Many female firefighters reported that they were unable to get an adequate seal with their SCBA face pieces (iWomen, 1995), which could dramatically increase exposure risk to potentially harmful chemicals and toxins (Jahnke et al., 2012).

Research findings do, in fact, suggest certain exposures may negatively impact the reproductive health of firefighters. For example, studies report that certain toxic exposures may increase birth defects among the offspring of male firefighters (Olshan, Teschke, & Baird, 1990), and exposure to carbon monoxide and high temperatures may increase the risk of birth defects among female firefighters (McDiarmid, Lees, Agnew, Midzenski, & Duffy, 1991). In addition, exposure to loud noises during pregnancy may result in lower fetal weight and increase chances of fetal mortality (Olshan et al., 1990).

In short, various workplace exposures and hazards can affect the reproductive health of females. Certain exposures and hazards can have consequences not only on the ability to become pregnant, but also fetal health and development (National Institute of Occupational Safety and Health [NIOSH], 2015). Workplace health and safety laws do not always protect a woman's reproductive health. Hazards encountered in the workplace can lead to reproductive health problems such as infertility/reduced fertility, menstrual/ovulatory cycle disorders, sex-hormone imbalances, miscarriages, stillbirths, birth defects, child developmental disorders, premature births, or lower birth-weight babies (NIOSH, 2015).

Although the National Institute of Occupational Safety and Health (NIOSH) states that while most pregnant employees can still safely perform their jobs, it admits that pregnancy can sometimes negatively

affect worker safety (NIOSH, 2015). It has also been posited that shift work, which is very common among firefighters, has a connection to miscarriage and preterm delivery (Amani & Gill, 2013; Mozurkewich, Luke, Avni, & Wolf, 2000; Nurminen, 1995; Puttonen, Härämä, & Hublin, 2010). It is well documented that shift work negatively impacts physiological function through disruption of circadian rhythms (Knutsson, 2003). An in-depth review of health disorders among shift workers summarized the findings of the effects of shift work while pregnant and reported a strong association between shift work and miscarriage, low birth weight, and preterm birth (Knutsson, 2003).

Recent research conducted by Jahnke, Poston, Jitnarin, & Haddock (2018) attempted to quantify birth outcomes among female firefighters. They noted that miscarriage rates among female firefighters were at least 2.3 times higher among firefighters compared to the US National average of 10% (American College of Obstetricians and Gynecologists [ACOG], 2015). They also found that history of preterm birth was higher among female firefighters than the general population (Jahnke et al., 2018).

Pregnancy-policy existence and language varies among fire departments. Unfortunately, some departments do not even have a policy in place for pregnant firefighters (Sprenger & Bates, 2003). Fire departments should educate all firefighters on the potential of risks on reproductive health associated with job duties. An example using National Fire Protection Association® (NFPA®) 1582 ([National Fire Protection Association® NFPA®], 2018) will illustrate this point. The NFPA® is the governing body for fire departments or organizations that provide rescue, fire suppression, emergency medical services, hazardous-materials mitigation, special operations, and other emergency services and specifies the minimum requirements for occupational safety. NFPA® 1582 is the policy standard on fire-department comprehensive occupational medical programs (NFPA®, 2018). The Essential Job Tasks outlined by NFPA® 1582 (2018) contains 14 essential job duties that have the potential to result in negative birth outcomes for the pregnant firefighter. (See Appendix A for NFPA®'s Essential Job Tasks). For example, the first-listed essential job task states the following:

While wearing personal protective ensembles and self-contained breathing apparatus (SCBA), performing fire-fighting tasks (e.g., hoseline operations, extensive crawling, lifting and carrying heavy objects, ventilating roofs or walls using power or hand tools, or forcible entry), rescue operations, and other emergency-response actions under stressful conditions, including working in extremely hot or cold environments for prolonged time periods. (pp. 12–13)

In this first essential job task, there are several potential risks to the pregnant firefighter. PPE may not adequately fit the firefighter over the course of a pregnancy, and poor-fitting turnout jackets and pants may increase exposure to toxic air particles and harmful chemicals (iWomen, 1995). Certain chemicals and metals may be absorbed faster by pregnant females compared to nonpregnant females, and certain chemical exposures are riskier for a fetus because of its rapid development and size than for the pregnant woman (NIOSH, 2015). Second, high ambient temperatures are associated with shorter gestation periods and greater occurrence of stillbirth (Strand, Barnett, & Tong, 2011). In addition, maternal hyperthermia is associated with neural-tube defects during early pregnancy (Moretti, Bar-Oz, Fried, & Koren, 2005). Both El-Metwalli, Badawy, El-Baghdadi, & El-Wehady (2001) and Wong et al. (2010) report that extensive bending/crouching is associated with elevated risk of miscarriage.

In summary, despite research findings that suggest toxic exposures, occupational hazards, job duties, and shift work can negatively impact the reproductive health of female firefighters, there is still much to learn (Jahnke et al., 2012; McDiarmid et al., 1991; Olshan et al., 1990). The purpose of the current study is to add to the growing literature in this area of inquiry by identifying perceptions and concerns about the occupational impact of fire fighting on reproductive health for females. In order to better understand these perceptions and concerns, focus groups and interviews were held with 87 US firefighters. The next section outlines the methods used to guide the study.

Methods

This methods section is divided into three parts. First, the study design and participants from which the data were gathered are outlined. Second, the questions asked study participants are reviewed. Third, grounded theory and the data-analysis methods are discussed.

Study Design and Participants

This qualitative study included a national sample of 46 female firefighters, 27 female fire-service leaders, and 14 male fire-service leaders — a total of 87 individuals. Participants were recruited via national conferences, fire departments where the research team had access to large numbers of female firefighters, and recommendations from fire-service advisors. The female firefighters participated in one of eight focus groups. Based on recommendations from fire-service advisors, individual interviews were conducted with the fire-service leaders. Participants ranged in age from 25 to 66 and had been in the fire service from 3 to 30 years.

Questions Asked Participants

Once the purpose and operating procedures of the study were explained, all participants were given the opportunity to ask questions. An informed consent document was then signed, and participants completed a demographic questionnaire.

The guided discussion on reproductive health generally began with the question, “What concerns exist related to reproductive health among women in the fire service?” In addition to the responses collected from the reproductive-health domain, other questions were asked about reproductive-health education, recruitment and retention, and leave and pregnancy policies. One such question was, “What policies are you aware of that are most common concerning pregnancy?” All focus groups and interviews were transcribed verbatim, and responses from the resulting discussions that were relevant to reproductive health were analyzed.

Data Analysis

Focus-group transcriptions were uploaded into QSR International’s NVivo10 (a qualitative data analysis software product). Two trained qualitative researchers analyzed the data through the process of grounded theory. Through developing, checking, and integrating theoretical categories, emerging key words and ideas were drawn from the data. Gradually, codes and themes were created so that inferences could be made from the data and conceptualizations developed (Miles & Huberman, 1994).

One research team member read and reread each transcript to develop initial codes and subsequent themes. Then, the second researcher read and reread each transcript to create, refine, and add further codes and themes. The researchers then discussed discrepancies until a consensus was achieved. After this process, a third trained researcher read the coded data for final confirmation of the overall themes — thus completing the three-phase coding process.

Grounded theory is a qualitative research-method procedure that flows from one inductive inference to another through selective data collection (Glaser, Strauss, & Strutzel, 1968). Using grounded theory involves a systematic collection and data-analyzing process that leads to creation of theories on patterns of human behavior in social contexts. This research method can increase our understanding of social phenomena (Clamp, Gough, & Land, 2005), but it also enables a solid generation of theories that are informed by the data, as opposed to using the data to test an existing theory (Harris, 2015). This study adhered to the RATS guidelines for reporting qualitative research developed by J. P. Clark (2003).¹

Results

Study results were centered around five key themes that emerged from the analysis of the focus group and interview data. Four of the five key themes focused directly on concerns about reproductive health among female firefighters. These four concerns included the following: (1) a wide variation among fire departments in pregnancy policies; (2) decision-making choices among firefighters for disclosure of a pregnancy; (3) the lack of education, research, and information for firefighters on reproductive-health issues; and (4) how reproductive health concerns impact female recruitment and retention. The fifth study-participant theme emerging from the data analysis was not related to a reproductive-health concern. Rather, the theme focused on successful and positive policies implemented by departments with regards to female firefighter reproductive health and innovations within the fire service with regard to female reproductive-health policy. A discussion of each theme is given in the following sections.

Wide Variation Among Fire Departments in Pregnancy Policies

Among American fire departments, there is no single policy to follow for a firefighter who becomes pregnant. Study participants, however, unanimously agreed that departments should have a policy in place to guide firefighters who become pregnant. Most participants reported that their respective departments either had no policy or that its policy was unfavorable toward females in some way. Departments with no set pregnancy policies usually had few female firefighters; which resulted in a scramble to find a policy and caused confusion within the department when a pregnancy was announced. Three examples of statements about this concern from participants included the following:

- **Female Fire-Service Leader:** “. . . it was a scramble to find a policy that — that could — that they could use to protect both the firefighter and the department and the baby. It was interesting, you know, it was almost like wait until you’re walking through the door, and now I got to come up with something? Never a good move.”
- **Female Firefighter:** “A lot of places don’t have policies . . . And we still don’t have a policy.”
- **Female Fire-Service Leader:** “No policies for like, when we’re pregnant or anything like that. Um, we had two females in the past that neither one of them had kids while they were working, so it was never an issue.”

Pregnancy policies that were viewed as unfavorable occurred when firefighters had to use sick time,

vacation time, or a combination of both when they were no longer able to work during a pregnancy. This situation happened in small departments that did not have light-duty assignments or that had budgetary constraints. One study participant noted the following:

Female Firefighter: “Mine is you use up your sick time, vacation time, and you go on unpaid leave.”

For the participants that knew of their department’s pregnancy policy, it was typical that the firefighter was given a light-duty assignment for the remainder of her pregnancy. A light-duty assignment is typically clerical day work and means that they do not respond to emergency calls. One large difference noted in light-duty assignments was that some firefighters had a policy that let them and/or their health-care practitioners decide when to go on light duty, and some departments had a policy that immediately removed pregnant firefighters from active duty. The following three statements highlight these issues:

- **Female Firefighter:** “Our folks all have a light duty or a temporary modified work-assignment option. So, if they choose, if they choose, as soon as they find out, um, that they’re pregnant, they go on temporary modified.”
- **Male Fire-Service Leader:** “The moment that a female firefighter notifies the fire department that she is pregnant, um, we bring her off-line. Um, we put her on day work . . . She remains on day work, um, in a nonoperational capacity until she delivers.”
- **Female Fire-Service Leader:** “We have a policy that once you become pregnant, you have to tell our administration, and they take you off-line. So our administration is pretty proactive in that. And we’ve actually taken some heat from that.”

Decision-Making by Firefighters for Disclosure of a Pregnancy

Disclosure of pregnancy by firefighters greatly varied, along with reasons for choosing when to do so. Some females chose to disclose their pregnancies to their departments right away, while some chose to wait as long as possible before letting their departments know in order to stay working on active duty. The most cited reason for early disclosure of pregnancy included concern for fetal and/or maternal health when responding to calls. Two study participants noted the following situations:

- **Female Firefighter:** “I would never want to have to make a choice between somebody in the — a firefighter in a house, or my child. I don’t want to make that choice. And so I — I made the choice

to go to days and to go to limited duty, off shift. And I — I feel it was a good choice.”

- **Female Firefighter:** “When I got pregnant, um, I — I was very careful not to let anyone know for a — a good period of time. Because one, I was afraid I was going to be forced to go off shift or there would be other decisions to make.”

Few participants reported disclosing a pregnancy and then staying on active duty. In these cases, judgment and criticism from coworkers were received, along with unnecessary protective treatment. Firefighters who disclosed a pregnancy but chose to continue to *ride the engine* reported being accused by coworkers of being irresponsible and negligent of their unborn children. For example, two female firefighters said the following:

- **Female Firefighter:** “But he’s like, ‘. . . doesn’t she risk . . . the fetus? And then won’t the coworkers feel responsible to have to, you know, watch her a little bit closer?’ ”
- **Female Firefighter:** “There’s a perception that a woman, once she becomes pregnant, has a handicap.”

Many participants reported they decided to stay on active duty as long as possible until their pregnancies prevented them from continuing. Some firefighters reported coming off the line once their turnout gear no longer fit or when they felt they could not perform their duties adequately. One study participant commented as follows:

Female Firefighter: “I didn’t tell anybody — as soon as — I felt like that I was going to be, um, harmful to the crew or I wasn’t pulling — able to pull my own weight, well then it was time for me to try to find some light duty. Somewhere you know, you know, not to be a hindrance. Um, so I just didn’t tell anybody — for me, at six months it was, you know, it was time to go.”

One of the most cited reasons for choosing to stay on active duty while pregnant was to avoid being placed in a light-duty assignment. This type of work was reported to involve a position that was mainly clerical day work and was generally viewed as a boring or meaningless job. Coworkers also sometimes viewed it as an excuse for the pregnant firefighter to choose light duty as a way to *slack off* but still be paid. Three examples of participant statements that reflect this viewpoint are as follows:

- **Female Firefighter:** “. . . light duty is a punishment. It’s the worst.”

- **Female Firefighter:** “I don’t want to sit there and do desk stuff and menial job; I want to work my shift 24 hours. You know, Monday through Friday sucks for people that aren’t used to that kind of shift.”
- **Female Firefighter:** “They think that ‘Oh, you want light duty for pregnancy, oh you just want to get paid to do nothing.’ ”

In some cases, the decision to stay on active duty was a financial issue, since other assignments were not available for the firefighter. Other reasons reported for staying on active duty included believing that their pregnancy had no impact on being a firefighter as long as they could perform their job or to prove a point to the men that pregnancy was not a handicap. One female noted the following:

Female Fire Service Leader: “Boy, it is a heated, heated issue — you got the people that don’t think you should be working and endangering your child.”

Some participants said that their decision to disclose a pregnancy or not had to do with promotional or seniority factors. One participant recounted disclosing a pregnancy early and going off active duty only to lose a promotion because of it. The same participant chose to keep her pregnancy a secret with her second pregnancy so she would not lose her seniority again. Other firefighters reported not disclosing a pregnancy and staying on active duty because they did not want to use up their sick time and vacation time.

Lack of Education, Research, and Information for Firefighters on Reproductive Health

It was unanimously agreed that the fire-fighting industry lacked education, research, and general knowledge about female firefighters’ reproductive health. Participants reported that there were limited informational resources to guide or counsel them if they became pregnant. Two firefighters believed the following:

- **Female Firefighter:** “We really need to have some . . . kind of guidelines for women that — that they can look at and whether there’s an impact on — on their, uh their children long term, uh, or not. Or you know, something that is solid to be able to look to for information.”
- **Female Firefighter:** “It would be nice if somebody had, you know, some rhyme or reason to when is a good time to go and when’s not, you know? But it seems like we’re all on our own.”

Extreme heat, hazardous-material incidents, exposure risk (hydrogen cyanide, smoke, sick people, carcinogens, byproducts of combustion, chemicals, and blood-borne pathogens), poor fit of personal-protective ensembles, and carrying/transporting heavy victims were cited as possible and questionable threats to firefighter and fetal safety. Three study participants said the following:

- **Male Fire-Service Leader:** *“We’ve had some people who have gotten pregnant recently, and I don’t think they realized what the risk is, because some of them have stayed on duty six, seven months into their pregnancy.”*
- **Female Fire-Service Leader:** *“There should be more, um, information out there for women who are planning to be pregnant while they’re in the fire service as to know when it is safe for them to be in combat and then not, you know, and then have to go on light duty.”*
- **Female Firefighter:** *“When the baby’s making, you know, the critical time in the first trimester . . . you’re going in a heated environment and things like that. Isn’t that bad?”*

Lack of knowledge, specifically from health-care practitioners and fire-service leaders, was also reported by participants. Several firefighters reported that when they asked for information or counsel regarding the risks involved with fire fighting while pregnant, they were not given satisfactory answers. Two examples of such statements included the following:

- **Female Firefighter:** *“Even my doctor, my OB had no idea. She’s like, ‘So what do you want to do?’ I’m like, ‘Well, I thought you could answer that for me.’”*
- **Female Firefighter:** *“My chief at the time comes up to me and goes, ‘Now what do I do with you?’ Like I said, nobody has a clue.”*

Although research and education for pregnancy while working active duty were the primary concerns from participants, other areas that needed more research and information for firefighters included breast-milk contamination, reproductive cancers, fertility, long-term health of a child conceived by a working firefighter, and the overall long-term impacts on female-firefighters’ reproductive health.

Reproductive Health Concerns Impact Female Recruitment and Retention

Many firefighters reported delaying becoming pregnant during their careers. Reasons for delaying pregnancy were trying to save up or *bank* sick time

so that they could accrue time off in the pregnancy or postpartum period, to get past their probationary period, or because they were trying to get promoted. These planned delays in pregnancy were reported to cause fertility issues in some cases, especially for those firefighters who waited until their 30s to try and conceive. This situation was said to have caused additional stress, uncovered fertility-treatment bills, and questioning by females of whether a career in the fire service was *worth it*. Two female firefighters noted the following:

- **Female Firefighter:** *“I understand some of the issues, but when — I’m like, when you look at the big picture of, I’m here for this entire career.”*
- **Female Firefighter:** *“. . . we’ve lost women who’ve become pregnant and because of the policy.”*

It was also reported that when firefighters declared pregnancy and could no longer work active duty, they were unfairly treated. Some departments, due to budget restrictions and department size, forced pregnant firefighters to use sick time, vacation time, or take unpaid leave during the rest of their pregnancies. Three statements about these issues included the following:

- **Female Firefighter:** *“You’re kind of penalized for being female.”*
- **Female Firefighter:** *“And so I think if pregnancy leave and return isn’t really well done, that could be a big black hole as to why women fall out of the fire service after getting, uh, after becoming mothers.”*
- **Female Fire-Service Leader:** *“Out of the four ladies that I can tell you left the fire service, three of them left because they became mothers.”*

It was reported by participants that pregnancy and managing a family were sometimes treated like inconveniences for the department. It was mentioned multiple times that firefighters felt as though they had to choose between starting a family and their careers because doing both did not benefit the department. Two firefighters said the following:

- **Female Firefighter:** *“You chose to have this family. You know what the rules are.”*
- **Female Firefighter:** *“You chose this. You want to be one of us.”*

Many female firefighters also pointed out that their departments or unions often chose to ignore their reproductive-health concerns and pregnancy-leave

options because there were so few females overall. Also, their gender was a discriminatory factor in making departmental decisions. The following two statements reflect these concerns:

- **Female Firefighter:** *“The unions are like, ‘Well, that only, you know, we’re here to protect the greater — the majority.’ . . . I’m stuck being a woman.”*
- **Female Firefighter:** *“They’re just like, ‘Well we can only bring so many things to the table, and you’re one person. So, you know, are we going to sacrifice one of our important things for just helping one person?’ ”*

It was generally agreed that many female firefighters had to battle to find their place within the male-dominated profession of fire fighting. In certain cases, female firefighters reported not wanting to recruit or convince other females to join the fire service because they did not want other females to experience what they went through with regards to having fertility issues, taking leave due to starting a family, or receiving judgment from other firefighters for taking leave due to pregnancy. One female firefighter noted the following, for example:

Female Firefighter: *“. . . yesterday their big thing was the recruitment drive, and we have to get more women involved. And I struggle with that because I have a hard time going and recommending this to any woman. I’m like ‘Why would you put yourself through what I did?’ ”*

Family building and pregnancy were also framed by one firefighter as being relatively short amounts of time in the context of a 30-year career. She reported it was unfair for females to have so few options when pregnant or to feel as though females were penalized by less pay, leave options, or opportunity for promotion because they wanted to start a family. Others felt as though being a firefighter and female forced them to choose between having a family or continuing to be a firefighter, because having both was not an option. One study participant believed the following:

Female Firefighter: *“It was such an inconvenience to everybody that I had a child, and it was such a big deal.”*

A lot of females agreed unanimously that they felt uncomfortable being the person who spoke up to say that things were unfair for female firefighters. They did not want to be a person who was viewed as a troublemaker or a whistle-blower because this view would reflect negatively upon them. Participants also felt that while fire departments had gotten better in recent years with respect to how they treated females and their specific issues in the fire-service workplace, there was still a long way to go with females and reproduction within the fire service.

Innovations within the Fire Service with Respect to Female Reproductive-Health Policies

A minority of participants reported successful and positive policies implemented by departments with regard to female-firefighter reproductive health. These innovations are presented in **Table 1**.

Table 1: Innovations Within Fire Departments

Department Strategy	Example
Create an opportunity to take paid leave during pregnancy	<i>“They instituted . . . a short-term disability you could opt into. And so that was what the . . . females . . . would utilize once they couldn’t work anymore. They would . . . take the short-term disability and then . . . maternity leave after that.” — Male Fire-Service Leader</i>
Give female firefighters options to decide	<i>“Our folks all have a light duty or temporary modified-work assignment option. So if they choose . . . as soon as they find out that they’re pregnant, they go on temporary modified.” — Female Fire Service Leader</i>
Give female firefighters job security	<i>“when you got pregnant, there was a spot for you to go to continue working . . . they either put them at the chief’s office answering phones, at fire prevention, . . . they have worked in applicant processing, recruiting.” — Female Firefighter</i>
Create modified work assignments that do not feel like punishment	<i>“take people’s talents and find some place to . . . have them productive and giving back . . . I never realized how exciting it could be and how I can make a bigger influence being in a staff assignment as opposed to just being an operations battalion chief.” — Female Fire Service Leader</i>
Offer female firefighters longer than 12 weeks of leave from FMLA (Family and Medical Leave Act)	<i>“I get 70% of my pay . . . for one year.” — Female Firefighter</i> <i>“We have a year maternity leave from the time that the baby’s born. And then from there . . . if we require additional time, um, it’s something that we have to coordinate with the fire chief.” — Female Firefighter</i>

Attention now turns to a discussion of the female reproductive-health concerns mentioned in this section.

Discussion

Study participants' comments presented in the previous Results section clearly show that female reproductive health is a significant, although frequently underrecognized, area of concern in the fire service. Data analyses of responses gathered from the national sample of 87 firefighters identified four themes that represented major areas of reproductive health concerns expressed by study participants. The following sections offer a discussion of these concerns.

Concern 1: Wide Variation among Fire Departments in Pregnancy Policies

Within NFPA® 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*, there is a recommended policy for the treatment and care of pregnant firefighters in Section 9.18 (see Appendix B) (NFPA®, 2013). Although the standard offers policy recommendations for fire departments, it is important to note that the recommendations are just that, recommendations; they are not mandatory, enforced, nor monitored within fire departments (NFPA®, 2018). However, it is also important to note that the recommended policy language addresses many of the concerns highlighted by participants in the present study. The recommendations include (1) an immediate report to the department physician once a pregnancy is known; (2) full disclosure to the firefighter of fire-related hazards that can affect the pregnancy and fetus; (3) provision of an alternative-duty assignment that is safe; and (4) on-going medical evaluation to determine any restrictions from activities that the female firefighter is not able to perform in a safe manner (NFPA®, 2013).

The standard also states that educational materials should be provided, highlighting reproductive health risks for both male and female firefighters (NFPA®, 2013). The standard notes that certain essential job tasks will eventually become unsafe for the pregnant firefighter due to her diminished aerobic capacity, speed, balance, and agility, and that the firefighter will need to be restricted from those job tasks upon medical evaluation from the fire-department physician. Additionally, the pregnant firefighter may also request an alternative-duty assignment at any stage of pregnancy (NFPA®, 2013).

In short, fire departments need to have a pregnancy policy in place. It is not acceptable or fair to the female firefighter to have to figure out what to do in the event of a pregnancy. As noted in the Results section, the majority of fire departments from which participants

came either lacked a policy altogether or had a limited pregnancy policy in place that did not satisfy the needs of the firefighters interviewed.

Concern 2: Decision-making Choices among Firefighters for Disclosure of a Pregnancy and Concern 3: Lack of Education, Research, and Information for Firefighters on Reproductive Health Issues

Some study participants reported that they suffered judgment and criticism from coworkers after disclosing a pregnancy and choosing to remain on active duty. They were accused of being irresponsible and negligent of their unborn child. Occupations that exhibit harassment and discrimination towards women prevent women from fully engaging in their work environments (Hulett et al., 2008).

While the NFPA® pregnancy policy (2013) is a strong starting point, especially for departments that have nothing in place, it is important to point out that some of the largest concerns highlighted from research reported here appear to be the overall lack of knowledge and education of health-care providers and fire-service leadership. Subsequently, this situation has led to a lack of educational materials for firefighters. In support of our findings, FEMA (Federal Emergency Management Agency) (1996) has also stated that physicians need to be better updated on the demands of first-responder duties.

There is a body of occupational-health research (although the majority of the research is not firefighter specific), associating certain firefighter job duties with adverse reproductive-health outcomes (American Pregnancy Association, 2018; Bhatt, 2000; El-Metwalli et al., 2001; Fabian et al., 2010; iWomen, 1995; McDiarmid & Agnew, 1995; McDiarmid et al., 1991; McDonald et al., 1988; Moretti et al., 2005; NIOSH, 2015; NIOSH, 1999; Strand et al., 2011; Taskinen, Kyyrönen, & Hemminki, 1990; Treitman, Burgess, & Gold, 1980; Wong et al., 2010). This research is a good *starting* point for learning about reproductive health in the fire service and should be shared with as many fire departments as possible.

Providing information and education to health-care providers about the essential job tasks of fire fighting could help close this knowledge gap (FEMA, 1996). Although our research has focused on the female firefighter, much of this evidence is not limited to females. For example, as noted previously in the study, toxic exposures may also increase the risk of birth defects among children of male firefighters (Olshan et al., 1990).

In response to study participants' concerns over the lack of information and education on reproductive health, it is proposed that a pregnant firefighter bring a

copy of **Table 2** to discuss with her primary-care physician to help her decide whether she should continue working active duty. Under Title VII of the Civil Rights Act, a department cannot forbid a female firefighter from performing certain job tasks; otherwise they will face liability for violation of the sex-discrimination prohibition (Miller, 1966). **Table 2** outlines NFPA® 1582 Essential Job Tasks (2018) and specifically highlights the potential reproductive-health risks for a pregnant firefighter so that an informed decision on working active duty can be made. Fire departments should also provide reproductive-health education for all firefighters in order to decrease stigma or negative judgment that may follow a pregnant firefighter going off active duty.

Concern 4: Reproductive Health Concerns Impacts Female Recruitment and Retention

Evidence suggests that showing employees that their health and safety and the health of their families are valued improves employee morale and retention (NIOSH, 2015). Pregnancy among female firefighters tends to be treated as a sickness and not a condition, and many female firefighters are forced to save sick time and vacation time to use once they become pregnant due to a lack of or poor policy provisions. This situation has obvious negative retention and recruitment implications, since the ability to utilize sick

Table 2: Reproductive Health Concerns within Essential Firefighter Job Tasks^a

NFPA® 1582 Essential Job Tasks (2018)	Reproductive Health Concerns
<p><i>(1) “While wearing personal protective ensembles (PPE) and self-contained breathing apparatus (SCBA), performing fire-fighting tasks (e.g., hoseline operations, extensive crawling, lifting and carrying heavy objects, ventilating roofs or walls using power or hand tools, forcible entry), rescue operations, and other emergency-response actions under stressful conditions, including working in extremely hot or cold environments for prolonged time periods”</i></p>	<ul style="list-style-type: none"> • Maternal hyperthermia is associated with neural-tube defects during early pregnancy (Moretti, Bar-Oz, Fried, & Koren, 2005). • PPE may not adequately fit the female firefighter over the course of a pregnancy, and poorly fitted turnout jackets and pants may increase workplace exposure to toxic air particles and harmful chemicals (FEMA, 1996). • High ambient temperatures are associated with shorter gestation periods and greater occurrence of still birth (Strand, Barnett, & Tong, 2011). • Bending/crouching have been associated with elevated risk of miscarriage (El-Metwalli, Badawy, El-Baghdadi, & El-Wehady, 2001; Wong et al., 2010).
<p><i>(3) “Exposure to toxic fumes, irritants, particulates, biological (infectious) and nonbiological hazards, and heated gases, despite the use of personal protective ensembles and SCBA”</i></p>	<ul style="list-style-type: none"> • Certain chemicals and metals are absorbed faster by pregnant females compared to nonpregnant females, and certain chemical exposures are riskier for a fetus than the pregnant woman because of its rapid development and size (National Institute of Occupational Safety and Health [NIOSH], 2015). • Lead exposure: Found in smoke particles, (Fabian et al., 2010) can lead to miscarriage, low birth weight, infertility, or developmental disorders (NIOSH, 1999). • Lead can cross the placental barrier at 12 weeks of gestation, which could lead to brain-development issues (Bhatt, 2000; NIOSH, 1999). • Carbon disulfide exposure (found in personal air-sampling devices among firefighters) (Treitman, Burgess, & Gold, 1980) can lead to menstrual-cycle changes, which can lead to fertility issues (NIOSH, 1999). • Carbon-monoxide (a gas created when fuels burn incompletely) exposure (NFPA®, 2008) likely increases risk of birth defects in pregnant female firefighters (McDiarmid & Agnew, 1995). • Other products of combustion: aldehydes (e.g., acetaldehyde, formaldehyde, acrolein), benzene, carbon dioxide, chloroform, dichlorodifluoromethane, hydrogen chloride, hydrogen cyanide, methylene chloride, nitrogen dioxide, nitrogen oxide, perchloroethylene, sulfur dioxide, toluene, trichloroethylene, and trichlorophenol) have been found to be of concern for reproductive health in either animals or humans (McDiarmid, Lees, Agnew, Midzenski, & Duffy, 1991). <p style="text-align: right;"><i>(continued)</i></p>

^a NFPA® 1582 Essential Job Tasks numbers 2, 10, and 13 were not included in Table 2 since they did not pose negative reproductive health-care concerns.

Table 2: (Concluded)

NFPA® 1582 Essential Job Tasks (2018)	Reproductive Health Concerns
(4) "Depending on the local jurisdiction, climbing six or more flights of stairs while wearing a fire-protective ensemble, including SCBA, weighing at least 50 lb. (22.6 kg) or more, and carrying equipment/tools weighing an additional 20 to 40 lb. (9 to 18 kg)"	<ul style="list-style-type: none"> • Heavy occupational lifting has an observed effect of miscarriage late in pregnancy or premature delivery (McDonald et al., 1988; NIOSH, 1999; Taskinen, Kyyrönen, & Hemminki, 1990).^b • Excessive occupational physical activity (reported high intensity, high fatigue, and unfavorable working hours) (El-Metwalli et al., 2001) and bending or crouching have been associated with elevated risk of miscarriage (El-Metwalli et al., 2001; Wong et al., 2010).^b
(5) "Wearing a fire-protective ensemble, including SCBA, that is encapsulating and insulated, which will result in significant fluid loss that frequently progresses to clinical dehydration and can elevate core temperature to levels exceeding 102.2°F (39°C)"	<ul style="list-style-type: none"> • Maternal hyperthermia is associated with neural-tube defects during early pregnancy (Moretti et al., 2005). • Maternal dehydration can lead to pregnancy complications like neural-tube defects, low amniotic fluid, inadequate milk production, premature labor, and birth defects (American Pregnancy Association, 2018).
(6) "While wearing personal protective ensembles and SCBA, searching, finding, and rescue-dragging or carrying victims ranging from newborns to adults weighing over 200 lb. (90 kg) to safety despite hazardous conditions and low visibility"	<ul style="list-style-type: none"> • Heavy occupational lifting has an observed effect of miscarriage late in pregnancy or premature delivery (McDonald et al., 1988; NIOSH, 1999; Taskinen et al., 1990).^b
(7) "While wearing personal protective ensembles and SCBA, advancing water-filled hoselines up to 2 1/2 in. (65 mm) in diameter from fire apparatus to occupancy [approximately 150 ft. (50 m)], which can involve negotiating multiple flights of stairs, ladders, and other obstacles"	<ul style="list-style-type: none"> • Excessive occupational physical activity (reported high intensity, high fatigue, and unfavorable working hours) has been associated with elevated risk of miscarriage (El-Metwalli et al., 2001).
(8) "While wearing personal protective ensembles and SCBA, climbing ladders, operating from heights, walking or crawling in the dark along narrow and uneven surfaces that might be wet or icy, and operating in proximity to electrical power lines or other hazards"	<ul style="list-style-type: none"> • Bending/crouching have been associated with elevated risk of miscarriage (El-Metwalli et al., 2001; Wong et al., 2010).
(9) "Unpredictable emergency requirements for prolonged periods of extreme physical exertion without benefit of warmup, scheduled rest periods, meals, access to medication(s), or hydration"	<ul style="list-style-type: none"> • Excessive occupational physical activity (reported high intensity, high fatigue, and unfavorable working hours) has been associated with elevated risk of miscarriage (El-Metwalli et al., 2001).
(11) "Critical, time-sensitive, complex problem solving during physical exertion in stressful, hazardous environments, including hot, dark, tightly enclosed spaces, that is further aggravated by fatigue, flashing lights, sirens, and other distractions"	<ul style="list-style-type: none"> • High job stress is associated with increased risk of miscarriage and low birth weight in females (Brandt & Nielsen, 1992). • Bending/crouching have been associated with elevated risk of miscarriage (El-Metwalli et al., 2001; Wong et al., 2010).
(12) "Ability to communicate (give and comprehend verbal order) while wearing personal protective ensembles and SCBA under conditions of high background noise, poor visibility, and drenching from hoselines and/or fixed protection systems (sprinklers)"	<ul style="list-style-type: none"> • Textile workers exposed to more than 85 decibels from a wide range of noise exposures were found to have significantly increased rates of miscarriage (Zhan et al., 1991)^c
(14) "Working in shifts, including during nighttime, that can extend beyond 12 hours"	<ul style="list-style-type: none"> • Evidence strongly suggests that shift-work is associated with higher rates of miscarriage, preterm birth (Amani & Gill, 2013; Knuttson, 2003; Mozurkewich, Luke, Avni, & Wolf, 2000; Nurminen, 1995; Puttonen, Härmä, & Hublin, 2010) and low birth weight. • Working long hours has a strong association with miscarriage (Schenker, Eaton, Green, & Samuels, 1997).

^b Epidemiologic evidence for physical activity has not been consistent (Wong et al., 2010). Occupational heavy lifting has been previously associated with both risk reductions and elevations (McDonald et al., 1988; Taskinen et al., 1990). Occupational physical exertion research has been mixed with some null studies (Axelsson, Rylander & Molin 1989; Fenster, Hubbard, Windham, Waller, & Swan, 1997; John, Savitz, & Shy 1994).

^c Epidemiologic evidence for noise exposure has not been consistent (no elevations in miscarriage risk were identified for females holding jobs considered to have moderate or loud noise levels) (Wong et al., 2010).

time for its actual purpose is impacted. Similarly, taking vacation time to have a child loses the designation and purpose of this time off from work.

Study participants' statements clearly suggest that making female firefighters use their sick times and/or vacation times as "pregnancy policies"

negatively impacts firefighter recruitment and retention; it makes more traditional jobs with clear maternity- and pregnancy-leave policies more appealing than working for the fire service. Female-firefighter retention may be improved if better policies regarding pregnancy and maternity leave are implemented. In addition

to potentially increased retention, departments may also benefit financially. Research suggests that implementing successful health systems (such as a pregnancy policy) could reduce injury and illness costs and have a high return on investment (NIOSH, 2015).

Limitations of Study

As with any qualitative study, the limitations of the research presented includes the possibility that results may be specific to our participants. However, findings reported align with previous research and bolster the suggestion that reproductive health is a warranted concern among firefighters, both male and female (FEMA, 1996). Although study participants were drawn from a national sample of mostly female firefighters (with several key male leaders), it is possible that some attitudes and experiences may have been missed in this study. As such, more research is clearly required.

Conclusions and Recommendations

The concern and call for more research on firefighters' reproductive health highlighted by this study are the same issues identified more than 20 years ago by FEMA (1996). Yet, too little focus has been placed on female firefighters' reproductive health needs. This situation highlights a huge gap in the literature and possibly exposes some of the problems with recruitment and retention of females in the fire service.

The research presented indicates that reproductive health is both a *significant and major* concern of US female firefighters. Findings reinforce the need for further research and lay a foundation for the identification of key issues. It would be interesting to know if similar concerns exist outside of the US. In addition, it would be useful to know if reproductive health is as great of a concern to male firefighters as it is to female firefighters. For instance, exposure risks are harmful to not only pregnant females but males also. One study, for example, found that birth defects such as heart anomalies, hypospadias, and ventricular and atrial septal defects were significantly higher among firefighters overall and that paternal exposure prior to conception was to blame (Chia & Shi, 2002).

Whether females compose a small percentage of a fire department or even in departments where females have yet to be employed, it is imperative that every fire department have a clear pregnancy policy in place. Employers are required to provide a safe workplace for employees (NIOSH, 2015). This provision includes educating employees about safe work practices and providing them with appropriate equipment for job safety (NIOSH, 2015). The pregnancy policy set by departments should involve the department's physician and should clearly communicate the risks involved (iWomen, 1995) as outlined in this study (see Table 2).

Implementation of a sound policy should also include guidelines for the firefighter to report her condition. Once a firefighter has disclosed her condition, ideally, her department's physician will administer a medical release form that complies with NFPA® 1582 (2018), so that her ability to perform essential job tasks can be assessed and a guideline can be given to the firefighter as to when those duties should be modified.

One of the larger concerns is the possibility of exposure during the early stages of pregnancy. The first 12 weeks of a pregnancy is a particularly vulnerable time for the fetus, because it is a critical developmental stage (NIOSH, 1999). Even small exposures can elicit lasting adverse fetal health outcomes (Grandjean et al., 2008). Education for the firefighter, the department, and any health-care practitioners working with firefighters should acknowledge the potential negative implications of fire fighting and pregnancy. Education specifically for male firefighters could potentially decrease the reports of discrimination and harassment from female firefighters, which could, in turn, lead to increased work engagement (Hulett et al., 2008). Sharing successful program information between and among fire departments is also a simple strategy that may lead to a more uniform approach to reproductive health-care policies and could also avoid false starts in which a department tries an unsuccessful attempt to implement something new (FEMA, 1996).

Table 1 showed examples of fire departments that have championed reproductive health in various ways. Sharing successful policy creation, reproductive health education, recruitment and retention tactics, and connecting fellow departments with informed departmental physicians are some of the areas where departments could support one another. A successful program-sharing option could be developed using firefighter publications or through national firefighter conferences.

The military, which boasts a much higher representation of females than does the fire service generally, has invested in research for adjustments that make its equipment more accessible to men and women (FEMA, 1996). A centralized focus on proper fitting PPE for a female firefighter could be an important next step for decreasing reproductive-health concerns due to poor-fitting clothing and breathing apparatus.

A combination of an appropriate pregnancy policy, dissemination of what is known regarding occupational health, and further research on the maternal and fetal risks from fire fighting prior to conception and while pregnant is the recommended starting point. A strongly implemented pregnancy policy could lead to safer pregnancy outcomes, healthier firefighters, and better retention and recruitment for current and future female firefighters. Further research and subsequent dissemination to departments and health-care practitioners that work with this population are desperately needed.

Pregnant firefighters deserve to make an informed decision when it comes to working active duty. In order to make an informed decision, the repercussions of fire fighting while pregnant need further research. Staying on active duty because of poor or lacking pregnancy policies, fear of harassment, avoidance of light duty, or loss of promotion/seniority should not be deciding factors for the female firefighter. The implications of this research benefit not just the current female firefighter, but could pave the way for better reproductive health protection for future firefighters and their children.

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- performing fire-fighting tasks (e.g., hoseline operations, extensive crawling, lifting and carrying heavy objects, ventilating roofs or walls using power or hand tools, or forcible entry), rescue operations, and other emergency-response actions under stressful conditions, including working in extremely hot or cold environments for prolonged time periods
- (2) Wearing an SCBA, which includes a demand valve-type positive-pressure facepiece or high-efficiency particulate air (HEPA) filter mask, which requires the ability to tolerate increased respiratory workloads
- (3) Exposure to toxic fumes, irritants, particulates, biological (infectious) and nonbiological hazards, and heated gases, despite the use of personal protective ensembles and SCBA
- (4) Depending on the local jurisdiction, climbing six or more flights of stairs while wearing a fire-protective ensemble, including SCBA, weighing at least 50 lb (22.6 kg) or more and carrying equipment/tools weighing an additional 20 to 40 lb (9 to 18 kg)
- (5) Wearing a fire-protective ensemble, including SCBA, that is encapsulating and insulated, which will result in significant fluid loss that frequently progresses to clinical dehydration and can elevate core temperature to levels exceeding 102.2°F (39°C)
- (6) While wearing personal protective ensembles and SCBA, searching, finding, and rescue-dragging or carrying victims ranging from newborns to adults weighing over 200 lb (90 kg) to safety despite hazardous conditions and low visibility
- (7) While wearing personal protective ensembles and SCBA, advancing water-filled hoselines up to 2½ in. (65 mm) in diameter from fire apparatus to occupancy [approximately 150 ft. (50 m)], which can involve negotiating multiple flights of stairs, ladders, and other obstacles
- (8) While wearing personal protective ensembles and SCBA, climbing ladders, operating from heights, walking or crawling in the dark along narrow and uneven surfaces that might be wet or icy, and operating in proximity to electrical power lines or other hazards
- (9) Unpredictable emergency requirements for prolonged periods of extreme physical exertion without benefit of warm-up, scheduled rest periods, meals, access to medication(s), or hydration
- (10) Operating fire apparatus or other vehicles in an emergency mode with emergency lights and sirens

Endnote

¹ RATS is a guide to peer reviewing qualitative manuscripts developed by J. P. Clark, 2003. The components of RATS include: R — Relevance of Study Question; A — Appropriateness of Qualitative Method; T — Transparency of Procedures; and S — Soundness of Interpretative Approach.

Appendix A

NFPA® 1582 (2018)

Standard on Comprehensive Occupational Medical Program for Fire Departments

Chapter 5: Essential Job Tasks

(1) While wearing personal protective ensembles and self-contained breathing apparatus (SCBA),

(11) Critical, time-sensitive, complex problem solving during physical exertion in stressful, hazardous environments, including hot, dark, tightly enclosed spaces, that is further aggravated by fatigue, flashing lights, sirens, and other distractions

(12) Ability to communicate (give and comprehend verbal order) while wearing personal protective ensembles and SCBA under conditions of high background noise, poor visibility, and drenching from hoselines and/or fixed protection systems (sprinklers)

(13) Functioning as an integral component of a team, where sudden incapacitation of a member can result in mission failure or in risk of injury or death to civilians or other team members

(14) Working in shifts, including during nighttime, that can extend beyond 12 hours

Appendix B

NFPA® 1582 (2013)

Standard on Comprehensive Occupational Medical Program for Fire Departments

Chapter 4: Roles and Responsibilities

9.18 Pregnancy and Reproductive Health.

9.18.1 Fire Departments shall make available to all male and female firefighters educational materials outlining the risks from fire fighting on reproductive health.

9.18.2 It is recommended that members who become pregnant report the pregnancy immediately to the fire-department physician. Once informed of the pregnancy, the fire-department physician shall inform the pregnant member of the numerous hazards to the pregnancy and the fetus encountered during routine fire-fighting tasks.

9.18.2.1 If the member requests an alternative duty assignment in an environment deemed safe for the pregnancy and the fetus, the physician shall provide appropriate restrictions for essential job tasks 1, 3, 5, 6, 7, and 8 that are unsafe for her or her fetus.

9.18.3 During later stages of pregnancy, the member will eventually be unable to safely perform essential job tasks 1, 2, 3, 4, 5, 6, 7, 8, and 9 due to issues with diminished aerobic capacity, balance, speed, and agility. As with any other member, when performance due to medical issues is of concern, the AHJ (authority having jurisdiction) shall inform the fire-department physician, and a medical evaluation will be performed to determine the need for restricting the member from those activities that they are not able to safely perform. The NFPA® has no power, nor does it undertake, to police or enforce compliance with the contents of NFPA® Documents. Nor does the NFPA® list, certify, test, or inspect products, designs, or installations for compliance with this document. Any certification or other statement of compliance with the requirements of this document shall not be attributable to the NFPA® and is solely the responsibility of the certifier or maker of the statement.

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When Passion Fuels the Fire: Knowledge Sharing Among Volunteer Firefighters in Canada

Abstract

Little is known about how knowledge is managed in the fire service (Beauchamp, 2017; Massaro, Dumay, & Garlatti, 2015). Based on data from (1) a survey of volunteer firefighters in the Province of Quebec, Canada, (2) 20 fire department municipal websites, and (3) semistructured interviews, this article presents, to our knowledge, the first model explaining knowledge management in volunteer fire departments. Findings emerging from the analysis of the data support the three propositions guiding the research effort. First, knowledge sharing among firefighters, called Buddy Learning in this study, is the main source of learning for firefighters. Second, serious leisure components are levers of knowledge management in volunteer fire departments. Third, turned inward, the fire service organizational culture impairs knowledge transfer from external sources such as other fire departments, partners, customers, suppliers, and academic and applied research.

Keywords: *knowledge management in the fire service, firefighters, volunteer fire departments, Buddy Learning, serious leisure, factor analysis*

Introduction

A recent literature review of 238 peer-reviewed studies found that research focusing on the fire service could be grouped into three metacategories: studies on (1) health and safety, (2) management, and (3) organizational culture (Beauchamp, 2017). Research on health and safety showed that new strategies are necessary to reduce the risks associated with cancer, cardiovascular incidents, or stress in a culture prone to poor health habits (Jahnke, Poston, Haddock, & Jitnarin, 2013; Jitnarin, Haddock, Poston, & Jahnke, 2013; Kunadharaju, Smith, & Dejoy, 2011; Onieal, 2010). Studies on management explained why fire-service leaders must now maneuver through complex managerial challenges such as service optimization, diversity, work-agreement negotiations, and rising service expectations in an austere financial environment (e.g., Devinatz, 2015; England & Brown, 2014). Finally, scholars investigated the fire service's organizational culture, mostly in the context of volunteer fire departments (e.g., Perkins, 1989; Perkins & Benoit, 1997). In the serious leisure of volunteer fire fighting (Stebbins, 1996), firefighters find a purpose that helps shape their identities; they are held in high esteem by their fellow citizens (Jeantet & Gernet, 2011; Tracy & Scott, 2006).

Firefighters, regardless of whether they are career or volunteer, are expected to develop and use the appropriate knowledge to protect their fellow citizens (Yarnal & Dowler, 2002). Beauchamp's extensive literature review of 238 peer-reviewed studies confirmed previous findings by Massaro, Dumay, and Garlatti (2015) that one of the current limits of research about

the fire service is understanding how knowledge is managed in modern fire departments.

Problems related to knowledge management (KM) have been documented as important organizational challenges in fire departments in the United States, the United Kingdom, and Canada. For example, numerous reports identified KM flaws as contributing factors in firefighters' injuries or deaths (e.g.: Commission de la santé et sécurité du travail (CSST), 2009a, 2009b; National Institute for Occupational Safety and Health (NIOSH), 2015, 2017; Watterson, 2015). Key recommendations to address problems caused by the lack of KM include the following: (1) the creation/revision of standard operating procedures; (2) the transfer of current academic and applied fire-service research to improve fire-fighting practices, health and safety, and organizational culture; (3) the revision/implementation of training programs; and (4) the gathering of information through preincident planning.

The purpose of this study is to provide an exploratory analysis of KM processes in volunteer fire departments in Canada. The research is organized into six remaining sections. The first section identifies the research propositions guiding the study. Section two presents the conceptual framework guiding the research effort, and section three discusses the methodology used to test research propositions. Findings emerging from data analyses are outlined in section four. Section five offers a discussion of findings. Finally, a conclusion is offered in which limits of the study are identified and future research suggestions are offered.

Research Propositions

This section discusses the three research propositions that guide the present study. The three topics are knowledge sharing and learning among firefighters, volunteer firefighting as a serious leisure (SL) activity, and tradition as a barrier to knowledge management.

Knowledge Sharing and Learning Among Firefighters

Fire fighting is a team-based profession. Training allows firefighters to share their knowledge with each other to master the use of equipment and coordinate their actions (Myers, 2005; Perkins, 1990). By sharing their knowledge with each other, firefighters ensure that agreed-upon practices are taught and maintained in the group. In this context, storytelling plays an important part in the dissemination of knowledge as the novice firefighter “engages with institutionally sanctioned information” (Lloyd & Somerville, 2006, p. 190) and the newcomer slowly becomes an insider (Huysman, 2004).

In fact, learning from the *old timers* is an occasion to develop a singular understanding of social rules in the fire service as well as its organizational culture (Myers, 2005; Perkins, 1989; Yarnal & Dowler, 2002). “When discussing initial firefighter training, it is not simply technical skill training, but an introduction into the ‘culture of firefighting’” (Taber, Plumb, & Jolemore, 2008, p. 274). Therefore, knowledge sharing among firefighters is an important mechanism of KM in volunteer fire organizations, which leads to proposition one:

Proposition 1: Knowledge sharing among firefighters is their main source of learning.

Volunteer Firefighting as a Serious Leisure (SL) Activity

Volunteer fire fighting has been described as a serious leisure (SL), which is defined as:

The systematic pursuit of an amateur, hobbyist, or volunteer activity sufficiently substantial, interesting, and fulfilling for the participant to find a (leisure) career there acquiring and expressing a combination of its special skills, knowledge, and experience (Elkington & Stebbins, 2014, p. 4).

In a SL, individuals enter a specific world-view characterized by groups, events, routines, practices, organizational structures, and a unique knowledge stock (Stebbins, 1996, 2008). Volunteer firefighters are citizens who work in different occupations where they have developed their personal skill sets which, in turn, they bring to the fire department. Individuals join the fire service for a variety of reasons — to help their communities, as extra sources of income, to avoid personal isolation, to make friends, etc. (Perkins & Mets, 1988; Thompson, 1993, 1995; Thompson & Bono, 1993).

Regardless of why they choose to join, most individuals engage with passion in the serious leisure of volunteer fire fighting; they find unique qualities in the core activities of fire fighting. The volunteers have access to a unique knowledge stock that contributes both to durable benefits and a distinctive identity in society. As these *just plain folk* (Brown, Collins, & Duguid, 1989; Lave, 1988) enculturate through apprenticeship in the fire service, they seek to acquire the signature skills (Davenport & Prusak, 2000) of fire fighting. Therefore, to learn is also to become part of a team as the individual develops the capacity to contribute to the group’s performance and success. As such, the second proposition upon which the present study is based is as follows:

Proposition 2: Serious leisure components are levers of knowledge management in volunteer fire organizations.

Tradition as a Barrier to Knowledge Development

The fire service’s organizational culture is characterized by a dominant logic expressed by the importance of hierarchy, tradition, conservatism, and reluctance to change (Bettis, Wong, & Blettner, 2011; Thompson, 1995). Routines are reinforced by role models, status rituals, procedures, and vocabularies (Miller, 1996) as firefighters show pride in their standings and will ostracize anyone who does not conform (Brauer, 2016).

In fact, strong consensus discourages interventions that would question tradition (Lucas & Kline, 2008). As such, firefighters may eschew external knowledge sources that challenge the status quo such as academic and applied research (Rouse, 2004) or avoid transferring into the organization knowledge from partners, suppliers, or customers towards the implementation of best practices. Tradition as a barrier to knowledge development leads to proposition 3, which states the following:

Proposition 3: Turned inward, the fire service organizational culture impairs knowledge transfers from external sources such as other fire departments, partners, customers, suppliers, and academic and applied research.

Conceptual Framework

This research’s conceptual framework is based on the four dimensions of KM: (1) management, (2) content, (3) processes, and (4) external environment. In addition, the framework is built upon the four components of a SL: (1) qualities, (2) rewards/motivation, (3) thrills/psychological flow, and (4) devotee work. It also includes selected elements from each of the four components. A discussion of KM dimensions and SL components is given in the following sections. To aid the reader, a list of acronyms associated with KM dimensions and SL components is provided in **Appendix A**.

Knowledge Management Dimensions

KM is comprised of four dimensions — management, content, processes, and external knowledge sources. These dimensions are discussed in the following sections.

Management. Management refers to how top management (TM) supports KM practices and how it uses information technologies (IT) to maintain an up-to-date internal knowledge base. Management is defined as “the degree to which top management understands the importance of knowledge management and the extent to which [it] is involved in knowledge management practices” (Lin, 2011 in Oliveira, Pedron, Nodari, & Ribeiro, 2014).

Content. Content is the dimension related to tacit knowledge (TK) and explicit knowledge (EK). Individuals tacitly own knowledge, and organizational strategies are deployed to render this knowledge explicit through codification and transfer to other individuals. Knowledge transfer then allows for experience sharing (Argote & Ingram, 2000; Argote, Ingram, Levine, & Moreland, 2000), perpetuation and codification of organizational culture (Cohen & Levinthal, 1990; Paulus & Yang, 2000; Rouiller & Goldstein, 1993), and creation of new knowledge (Nonaka, 1994; Nonaka & Toyama, 2003).

Processes. Knowledge creation (KC) is defined as “the development of new tacit or explicit knowledge from data and information or from the synthesis of prior knowledge” (Hsieh, Lin, B., & Lin, C., 2009, p. 4089). Knowledge storage (KST) refers to “appropriation, revision and organization of knowledge in a way that allows it to be accessed and updated” (Oliveira, Pedron, Nodari, & Ribeiro, 2014, p. 758) and is often associated with efficiency in sharing explicit and tacit knowledge (Hsieh et al., 2009). Knowledge sharing

(KSH) is the action by which individuals or units share their acquired knowledge with others, therefore enhancing organizational capabilities (Ipe, 2003; Nordin, Pauleen, & Gorman, 2009).

External Knowledge Sources. External knowledge sources can be accessed by an organization outside its boundaries such as trying to gain knowledge from the external environment (Hartley & Allison, 2002; Powell & Grodal, 2005) or accessing training, communication, observations, technology transfer, scientific publications, or presentations (Argote et al., 2000). In this study, external sources include suppliers (SUP), partners (PART), customers (CUST), and academic and applied research (AAR).

Suppliers (SUP) are private-sector firms that provide fire-fighting/rescue equipment to the fire department. Partners (PART) are either other municipal departments or mutual-aid fire departments that interact with the fire department. Customers (CUST) are the citizens to whom the fire department provides services. Finally, academic and applied research (AAR) refers to knowledge generated by studies on the fire service.

Serious Leisure Components and Elements

A serious leisure is characterized by the four components shown in **Table 1**. The first component is *qualities*, which is defined by six distinctive elements such as perseverance and distinctive identity. The second component of serious leisure is rewards and motivation, which is comprised of seven personal (e.g., self-actualization and self-image) and three social (e.g., social attraction and group accomplishment) rewards gained through participation in the serious leisure. The third component shown in Table 1 is thrills and psychological flow that the firefighter may experience. Examples of elements in this component include a sense of deep and focused involvement in the activity

Table 1: Serious Leisure Components and Elements

Component: Qualities	Component: Rewards/ Motivation	Component: Thrills/ Psychological Flow	Component: Devotee Work
<p>Elements</p> <ol style="list-style-type: none"> 1. Perseverance 2. Opportunity to follow a leisure career 3. Significant personal effort (using specially acquired knowledge, training, skills, or all three) 4. Durable benefits 5. Unique ethos 6. Distinctive identity 	<p>Elements</p> <p><u>Personal Rewards:</u></p> <ol style="list-style-type: none"> 1. Personal enrichment 2. Self-actualization 3. Self-expression 4. Self-image 5. Self-gratification 6. Re-creation 7. Financial return <p><u>Social Rewards:</u></p> <ol style="list-style-type: none"> 8. Social attraction 9. Group accomplishment 10. Contribution to group 	<p>Elements</p> <ol style="list-style-type: none"> 1. Sense of competence in executing the activity 2. Requirement of concentration 3. Clarity of goals of the activity 4. Immediate feedback from the activity 5. Sense of deep, focused involvement in the activity 6. Sense of control in completing the activity 7. Loss of self-consciousness during the activity 8. Sense of time is truncated during the activity 	<p>Elements</p> <ol style="list-style-type: none"> 1. Valued core activity 2. Core offers significant variety 3. Core offers significant opportunity for creative innovation (showing imagination and application of routine skill or knowledge) 4. Reasonable control over the amount of time to put into the core activity 5. Aptitude and taste for the required work 6. Physical and social milieu encourages the pursuit of the core activity

Source: Adapted from Elkington & Stebbins, 2014.

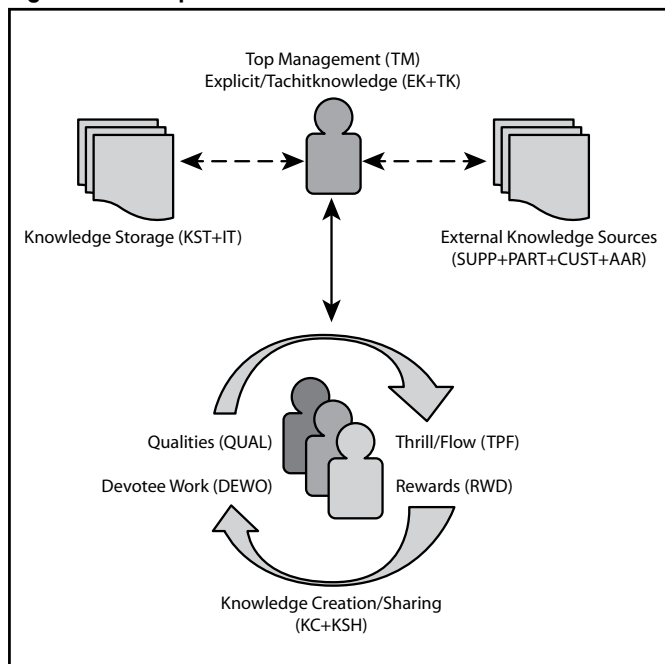
and the sense of loss of self-consciousness during the activity. In total, eight different elements help define the thrills/psychological flow component. Finally, devotee work is the fourth quality. This quality is based on six criteria that generate devotion to the core activity of the serious leisure.

As part of the conceptual framework, selected *specific elements* from each of the four SL components were chosen to include in the survey administered to study participants. These elements reflect how and why firefighters engage in volunteer fire fighting and how the organizational culture of volunteer firefighters may impact KM processes.

Conceptual Framework Model

Based on the KM dimensions and SL components discussed in the last section, the conceptual framework guiding this study can be represented by the model shown in **Figure 1**. Explanation of the model follows.

Figure 1: Conceptual Framework



First, volunteer fire departments appear conducive to knowledge creation and sharing (KC + KSH) among firefighters at the team level. This form of KM is tested by **Proposition 1**: Knowledge sharing among firefighters is their main source of learning.

Second, in managing explicit and tacit knowledge (EK + TK), top management (TM) could realize gains in KM by leveraging different components of the organizational culture. **Proposition 2**, which states SL components positively support KM in volunteer fire organizations, tests this aspect of the model.

Finally, volunteer fire departments seem unwilling to input into the organization knowledge generated from external sources (SUPP + PART + CUST + AAR),

which results in minimal knowledge storage strategies (KST + IT). This avoidance of transfer of knowledge into volunteer fire departments from external sources is tested by **Proposition 3**, which states, turned inward, the fire service organizational culture impairs knowledge transfers from external sources such as other fire departments, partners, customers, suppliers, and academic and applied research.

Methodology

This research was conducted in volunteer fire departments in the Province of Quebec, Canada. Volunteer firefighters, or part-time firefighters as they are called in this Province, are in the majority (78%; $N = 13,860$) (Québec, 2013) — as is the case throughout North America (Karter & Stein, 2013; National Fire Protection Association® [NFPA®], 2015; Perkins & Metz, 1988).

The research strategy was based on data triangulation from three sources. First, an online survey of volunteer firefighters was used to gather data throughout the Province. Second, fire departments' municipal websites were reviewed to document the extent to which e-government practices were used to communicate with citizens. Finally, semistructured interviews were conducted to complement and enrich survey results. Each data source is discussed further in the sections that follow.

Online Survey

Using a five-point Likert scale ranging from one (strongly disagree) to five (strongly agree), the online survey questionnaire was designed to measure firefighters' perceptions about their preferred knowledge sources and KM processes in their fire departments (Robson, 2002).

The survey included questions related to the four dimensions of KM and four components of the serious leisure of fire fighting (see Conceptual Framework section). The survey was constructed using an online survey engine and was made accessible through a dedicated web page acquired for this research.

Survey Sampling. The Province of Quebec is divided into county regional municipalities (CRMs). This geographical division served as a base for a two-step sampling strategy. First, a purposive sample (Sample A) (Robson, 2002; Teddlie & Yu, 2007) was composed of the 17 volunteer fire departments located in one CRM. Of the seventeen chiefs contacted, thirteen agreed that their firefighters ($N = 351$) could be solicited for the survey. Out of the 351 firefighters, 47% ($N = 165$) participated in the survey.

The second sample (Sample B) was gathered through cluster sampling (Robson, 2002). Seven CRMs were randomly selected, based on their geographical location, to cover the entire Province. Next, random sampling was applied to select one volunteer fire

department from each CRM. These seven departments represent a sample of 356 firefighters. About 38% ($N = 136$) of the firefighters participated in this survey. In summary, out of a total of 707 solicited volunteer firefighters, 317 firefighters (44.9%) participated in both surveys. Sixteen respondents were deleted from the dataset because they did not answer a single question in the survey, thus leaving a final sample of 301 firefighters (42.5%).

The majority of the firefighters who completed the surveys were male, young, and spoke and read French and had studied either a trade in high school or a technical profession in college. A large majority of the firefighters had served in their departments for less than ten years. Finally, all of the firefighters were qualified or were in the process of obtaining their qualifications, as required by provincial legislation (see **Table 2**).

Exploratory factor analysis of survey data. Two exploratory factor analyses (EFAs) were conducted on aggregated data from both samples. The first EFA was focused on KM dimensions, and the second EFA focused on SL components. After oblique rotation, a three-factor solution provided the cleanest factor structure for both factor analyses; items were loaded with more precision on each factor with few cross loadings (Field, 2009; Kline, 1994; Osborne & Costello, 2009; Tabachnick & Fidell, 2013).

Fire Department Municipal Websites

A content analysis (Robson, 2002) was performed on the municipal website of each fire department ($N = 20$) participating in this study. Websites were all accessed the same day, allowing for contemporary comparison of published information about the following topics: composition of service/staffing, history, mission/vision/values statement, training, services provided, social implication, statistics on calls/runs, information on the departmental regional safety cover plan, and questions

by citizens if a link was present on the website that allowed for them.

Firefighter Interviews

After survey results were analyzed, interviews were conducted. Data were gathered through semistructured interviews, and saturation was reached after 10 respondents (i.e., no new information was provided after 10 interviews) (see Mason, 2002; Teddlie & Yu, 2007).

Interviews were based on the following five main questions:

- (1) What are the main sources of knowledge in your fire department?
- (2) What is the impact of the fire-service organizational culture on knowledge management in your fire department?
- (3) What concrete measures are in place to manage knowledge in your fire department?
- (4) Is knowledge shared between your fire department and other organizations?
- (5) Is knowledge from research transferred in your fire department?

Findings

Findings emerging from the factor analyses of the KM and SL survey questions are organized into two sections. In the first section, factor analysis as a statistical tool is discussed, and the KM and SL factor analyses are presented and reviewed more from empirical and statistical perspectives. In the second section, the six factors that emerged from the factor analyses of the KM and SL survey responses are discussed from a more theoretical and substantive perspective. This discussion is also enriched with statements provided by study participants during in-depth interviews,

Table 2: Demographic Data

Firefighter	Sample A	Sample B
Gender = Male	96%	91%
Age:		
Between 18 and 40	49.8%	56.8%
Between 41 and 50	27.8%	20.0%
Between 51 and 60	9.1%	16.8%
Over 60	13.3%	6.4%
Language	French as first language. Individuals indicate basic capacities in English.	French as first language. Individuals indicate basic capacities in English.
Academic background (between third year of high school to either a trade certification or second year of College) ^a	90.7% (e.g.: carpenter, plumber, contractor, technician, etc.)	87.7% (e.g.: carpenter, plumber, contractor, technician, etc.)
Years of service in the fire department	0 – 10 years = 70%	0 – 10 years = 68%
Firefighter qualifications ^b	All qualified, some in the process of obtaining their qualification.	All qualified, some in the process of obtaining their qualification.

^a In Quebec, there is a collegiate level between high school and university.

^b In Quebec, legislation mandates firefighter qualifications regardless of status (volunteer or career firefighter).

demographic information of survey participants, and the findings emerging from the review of the websites of the 20 Quebec volunteer fire departments that participated in the study.

Factor Analysis of KM and SL Survey Questions: Empirical and Statistical Perspectives

In order to identify *patterns* occurring in the 301 study participants' responses to survey questions, two factor analyses were performed — one of KM survey questions and one of SL survey questions. Factor analysis is a well-known, widely-used statistical tool employed to group interdependent variables into descriptive categories, usually called *factors*. As explained by factor-analysis expert R. J. Rummel (1967)¹:

Factor analysis is a means by which the regularity and order in phenomena can be discerned. As phenomena co-occur in space or in time, they are *patterned* (emphasis added); as these co-occurring phenomena are independent of each other, there are a number of *distinct patterns* (emphasis added) . . . Each pattern will appear as a *factor* (emphasis added) delineating a distinct cluster of interrelated data. (pp. 445, 447)

Appendices B and C show the full-pattern matrices for the KM factor analysis and the SL factor analysis, respectively.

The KM Factor Analysis. The KM pattern matrix shows that the factor analysis of the 39 variables produced three factors (the labelled columns in **Appendix B**) of interrelated data (i.e., survey questions): (1) Buddy Learning, (2) Knowledge Transfer, and (3) Knowledge Storage. Collectively, the three factors explained about 50% of the variation among all the variables involved in the patterns (Buddy Learning = 40.6%; Knowledge Transfer = 5.3%; and Knowledge Storage = 4.3%). The factor labelled Buddy Learning is the strongest factor (eigenvalue = 16.3) in the data, accounting for about 40% of the variance.

The alpha values or coefficients of reliability (shown as the symbol α in Appendix B) for the three factors show high reliability: 0.910 for Buddy Learning, 0.935 for Knowledge Transfer, and 0.923 for Knowledge Storage. Alpha values range from 0 to 1; the higher the α coefficient, the more the items (variables) in the factor share covariance and measure the same underlying concept (see University of Virginia, 2018).

The values shown in the columns under each factor in Appendix B are called *factor loadings*. They show which variables are involved in which factor pattern and to what degree (Rummel, 1967). They can be interpreted like correlation coefficients and show both the strength (from a +1.0 to a -1.0) and direction (positive or negative) of the relationship of a variable with a factor. Once again, the factor analysis of the KM variables

produced three factors. Factor 1 is called Buddy Learning and is defined by the 13 variables shown in bold font in the first column (from KSH3 to TK3). All of the variables in the factor are **positively** related to the factor. For example, for the first variable (knowledge sharing 3 = KSH3), survey respondents were **highly likely** (factor loading = 0.716) to **agree** with the statement that “In my fire department, when a firefighter is competent at a task, colleagues will ask him/her to show them how to do it.”

Factor 2 or Knowledge Transfer is comprised of the variables labelled AAR2 through PART6 shown in bold font in Appendix B. In contrast to Factor 1 or Buddy Learning, the variables in Factor 2 are **negatively** associated with Factor 2. For example, for the first variable associated with Factor 2 or Knowledge Transfer (academic or applied research 2 = AAR2), survey respondents were **highly likely** (factor loading = -0.934) to **disagree** with the statement that “In my fire department, results from academic or applied research on the fire service are used to modify practices and procedures.”

Finally, Factor 3 or Knowledge Storage is defined by the variables KST1 through PART4 shown in bold font in Appendix B. Like Factor 2, all of the variables in the Knowledge Storage factor are **negatively** associated with the factor. For example, for the first variable associated with Factor 3, Knowledge Storage (knowledge storage 1 = KST1), survey respondents were **highly likely** (factor loading = -0.863) to **disagree** with the statement that “In my fire department, processes and tools to store knowledge for future use are well organized.”

SL Factor Analysis. The SL pattern matrix in **Appendix C** shows that the factor analysis of the 11 variables produced three clusters (the labelled columns in Appendix C), or factors, of interrelated data (i.e., survey questions): (1) Personal Development, (2) Creativity, and (3) Commitment. Collectively, the three factors explained about 64 percent of the variation among all the variables involved in the patterns (Personal Development = 39.3; Creativity = 13.3; and Commitment = 11.5). The factor labelled Personal Development is the strongest factor in the data, accounting for about 40% of the variance (eigenvalue = 4.3).

The alpha values or coefficients of reliability (shown as the symbol α in Appendix C) for the three factors show high reliability: 0.833 for Personal Development, 0.816 for Creativity, and 0.763 for Commitment. As noted previously, alpha values range from 0 to 1; the higher the α coefficient, the more the items in the factor share covariance and measure the same underlying concept (see University of Virginia, 2018).

The values shown in the columns under each factor in Appendix C are called *factor loadings*. Factor loadings show which variables are involved in which factor pattern and to what degree (Rummel, 1967).

They can be interpreted like correlation coefficients and show both the strength (from a 1.0 to a -1.0) and direction (positive or negative) of the relationship of a variable with a factor. Once again, the factor analysis of the SL variables produced the following three factors:

- **Factor 1 (Personal Development)** — This factor is defined by the 4 variables shown in bold font in the first column — from RWD1 to QUAL4. All of the variables in the factor are **positively** related to the factor. For example, for the first variable (rewards 1 = RWD1), survey respondents were **highly likely** (factor loading = 0.800) to **agree** with the statement that “Being a firefighter encourages personal development by developing abilities and knowledge.”
- **Factor 2 (Creativity)** — Similarly, the variables labelled DEWO3 and DEWO2 in bold font in Appendix C) are also **positively** associated with Factor 2. For example, for the first variable associated with Factor 2, Creativity (devotee work 3 = DEWO3), survey respondents were **highly likely** (factor loading = 0.852) to **agree** with the statement that “Fire fighting allows me to demonstrate imagination in the application of abilities and knowledge.”
- **Factor 3 (Commitment)** — This factor is defined by the 5 variables QUAL1 to TPF1 shown in bold font in Appendix C. Like Factor 2, all of the variables in the Commitment factor are **positively** associated with the factor. For example, for the first variable associated with Factor 3, Commitment (qualities 1= QUAL1), survey respondents were **highly likely** (factor loading = 0.761) to **agree** with the statement that “In my fire department, firefighters persevere to become more competent.”

Attention now turns to a detailed discussion of the three factors that emerged from the KM factor analysis and the three factors that emerged from the SL factor analysis.

Factor Analysis of KM and SL Survey Questions: Theoretical and Substantive Perspectives

In order to facilitate this discussion of the individual survey questions (i.e., variables) associated with factors emerging from the KM and SL factor analyses, the full factor-pattern matrices shown in Appendices B and C have been stripped of their data components, and the survey questions truncated in some cases. In contrast to the pattern matrices shown in Appendices B and C, **Table 3** and **Table 4** show only the survey questions defining each factor and their codes (e.g., Factor 1 or Buddy Learning, KSH3 is the code for the question “When a firefighter is competent at a task, a colleague will ask him/her to show him/her how to do it.”) These codes are used to refer to the survey questions in the discussion in the following section.

Also, when discussing theoretically and substantively the factors associated with the KM and SL factor analyses, those **four** factors identified in the previous section that loaded **positively** with KM in the fire service are discussed together. As a reminder, the four factors are (1) Buddy Learning from the KM factor analysis and the three factors associated with the SL factor analysis, (2) Personal Development, (3) Creativity, and (4) Commitment. Then, the theoretical and substantive implications of the **two** factors that were **negatively** associated with knowledge management (i.e., Knowledge Transfer and Knowledge Storage) in the fire service associated with the KM factor analysis are discussed.

Table 3. Knowledge Management Factor Analysis (3 Factors and 39 Variables)^a

1. Buddy-Learning Factor	
1	KSH3. When a firefighter is competent at a task, a colleague will ask him/her to show him/her how to do it.
2	KSH4. When firefighters learn something new, they share it with their colleagues.
3	KSH2. Firefighters ask their colleagues to share their skills when they need to learn something new.
4	KSH1. Experienced firefighters willingly share their knowledge with new firefighters.
5	KC1. Firefighters can propose ideas and new knowledge.
6	KC3. Firefighters can propose new ways of doing things.
7	KSH5. Firefighters benefit the group with competencies developed in their primary occupations.
8	TM1. High-ranking officers believe it is important to encourage firefighters to share their knowledge with colleagues.
9	TM3. High-ranking officers are aware of motivations in the fire service, and they inform firefighters about it.
10	KC2. Firefighters train regularly on tasks to develop their competencies.
11	TM4. High-ranking officers (chiefs) foster motivation and change.
12	TM2. High-ranking officers adjust training after problems were encountered in operations to help firefighters improve.
13	TK3. Informal conversations and meetings are used to share knowledge.

^a The questions are slightly truncated in some instances, see **Appendix B** for entire text of each question.

Continued next page

Table 3: (Concluded)

2. Knowledge-Transfer Factor	
14	AAR2. Results from academic or applied research on the fire service are used to modify current practices and procedures.
15	AAR3. Results from academic or applied research on the fire service are incorporated in training.
16	AAR4. Results from applied or academic research on the fire service are used to further health and safety in the workplace.
17	AAR1. High-ranking officers (chiefs) use results from academic or applied research in their decisions.
18	CUST4. Knowledge obtained from citizens is used to innovate (for example: update prevention program).
19	CUST3. Knowledge obtained from citizens is incorporated into the department's operations.
20	SUP3. Knowledge obtained from service or equipment suppliers is used to innovate.
21	SUP1. Knowledge is shared from either side with services and equipment suppliers.
22	PART2. Knowledge obtained from partners is incorporated into the department's operations.
23	CUST2. Citizens are asked to share their knowledge (for example: information while on emergency scenes).
24	AAR5. It is considered important that knowledge from research be known.
25	PART1. Knowledge is shared reciprocally with partners (for example: public works, police, and ambulance).
26	PART3. Knowledge obtained from partners (for example: police) is used to innovate.
27	CUST1. Firefighters share their knowledge with citizens (for example: explanations, prevention tips, etc.)
28	SUP2. Knowledge obtained from service or equipment suppliers are incorporated into the department's operations.
29	PART5. Knowledge obtained from mutual-aid fire departments is incorporated in the department's operations.
30	PART6. Knowledge obtained from a mutual-aid fire department is used to innovate.
3. Knowledge-Storage Factor	
31	KST1. Processes and tools to store knowledge for future use are well organized (for example: data banks).
32	EK4. Knowledge is shared by means of documentation such as manuals.
33	EK1. Knowledge can be easily accessed through documents or manuals.
34	EK3. Results from projects or meetings are documented.
35	EK2. There is a standard training program, and its objectives are known by firefighters.
36	KST2. Firefighters take part in knowledge storage activities for future use (for example: review procedures).
37	KST3. Firefighters know where stored knowledge that can be useful to them can be found.
38	IT3. Firefighters regularly use information technologies in their tasks (for example: during inventory, etc.).
39	PART4. Knowledge is reciprocally shared with mutual-aid fire departments.

Table 4. Serious Leisure Factor Analysis (3 Factors and 11 Variables)

1. Personal-Development Factor	
1	RWD1. Being a firefighter encourages personal development by developing abilities and knowledge.
2	RWD2. Being a firefighter encourages self-expression by developing abilities and knowledge.
3	Qual3. Being a firefighter promotes personal enrichment, self-expression, a sense of accomplishment, social interactions, and a sense of belonging.
4	Qual4. Being a firefighter means to develop a distinctive identity in society and to be part of a group that share values, beliefs, and goals.
2. Creativity Factor	
5	DEWO3. Fire fighting allows firefighters to demonstrate imagination in the application of abilities and knowledge.
6	DEWO2. Fire fighting offers a significant opportunity for creative and innovative work, which favors personal expression.
3. Commitment Factor	
7	QUAL1. Firefighters persevere to become more competent.
8	QUAL2. Firefighters make significant efforts to use their knowledge, training, and skills.
9	TPF4. Firefighters feel a deep sense of involvement during fire fighting.
10	RWD3. Firefighters see as a reward their contributions to maintaining and developing the group.
11	TPF1. Firefighters have the feeling of being competent during fire fighting.

Buddy Learning, personal development, creativity, and commitment as factors positively associated with KM in the Canadian Volunteer Fire Service. The concept of Buddy Learning is inspired by an emergency technique called buddy breathing that is used by firefighters during interior fire fighting to tap into the air supply of a colleague in the event of failure of their own breathing apparatus. This technique is used as a metaphor in this study to explain how firefighters tap into their colleagues' knowledge to learn.

Firefighters do not hoard knowledge for their own benefit. They willingly share their knowledge with their fellow firefighters (KSH4, KC1). Moreover, firefighters believe that they can ask their colleagues questions in order to gain new knowledge and skills (KSH2, KSH3). Firefighters gain access to their colleagues' tacit knowledge (TK3) most often when working with experienced firefighters or sometimes through informal conversations.

As shown in the demographic data shown previously in Table 2, volunteer firefighters in Canada come from different trades and professions where they each developed a personal skill set. Individuals benefit the group by sharing (KSH5) the competencies developed in their primary occupations. They equate this behavior with their continuous contribution to the group: "We always strive to be better, always, always, I think nobody says, 'I know enough', so that's why I think that knowledge sharing is on-going, always, at all levels of the organization," said a firefighter in a personal interview. This attitude stems in part from a desire to project an image of professionalism to citizens: "You want the department to [present] an image of professionalism; [that] firefighters . . . are trained," said an acting lieutenant.

In volunteer fire departments, the firehouse becomes a physical and social space conducive to knowledge sharing (KSH). Data showed that top management (TM1) provides a social milieu where trust is valued, and KSH is encouraged. Training sessions at the firehouse give access to a valued knowledge stock while acting as gateways into the group. Hands-on training allows firefighters to master routine procedures and to avoid improvisation or freelancing in emergency operations. During training, firefighters will exchange ideas, practices, and tricks of the trade, but they will also discuss the latest calls because they cannot attend all calls. Sharing the knowledge that can be drawn from these past experiences maintains group cohesion and a sense of belonging. Furthermore, training is adjusted by top management (TM2) after problems are encountered in operations. In summary, the firehouse offers tangible occasions to transcend the boundary of the actual self to acquire a new identity through learning — to learn to fight fires is to become a firefighter.

This sharing behavior serves two purposes: First, at the individual level, it is a way to foster relationships

with others. As one firefighter said, "We have learned to know each other." In fact, firefighters exhibit care towards each other, which gives rise to mutual trust. One firefighter commented: "You need to trust the person with you and you need to trust the pump operator . . . to bring water, to trust the next guy, so you have no advantages in knowing more than the others." When asked if the department promoted knowledge sharing (KSH), one firefighter gave the following typical answer: ". . . it is a mentality that we have to help each other."

At the group level, KSH is a way to maintain cohesion and to regulate what is known by everyone. "Like I said, if someone would come here thinking, 'Well I will keep my knowledge to myself and I will use it to move on up in the hierarchy and do my own business,' well he will be put in his place by the group," said a firefighter. Thus, this KSH behavior is both an illustration of the democratic nature of knowledge among firefighters and of the cement that holds the team together. An illustrative comment came from an acting lieutenant: "You know, on the contrary, you have more advantages to know as much [as your teammates] and to mutually push together to become better rather than have one who knows everything and the others nothing." Data showed that being part of a group of firefighters promoted personal enrichment, self-expression, and self-actualization. By acquiring knowledge and a special skill set on fire fighting, individuals contribute to the group's accomplishments (RWD1; RWD2; QUAL3; RWD3). Therefore, firefighters are committed to persevere to become more competent (QUAL1). They make significant efforts to use their knowledge, training, and skills (QUAL2) as they feel competent during fire fighting (TPF1).

Buddy Learning is also a resultant of a passion in commitment to fire fighting. Asked why they are firefighters, survey respondents gave these typical answers. "Fire fighting has always been a passion for me. I found a great passion [in the fire service]." "[Fire fighting is] a passion and an opportunity to help citizens." As one lieutenant said: "We are united by our goal" to which another firefighter added, "fraternity . . . brotherhood."

During interviews, firefighters identified what they considered to be the main characteristics of the volunteer fire-fighting culture: passion, teamwork, fraternity, creativity, help, commitment, and personal development. When asked if these characteristics were levers or barriers to knowledge development, they unanimously answered that they constituted levers. "[Development of these characteristics] sure helps; we all want to be a family, we all want to be professionals, so you have every interest in sharing your knowledge," said an acting lieutenant. The volunteer firefighters are proud to be members of the fire service, and they pride themselves at being proficient at what they do. "I see [a report on the fire department's operations] on the

news, and I'm proud of my boys even though I wasn't on that call, and it makes me happy," said an acting lieutenant. Consequently, firefighters invest time and efforts in training where they can share knowledge with each other and develop their skills (KC2).

Their passion is also fueled by emergency work that requires concentration amid all the danger that such work brings. The dangerous situations also offer an opportunity for creative innovation. One firefighter said, "You need an open mind to learn multiple tasks; and, you know, fire fighting has become so complex that you need to be able to do everything." Therefore, firefighters feel they are challenged to find new approaches to resolve a variety of complex issues using their knowledge, imagination, abilities, and creativity (DEWO3, DEWO2). "That's the fun of it, when we try to find solutions," said one firefighter.

The passion to serve others has impacts well outside the physical space of the firehouse. Being a volunteer firefighter is to enter a social space where one is recognized positively by other firefighters and by citizens. Being a firefighter leads to a distinctive identity in society and the chance to contribute to a group that shares similar values, beliefs, and goals (QUAL4). It promotes a sense of accomplishment, social interactions, and a sense of belonging (QUAL3). Still, this dedication to the group and to public service comes with drawbacks. Firefighters acknowledged that their involvement with the fire department puts a lot of stress on their personal lives. "It's them [wife and children] that make the biggest sacrifice," said a firefighter. "It's tough on family life," said another firefighter.

While Buddy Learning helps explain the strong relationship among firefighters and KM in the fire service, the impact of Buddy Learning across departments is variable. Volunteer fire departments may be very different in various aspects such as the number of personnel, management of training requirements, volume of calls, and capabilities to train firefighters in realistic conditions. As one lieutenant said, "We have simulators, but we do not have a structure such as a marine container in which we could simulate a room-and-content fire." In contrast, a deputy chief from a department equipped with a complex structure made of marine containers underlined the fact that this facility had a real impact on training and consequently on the readiness of crews in emergency response. "Firefighters are better prepared, they understand the command structure, and they are better at doing forced entry, stretching water lines, or water supply."

In summary, results from the KM factor analysis supported Proposition 1 of this study. Knowledge sharing or Buddy Learning (Factor 1 of the KM factor analysis) among firefighters was the principal strategy used by volunteer firefighter survey participants to access and manage knowledge. Findings emerging from the SL factor analysis supported Proposition 2 of research

presented here. SL components produced three factors: (1) Personal Development, (2) Creativity, and (3) Commitment. These factors serve as positive levers of KM in volunteer fire organizations.

Knowledge Transfer and Knowledge Storage as Factors Negatively Associated with KM in the Canadian Volunteer Fire Service. The factor analysis of the 39 KM survey questions resulted in the identification of two factors that loaded **negatively** with KM in the fire service: (1) Knowledge transfer and (2) Knowledge Storage (see Pattern Matrix in Appendix B and Table 3). These negative factor loadings suggest that survey participants do **not** view external knowledge sources such as customers (CUST), suppliers (SUP), partners (PART), and academic or applied research (AAR) as key or important sources of KM in their fire departments. In other words, extraorganizational perspectives rarely challenge the organizational culture and knowledge stock of the volunteer fire departments participating in this study.

Firefighters do not consider citizens/customers as preferred sources of information (CUST1; CUST2; CUST3; CUST4). Similarly, the study of municipal websites (see **Table 5**) also shows that the 20 fire departments in this study do not share much information online with citizens.

Findings in Table 5 show that none of the volunteer fire departments published a strategic plan that could inform citizens about organizational priorities such as KM and mid-to long-term vision of this fire service. Three departments out of twenty provided information on KM activities related to training of personnel. Half of the departments provided information on the composition of the service and only two published data on calls/runs. In summary, little information is shared online to citizens by the fire departments in this study.

Even though fire departments routinely work with partners (PART1) such as other fire departments, police departments, ambulance providers, and other

Table 5: Comparison of Department's Municipal Web Page

Public Rendition About:	N = 20	%
Composition/Organization of Department	11	55
History of Department	3	15
Strategic Vision:		
• Mission	8	40
• Vision	0	0
• Values	0	0
Links to Regional Safety Cover Plan	2	10
Services Provided	10	50
Social Implication	4	20
Training	3	15
Number of Calls/Runs	2	10
Link for Questions from Citizens	16	80

city departments, knowledge transfer from these organizations remains scarce (PART2; PART3; PART5; PART6). When asked why fire departments do not share knowledge with other organizations, firefighters offered these explanations. "It's like a mentality, each department pretends to be able to manage everything on its own and doesn't need [anything] from other [organizations]," said one lieutenant. "Back in the days, there was a saying that there were little steeple wars between villages and fire departments, well it's still like that [today]," said another lieutenant. Moreover, firefighters indicated that knowledge was seldom exchanged with service or equipment suppliers (SUP1; SUP2; SUP3); they rarely used this source of knowledge to adjust work policies or procedures or to innovate.

When asked about the use of knowledge from academic or applied research on the fire service (AAR1; AAR2), firefighters did not believe that top-management officers (e.g., fire chiefs) often used research results in their decisions or to modify current practices and procedures. Moreover, research results (AAR3) seemed seldom incorporated into training policies or practices or used as reference knowledge (AAR4) when discussing current issues such as health and safety. Furthermore, even though some firefighters considered that it was important that knowledge from research be known (AAR5), current KM strategies in the fire departments did not favor this knowledge source. "There is no one to check on that and to give us feedback," said one lieutenant. During an interview, a deputy chief acknowledged that current knowledge from research was not transferred into the department and pointed to a language issue. "It's all published in English, and I have difficulties understanding English," he said.

All firefighters interviewed indicated that they often searched the Internet to find information about fire fighting. Still, this search was more an individual interest than a structured process to ameliorate practices. Results presented here suggest that external knowledge sources constitute blind spots for the volunteer fire departments in this study. This situation may not be estranged from the fact that knowledge-storage processes appear to not be well implemented, even for the internal knowledge stock of these departments. As noted previously, all items of the third factor (Knowledge Storage) in the Pattern Matrix shown in Appendix B have negative loadings. Results showed that storage of explicit knowledge (KST1) either by codification in documents or manuals or of results from projects or meetings (EK1; EK3) was not a favored strategy.

During interviews, firefighters said they received documentation while attending classroom sessions but rarely consulted the information after completing the course. Firefighters occasionally consulted standard operating procedures (SOPs) that reference

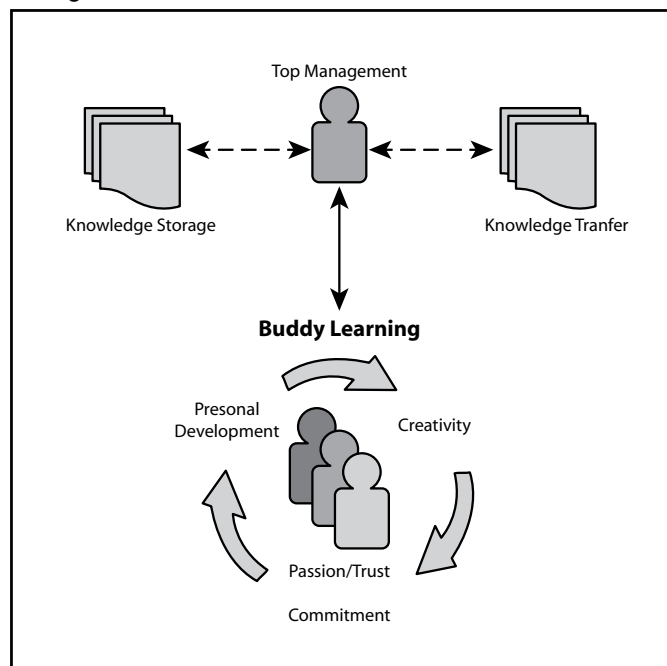
institutionalized ways of doing things in their departments, but it was not their strategy of choice to access knowledge (EK4). This type of behavior was also reflected in the fact that, even if they invested themselves in the hands-on part of training, firefighters did not show a great interest in the codified aspects of their training program (EK2). As one firefighter said, "It is not that I don't need to [consult documentation], but with all the hands-on training that we have [I don't feel the need to]." Moreover, results showed that firefighters did not regularly use information technologies (IT3) such as computers at the station to access knowledge or to perform their daily tasks. These results were not estranged from the fact that processes and tools to store knowledge for future use such as library materials, data banks, and manuals were not seen as priorities by firefighters (KST1; KST2; KST3). The use of information technologies is also influenced by the fact that many volunteer firefighters are present at the firehouse only when they respond to an emergency call or when they attend hands-on training sessions; thus, these firefighters do not believe they need such technologies.

In summary, the negative relationship of study participants' responses to survey questions found in Factor 2 (Knowledge Transfer) and Factor 3 (Knowledge Storage) of the KM factor analysis supports **Proposition 3** of this study. This proposition said: Turned inward, the fire-service organizational culture impairs knowledge transfers from external sources such as other fire departments, partners, customers, suppliers, and academic and applied research.

Discussion

Previous studies assert that research is needed to explain how firefighters relate to various knowledge sources and how KM processes are implemented in the fire service (Beauchamp, 2017; Massaro et al., 2015). The study reported here provides such research findings and has both empirical and theoretical significance. The use of survey research and factor analysis provides the first empirical evidence about KM processes in volunteer fire departments. The study also contributes to the general theoretical literature on KM and serious leisure. Findings of the analysis reported in the Results section are conceptualized in **Figure 2 (page 42)**.

First, this study illustrated how knowledge sharing among firefighters is the main process of KM in the fire service. This sharing process was labelled *Buddy Learning*. Empirical evidence indicated that top management supported knowledge sharing by enabling a context conducive to exchanges between and among firefighters (i.e., team members). Previous findings in the KM literature on the public service suggested that, in an organizational context, individuals tend to keep knowledge to themselves as a prized asset (see, for example, Amayah, 2013; Liebowitz & Chen, 2003,

Figure 2: Volunteer Fire Department Knowledge-Management Model

found in Syed-Ikhsan & Rowland, 2004), even to the point of creating knowledge monopolies (Davenport & Prusak, 2000). In contrast to previous findings, firefighters in this study *did not* base their actions on individuality and willingly shared their knowledge with each other. It was through Buddy Learning that firefighters showed creativity in sharing their own skill set with group members.

All firefighters interviewed were preoccupied by the safety of their colleagues. Since these firefighters regularly work in an environment immediately dangerous to health and life, they saw value in not only maintaining but also expanding the group's overall knowledge stock by sharing what they know with each other. Knowledge shared by seasoned firefighters and postmortem discussions following emergencies were good examples of mutual interest to learn from the experience of others.

At the same time, to have a positive effect on fireground efficiency, knowledge sharing appeared contingent on the fire department's capabilities. Lack of training in realistic settings, poor equipment quality, and lack of experience appeared to diminish the positive impact of knowledge sharing in actual fire-fighting operations — all factors already identified as contributors to line-of-duty deaths (Moore-Merrell, Zhou, McDonald, Ficher, & Moore, 2008).

Second, this research showed how serious leisure components can be relevant in understanding the influences of the volunteer fire service organizational culture on knowledge-management processes. Namely, personal development, creativity, and commitment (the three factors emerging from the factor analysis of serious leisure-related survey questions shown in

Appendix C) influenced how firefighters perceived their involvement with the fire department and how they interacted with their colleagues.

As described in previous studies, passion and trust sustain learning and knowledge sharing in a teamwork environment (e.g.: Dawes, Cresswell, & Pardo, 2009; Van Maanen & Barley, 1982; Von Krogh, 1998). In personal interviews, firefighters provided vivid descriptions of how passion and trust are central to their commitments to each other as they hoped to contribute to the team's knowledge stock. Fire fighting provides thrills and psychological flow, gratification, and value to the individual. Strong bonds are created among firefighters who trust each other and commit themselves to helping group members. Trust becomes the cornerstone of membership in the team; this trust regulates the individuals' actions by means of explicit and tacit rules.

The team also fosters mutual aid among firefighters who seek continuous improvement to maintain a public image of professionalism. Hence, it is at the intersection of passion and knowledge that serious leisure components help to explain a knowledge-sharing culture in volunteer fire departments. Therefore, not only is Buddy Learning a strong illustration of firefighters' commitment to teamwork, it becomes a personal and a social reward intrinsically part of volunteer fire fighting.

Finally, this study underlined the paucity of strategic KM in volunteer fire departments. These departments showed signs of organizational myopia (Catino, 2013) towards the transfer of knowledge from external sources and knowledge-storage processes. In contrast, previous research suggests that providing quality services and high performance in public services in an ever-changing environment requires knowledge transfer across organizational boundaries (Von Krogh, Ichijo, & Nonaka, 2000) and networking (Meier & O'Toole, 2010). Moreover, comprehensive knowledge-transfer strategies are said to add capabilities and approaches (Wiig, 2002) to further public services.

This research found that volunteer fire departments' strategic access to external knowledge sources was not a well-developed process. Transferring knowledge across boundaries was not a priority for top management. In turn, this situation may not be estranged from the fact that organizational capabilities vary greatly from one volunteer fire department to the other.

Analysis of the fire departments' websites corroborated previous findings from Moschella and Chou (2013) that these organizations make limited use of e-government strategies to interact with their external environments. As a result, fire departments face absorptive capacity challenges (Cohen & Levinthal, 1990) as they are turned inward maintaining a knowledge stock influenced by tradition and conservatism. Therefore, a high level of stickiness (Turner & Makhija, 2006; Szulanski, 1996) characterizes this knowledge

stock, which is rarely challenged by novelty or by scientific or applied data from research.

As this study also illustrated, the lack of knowledge transfer in volunteer fire organizations also has an impact on knowledge-storage strategies as new knowledge rarely challenges organizational memory (Moorman & Miner, 1998). In a now fast-paced environment where information and knowledge are rapidly transacted, it may be timely for volunteer fire organizations to rethink knowledge-storage processes to sustain continuous learning.

In summary, research reported here illustrates how KM processes are mobilized in volunteer fire departments. This area of research has received little attention. As such, this paper has contributed towards a better understanding of knowledge sharing among firefighters. In addition, this study provided evidence of a lack of strategies in volunteer fire departments to develop knowledge at the organizational and interorganizational levels.

The research adds to the application of serious-leisure theory. Scholars have noted that serious-leisure theory needs to deepen its understanding of the relationship and attachment that participants develop with the space associated with the core activity (Elkington, 2014). This attachment is said to be substantially determined by the “capacity of that space to facilitate the expression of skill and knowledge” (Elkington & Stebbins, 2014, p. 206).

This study provided an example of the importance of space in relation to learning and knowledge using the example of the firehouse. In this shared space, situations structure cognition (Brown et al., 1989), for example, through training sessions, informal discussions, or when *old timers* share knowledge with newcomers. In knowledge-creation theory, Nonaka and Konno (1998) have introduced the concept of *ba* to describe a shared space that serves as a foundation for knowledge creation. The firehouse certainly represents a *ba*: an iconic physical and emotional space for volunteer firefighters where they share knowledge. Still, other *ba* could be studied to better understand interactions in enabling knowledge creation (Nonaka, Toyama, & Konno, 2000) at the organizational and interorganizational levels of volunteer fire fighting.

Conclusion

Future research on KM in the fire service could focus on comparative studies of volunteer fire departments located in different countries. Undoubtedly, there may be jurisdictional characteristics that may differ — such as legislative requirements, codes, and standards — that may have different influences on KM strategies and practices in volunteer fire departments. Research results presented here are based on fire departments in one nation (Canada) and only one province

(Quebec) in that country. As such, while instructive, the study is exploratory in nature, and findings have limited generalizability. The body of knowledge on the fire service would also benefit from KM research in career and mixed (combination volunteer/career) fire departments. Such studies would provide for a comparative KM literature. In short, much research on KM in fire departments remains to be done. This study is a first step in that direction.

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Endnote

¹ Space does not allow for a detailed explanation of factor analysis as a statistical tool. Instead, the reader is referred to R. J. Rummel (1967). This article is one of the seminal statements on the statistical method. To interpret the factor-analysis data in **Appendices A** and **B** in this article, see Rummel (1967), especially p. 462.

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Appendix A

List of Acronyms Used in the Study

Knowledge Management Components

KM: Knowledge Management
 TM: Top Management
 IT: Information Technology
 TK: Tacit Knowledge
 EK: Explicit Knowledge
 KC: Knowledge Creation
 KST: Knowledge Storage
 KSH: Knowledge Sharing
 SUP: Suppliers
 PART: Partners
 CUST: Customers/Citizens
 AAR: Academic and Applied Research

Serious Leisure Components

SL: Serious Leisure
 QUAL: Qualities
 RWD: Rewards/Motivation
 TPF: Thrills/Psychological Flow
 DEWO: Devotee Work

Other Acronyms

CRM: County Regional Municipality
 EFA: Exploratory Factor Analysis

Appendix B: Knowledge Management (KM) Factor Analysis

	Pattern Matrix ^a			
	Factors			Community
	(1) Buddy Learning	(2) Knowledge Transfer	(3) Knowledge Storage	
KSH3. In my fire department, when a firefighter is competent at a task, colleagues will ask him/her to show them how to do it.	0.716	-0.008	0.021	0.58
KSH4. In my fire department, when firefighters learn something new, they share it with their colleagues.	0.714	-0.083	-0.011	0.64
KSH2. In my fire department, firefighters ask their colleagues to share their skills when they need to learn something new.	0.690	-0.114	0.053	0.61
KSH1. In my fire department, experienced firefighters willingly share their knowledge with new firefighters.	0.667	-0.073	0.085	0.51
KC1. In my fire department, firefighters can propose ideas and new knowledge.	0.588	-0.031	-0.155	0.73
KC3. In my fire department, firefighters can propose new ways of doing things.	0.567	-0.068	-0.224	0.77
KSH5. In my fire department, firefighters benefit the group with competencies developed in their primary occupation (for example: mechanic, carpenter, plumber, etc.).	0.555	-0.044	-0.078	0.42
TM1. In my fire department, high-ranking officers (chiefs) believe it is important to encourage firefighters to share their knowledge with colleagues.	0.465	-0.006	-0.273	0.59
TM3. In my fire department, high-ranking officers (chiefs) are aware of innovations in the fire service, and they inform firefighters about it.	0.445	-0.020	-0.338	0.61
KC2. In my fire department, firefighters train regularly on tasks to develop their competencies.	0.428	-0.070	-0.183	0.46
TM4. In my fire department, high-ranking officers (chiefs) foster innovation and change.	0.387	-0.156	-0.217	0.56
TM2. In my fire department, high-ranking officers (chiefs) adjust training after problems were encountered in operations to help firefighters improve.	0.361	-0.034	-0.313	0.53
TK3. In my fire department, informal conversations and meetings are used to share knowledge.	0.335	-0.124	-0.302	0.50
AAR2. In my fire department, results from academic or applied research on the fire service are used to modify current practices and procedures.	-0.195	-0.934	-0.070	0.89
AAR3. In my fire department, results from academic or applied research on the fire service are incorporated in training.	-0.211	-0.898	-0.082	0.80
AAR4. In my fire department, results from applied or academic research on the fire service are used to further health and safety in the workplace.	-0.141	-0.859	-0.030	0.71
AAR1. In my fire department, high-ranking officers (chiefs) use results from academic or applied research in their decisions.	-0.128	-0.854	-0.069	0.85
CUST4. In my fire department, knowledge obtained from citizens is used to innovate (for example: updated prevention program, new awareness campaign, etc.).	0.184	-0.613	0.003	0.70

^a Rotation converged in 13 iterations

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Appendix B: Knowledge Management (KM) Factor Analysis, Continued

	Pattern Matrix ^a			
	Factors			Community
	(1) Buddy Learning	(2) Knowledge Transfer	(3) Knowledge Storage	
CUST3. In my fire department, knowledge obtained from citizens is incorporated in the department's operations (for example: adjustments to practices, taking into account client services, etc.).	0.208	-0.556	0.084	0.69
SUP3. In my fire department, knowledge obtained from service or equipment suppliers is used to innovate (for example: new ways of using a piece of equipment, new work method, etc.).	0.205	-0.540	-0.023	0.66
SUP1. In my fire department, knowledge is shared from either side with services and equipment suppliers.	0.089	-0.533	-0.182	0.66
PART2. In my fire department, knowledge obtained from partners (for example: public works, police, or ambulance) is incorporated in the department's operations (for example: adjustments to work method, better understanding of the partners' work, etc.).	0.220	-0.516	-0.122	0.84
CUST2. In my fire department, citizens are asked to share their knowledge (for example: information while on emergency scenes.).	0.213	-0.507	0.179	0.55
AAR5. In my fire department, it is considered important that knowledge from research be known.	0.134	-0.505	-0.177	0.65
PART1. In my fire department, knowledge is shared reciprocally with partners (for example: public works, police, or ambulance).	0.180	-0.481	-0.128	0.72
PART3. In my fire department, knowledge obtained from partners (for example: public works, police, or ambulance) is used to innovate (for example: new work method, new procedure, etc.).	0.227	-0.471	-0.153	0.82
CUST1. In my fire department, firefighters share their knowledge with citizens (for example: explanations, prevention tips, etc.).	0.282	-0.463	0.061	0.44
SUP2. In my fire department, knowledge obtained from services or equipment suppliers are incorporated in the department's operations (for example: adjusting ways of doing something, best practices, safety tips, etc.).	0.179	-0.424	-0.064	0.59
PART5. In my fire department, knowledge obtained from mutual-aid fire departments is incorporated in the department's operations (for example: adjusting a work procedure, uniformization of work procedures, etc.).	0.102	-0.369	-0.324	0.83
PART6. In my fire department, knowledge obtained from the mutual-aid fire departments is used to innovate (for example: new work method, new procedure, etc.).	0.169	-0.335	-0.327	0.82
KST1. In my fire department, processes and tools to store knowledge for future use are well organized (for example : data banks, procedure manuals, information cards, library resources, etc.).	-0.119	-0.024	-0.863	0.72
EK4. In my fire department, knowledge is shared by means of documentation such as manuals.	-0.059	-0.072	-0.771	0.63
EK1. In my fire department, knowledge (how to or processes to resolve a problem) can be easily accessed through documents or manuals.	0.171	0.078	-0.715	0.65
EK3. In my fire department, results from projects or meetings are documented.	0.027	-0.094	-0.715	0.66

^a Rotation converged in 13 iterations

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Appendix B: Knowledge Management (KM) Factor Analysis, Concluded

	Pattern Matrix ^a			
	Factors			Communality
	(1) Buddy Learning	(2) Knowledge Transfer	(3) Knowledge Storage	
EK2. In my fire department, there is a structured training program, and its objectives are known by firefighters.	0.082	-0.008	-0.689	0.63
KST2. In my fire department, firefighters take part in knowledge-storage activities for future use (for example: document classification, procedures review, explanatory documents production, etc.).	0.027	-0.097	-0.672	0.63
KST3. In my fire department, firefighters know where stored knowledge that can be useful to them can be found.	0.104	-0.045	-0.629	0.67
IT3. In my fire department, firefighters regularly use information technologies in their tasks (for example during inventory, report writing, etc.).	0.176	-0.152	-0.324	0.42
PART4. In my fire department, knowledge is reciprocally shared with mutual aid fire departments.	0.150	-0.307	-0.308	0.73
Eigenvalue	16.308	2.512	2.129	
% of variance	40.571	5.339	4.283	
α	0.910	0.935	0.923	

Extraction Method: Principal axis factoring

Rotation Method: Oblique

^a Rotation converged in 13 iterations**Appendix C: Serious Leisure (SL) Factor Analysis**

	Pattern Matrix ^a			
	Factors			Communality
	(1) Personal Development	(2) Creativity	(3) Commitment	
RWD1. Being a firefighter encourages personal development by developing abilities and knowledge.	0.800	0.049	-0.020	0.62
RWD2. Being a firefighter encourages self-expression by developing abilities and knowledge.	0.749	0.088	0.042	0.62
QUAL3. Being a firefighter promotes personal enrichment, self-expression, a sense of accomplishment, social interactions, and a sense of belonging.	0.692	-0.089	0.022	0.42
QUAL4. Being a firefighter means to develop a distinctive identity in society and be part of a group that share values, beliefs, and goals.	0.685	0.050	0.026	0.44
DEWO3. Fire fighting allows me to demonstrate imagination in the application of abilities and knowledge.	-0.010	0.852	0.003	0.5
DEWO2. Fire fighting offers a significant opportunity for creative and innovative work which favors personal expression.	0.027	0.797	0.012	0.5
QUAL1. In my fire department, firefighters persevere to become more competent.	-0.112	-0.022	0.761	0.44

^a Rotation converged in 6 iterations

Concluded on next page

Appendix C: Serious Leisure (SL) Factor Analysis, Concluded

Pattern Matrix ^a				
	Factors			Communality
	(1) Personal Development	(2) Creativity	(3) Commitment	
QUAL2. In my fire department, firefighters make significant efforts to use their knowledge, training, and skills.	-0.073	0.073	0.718	0.47
TPF4. In my fire department, firefighters feel a deep sense of involvement during fire fighting.	0.182	-0.020	0.500	0.39
RWD3. In my fire department, firefighters see as a reward their contribution to maintaining and developing the group.	0.166	0.075	0.478	0.37
TPF1. In my fire department, firefighters have the feeling of being competent during fire fighting.	0.190	-0.031	0.468	0.36
Eigenvalue	4.325	1.459	1.266	
% of variance	39.314	13.263	11.514	
α	0.833	0.816	0.763	

Extraction Method: Principal axis factoring

Rotation Method: Oblique

^a Rotation converged in 6 iterations

About the Author

Claude Beauchamp is a doctoral candidate in public administration in the École nationale d'administration publique in Montréal, Canada. He currently serves as Director of the Quebec Provincial Occupational Health and Safety Agency. His previous positions include managerial leadership in emergency and fire-service training organizations as well as committee membership at the International Fire Service Accreditation Council (IFSAC) and the International Fire Service Training Association (IFSTA). Claude also served in a volunteer fire department, first as a firefighter and then as a training officer. Claude can be contacted at **Claude.beauchamp@enap.ca** or **Claude-beauchamp1@hotmail.com**

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