The Expanded Implementation of the Medical Priority Dispatch System (MPDS) in Pinellas County: A Public Value Perspective

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Abstract

The emergency medical services (EMS) system in Pinellas County, Florida has been regarded as one of the finest systems in the United States due to quick response times and the quality of care provided to the citizenry. It is designed of an amalgamation of 18 local fire departments, which deliver advanced life support (ALS) first response, and a private ambulance company, which provides emergency and non-emergency transport. As a whole, the system routinely surpasses its stated goal of arriving on the scene of an emergency medical incident within 7.5 minutes. However, Pinellas County has experienced an increase in population, tourism, homelessness, opioid-related 911 calls, and an aging baby boomer demographic. The EMS system has encountered a decrease in relative system capacity as the number of calls for service have steadily increased. Pinellas County's dispatch center uses a form of emergency medical dispatch (EMD) called the Medical Priority Dispatch System (MPDS), which employs a series of questions to determine the nature of the medical emergency and to coordinate the most appropriate response. Nevertheless, up to this point, even many of the lowest priority incidents still receive both a fire department and an ambulance response. This retrospective quantitative analysis examined the more than 200,000 emergency incidents that occurred in Pinellas County in calendar year 2018. After investigating impacts on apparatus commitment factor, call concurrency, and response time using inferential statistics, it is determined that the expanded implementation of MPDS in Pinellas County would have increased the relative response capacity and performance of the EMS system. The theoretical framework used for this research was Moore's public value theory, specifically, the application of the public value strategic triangle theoretical model.

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LIST OF ABBREVIATIONS

ACF	Apparatus Commitment Factor
AED	Automated External Defibrillators
ALS	Advanced Life Support
APCO	Association of Public-Safety Communications Officials
AVL	Automatic Vehicle Location
BLS	Basic Life Support
CARES	Community-wide Alignment of Resources for Efficiency and Service Plan
CPR	Cardiopulmonary Resuscitation
DSTATS	Dispatch Statistics
C-D-E-B-A-Ω	Determinants CHARLIE, DELTA, ECHO, BRAVO, ALPHA, OMEGA
EMD	Emergency Medical Dispatch
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
GPS	Global Positioning System
IAED	International Academies of Emergency Dispatch
MARVLIS	Mobile Area Routing and Vehicle Location Information System
MIH	Mobile Integrated Healthcare
MPDS	Medical Priority Dispatch System
OHCA	Out-of-Hospital Cardiac Arrest
PAIs	Pre-Arrival Instructions
PDIs	Post-Dispatch Instructions
PSAP	Public Safety Answering Point (PSAP)
QRV	Quick Response Vehicle
SSM	System Status Management
SUV	Sport Utility Vehicle
TSTATS	Truck Statistics

Chapter 1

INTRODUCTION

Before 1980, the emergency medical services (EMS) system in Pinellas County, Florida consisted of a variety of city-operated fire departments and private ambulance companies that provided service within their respective municipal and contractual boundaries. This patchwork deployment model "inspired little confidence" (Balaker & Summers, 2003, p. 7) and, in 1980, led to action by the Florida Legislature which passed 'special act' (80-585) that created the Pinellas County Emergency Medical Services System (IPS, 2011). The current system is directed by the Pinellas County Emergency Medical Services Authority, which is comprised of the Pinellas County Board of County Commissioners. The Pinellas County EMS System currently provides emergency response and ambulance transport throughout the county, regardless of the 24 municipal boundaries within it. The county created a public utility model by contracting with 18 local fire departments to deliver advanced life support first responder services and with a private ambulance company (Sunstar) to deliver emergency and non-emergency transport. A countywide ad valorem tax is levied to subsidize the cost of fire service first response and transport fees are used to support the private ambulance contractor. The EMS contracts between Pinellas County and the various local fire departments, as well as the private ambulance company, are periodically renegotiated.

The Pinellas County EMS System operates using a consolidated 911 dispatch and communications center, unified medical direction, and standardized medical operating procedures. These emergency medical services are collectively rendered within a mostly urban and suburban area of approximately 280 square miles, to more than 921,000 permanent and seasonal residents, as well as to more than six million visitors annually (Pinellas County, 2019a). Fire department advanced life support (ALS) apparatuses respond from the approximate 65 fire stations within Pinellas County spread out between the city of Tarpon Springs to the north and the city of St. Petersburg to the south (Figure 1). Meanwhile, Sunstar uses a system status management (SSM) deployment model that leverages historical data to determine how many ambulances are needed and where each should be located based on the time of day and the day of the week.

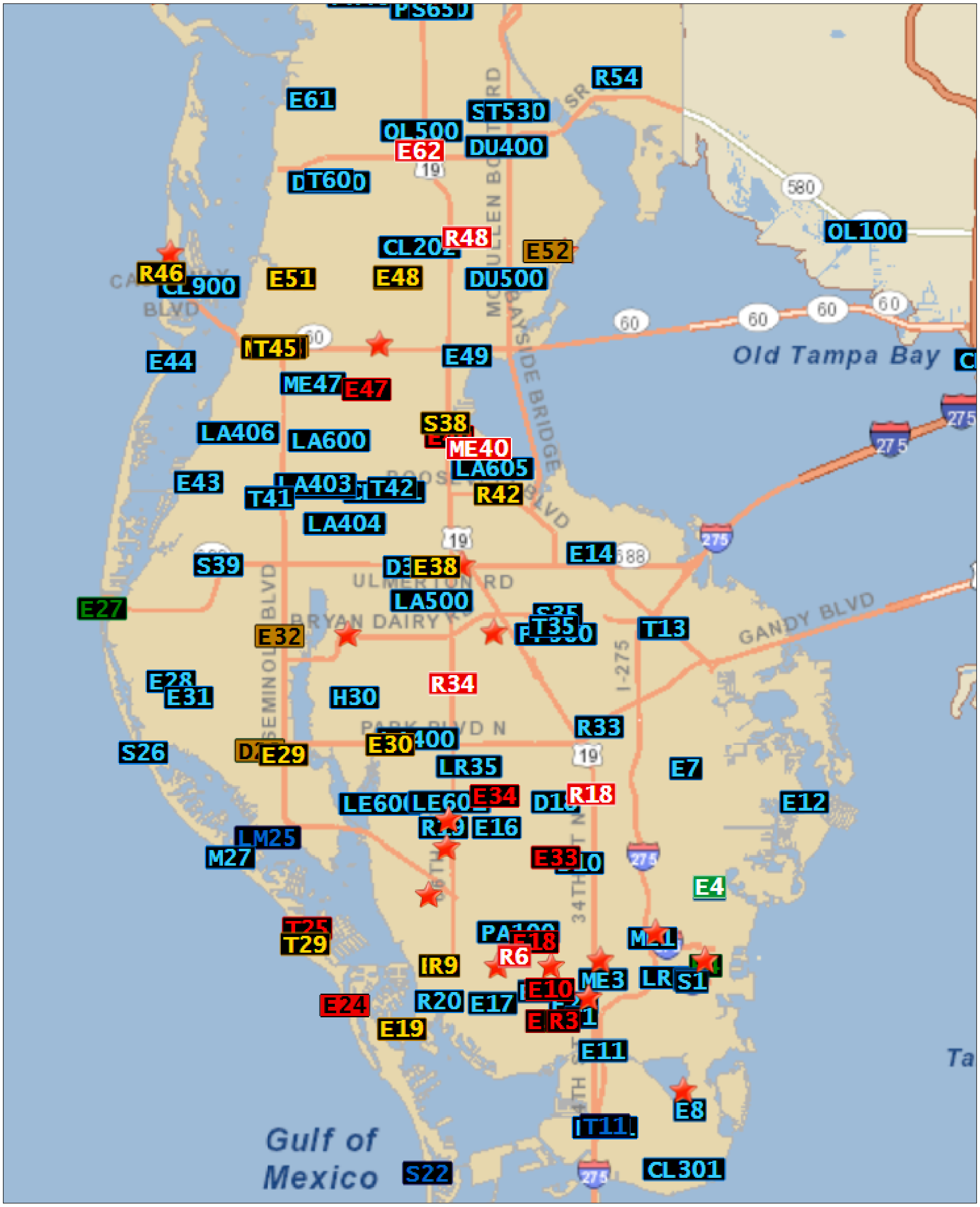

Figure 1. Map of Pinellas County depicting a point in time distribution of fire department apparatuses. The star icons represent 911 incidents and the different colors indicate apparatus status (Red = on scene of an incident, Yellow = responding to an incident, Light Blue = not assigned, etc.). Retrieved using Pinellas County's ESRI Software.

The EMS system in Pinellas County adds public value by ensuring a rapid response to high-severity medical incidents, vehicle accidents, and a large variety of other emergencies. Using the fire department for first response takes advantage of the geographically dispersed fire stations already in existence to reduce travel distance and response time.

Additionally, fire department personnel initiate patient care, collect patient information, and then transfer patients to Sunstar for transport, allowing them to become available quickly should another call for service arise. If the situation warrants (patient condition, combative patient, etc.), fire department paramedics can accompany the Sunstar crew in the ambulance to the hospital. According to data provided by the Pinellas County Radio and Technology Department, in 2018, fire department personnel accompanied Sunstar to the hospital approximately 5,500 times (J. Weinreich, personal communication, September 27, 2019).

Importance of the Topic

Population increases, homelessness, the opioid epidemic, an increase in tourism, and an aging baby boomer population have all potentially contributed to increases in calls for service for the Pinellas County EMS System. Since fiscal year 2009, the annual amount paid to the 18 fire service agencies used to provide ALS first response has increased by approximately 26% or $12 million annually (Pinellas County, 2019b). Additionally, compared to calendar year 2009, there has been an increase of over 45,000 fire and EMS incidents annually. According to Computer-Aided Dispatch (CAD) data obtained from the Pinellas County Radio and Technology Department (Figure 2), the 201,986 incidents that occurred in calendar year 2018 were 30% higher than in 2009. As stated by Clawson and Martin:

> Increased call volume without a concomitant increase in numbers of EMS units and personnel ultimately begins to strain those agencies with a maximal response policy. Wear and tear on the units and equipment becomes increasingly apparent, mechanical breakdowns become more frequent and dangerous, and the increased stress begins to take its inevitable toll on personnel. (1990, para. 7)

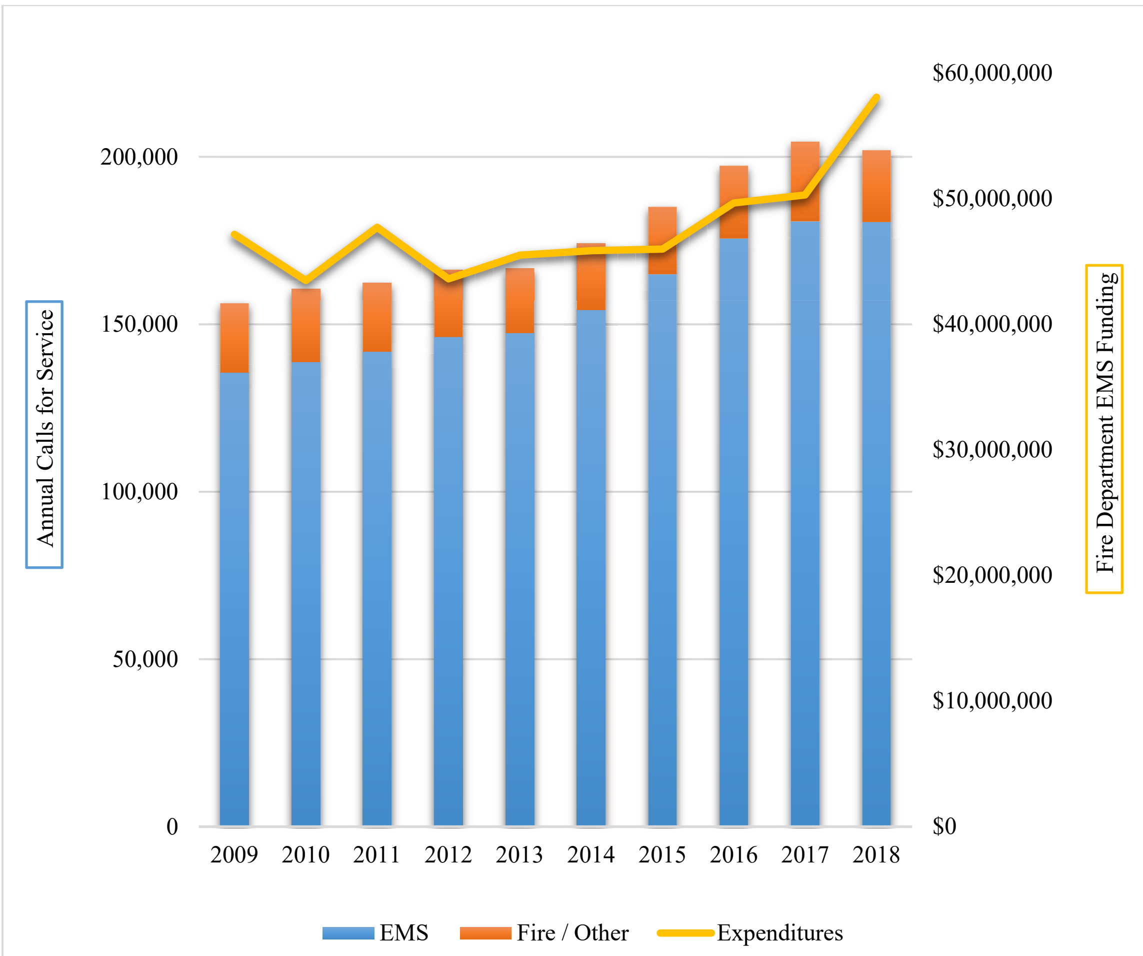

Figure 2. Pinellas County Calls for Service and Fire Department Funding. Calls for Service data provided by the Pinellas County Radio and Technology Department. Funding data provided by the Pinellas County Office of Management and Budget and retrieved from http://www.pinellascounty.org/budget/archive.htm.

According to a 2012 report issued by the National Alliance to End Homelessness, the Tampa-St. Petersburg (FL) metropolitan area had the highest rate of homelessness in the nation at 57 homeless for every 10,000 residents. Additionally, tourism in Pinellas County has been steadily increasing. In 2018, there were 6.5 million overnight visitors to Pinellas County compared to the 6.1 million that visited in 2015 (Visit St. Pete/Clearwater, 2019). The number of people residing in Pinellas County who are over the age of 65 is also on the rise. In 2017, there were 309,604 people over the age of 65 residing in Pinellas County compared to the 269,400 in 2012 (Florida Department of Elder Affairs, 2018). The homeless population and the ever-increasing number of tourists and elderly residents have all potentially contributed to the rise in number of annual 911 calls for service (Agarwal, Lee, McLeod, Mahmuda, Howard, Cockrell, & Angeles, 2019; Moeller, 2019).

Increases in calls for service can have an adverse impact on apparatus commitment. Apparatus commitment factor (ACF) is measured in the form of a percentage and refers to the amount of time emergency response apparatuses (fire engines, rescue trucks, etc.) are assigned to or involved in an incident or call for service (Powers, 2016). This percentage can be arrived at by dividing the total amount of time an apparatus is committed to an incident in a year by the total amount of time it is in service in a year. For instance, if an apparatus spent 2,190 hours in a year assigned to incidents, it has a 25% commitment factor (2,190 divided by the 8,760 hours that are in a year). A one percent decrease in ACF is equal to a 14 minute 24 second increase in daily apparatus availability (per 24-hour shift).

The higher the commitment factor, the busier the apparatus is, and the less likely it will be available to respond to calls for service (Powers, 2016). In 2015, the Henrico County, Virginia Division of Fire developed a general commitment factor scale:

- 0.16-0.24 indicates the "Ideal Commitment Range." Personnel are able to maintain training requirements and physical fitness and can consistently achieve response time benchmarks. Units are available to the community more than 75% of the day. Units below 0.16 should be evaluated for more efficient use as additional operating capacity is available.
- 0.25 indicates "System Stress," yet community availability and unit sustainability are not questioned. First-due units are responding to their assigned community 75% of the time, and response benchmarks are rarely missed. At this level, agency leaders must understand that commitment factor increases are imminent. The community this unit serves will begin to see increasingly longer response times as neighboring stations send apparatus during one out of four calls.
- 0.26-0.29 is the "Evaluation Range." In this range, the community served will experience delayed incident responses. Just under 30% of the day, first-due ambulances are unavailable; thus, neighboring responders will likely exceed goals. Agency leadership should immediately begin identifying funding sources to provide relief. At this range, commitment factors are only expected to increase.
- 0.3 is the "line in the sand" for commitment factors. "Not Sustainable: Commitment Threshold" shows our community has less than a 70% chance of timely emergency service and immediate relief is vital. Personnel assigned to units at or exceeding 0.3 may show signs of fatigue and burnout and may be at increased risk of errors. Required training and physical fitness sessions are not

> consistently completed. (Powers, 2016, pp. 35-36)

There are other factors that can increase commitment factors apart from an increase in the number of calls for service. For instance, the amount of time an apparatus stays on the scene of an incident will affect its commitment factor. It is not uncommon for crews to be on scene of a structure fire for well over an hour. Conversely, fire department rescue crews are sometimes canceled on the way to an incident by an ambulance crew who has already arrived on scene, which significantly shortens the time involved in the incident.

Occasionally, the system becomes overloaded or patient severity is such that a fire department rescue will transport a patient to the hospital instead of waiting for an available Sunstar unit. The fire department crew has to load the patient into the transport rescue, transport the patient to the hospital, complete billing information, transfer the patient to hospital staff, and prepare the rescue to go back in service. Each of these essential tasks can significantly prolong the time spent dedicated to the incident and, thus, increase the commitment factor.

Pinellas County is divided into emergency medical service response zones or EMS zones. An EMS zone is the geographic area surrounding a fire station, within which the apparatuses assigned to that fire station are considered first-due to respond to incidents. Response zone reliability refers to the percentage of calls that occur within an EMS zone that are handled or responded to by the first-due apparatuses. According to the Lynchburg Fire Department Standard of Response Cover:

> Response reliability would be 100% if every company were available in its station when a fire or emergency call is received. In reality, there are times a call is received when the first-due company is out of area or unavailable. (City of

Lynchburg, n.d., p. 7.1)

Likewise, call concurrency is a term used to describe the percentage of time multiple calls for service occur at the same time within a specific zone or response area (Figure 3). Analyzing concurrent incidents is important because these incidents can stretch available resources and extend response times (City of Scottsdale, 2015). Assuming incident duration and the number of apparatuses assigned to a zone is constant, the more calls for service that occur, the higher the probabilities of call concurrency and the higher the commitment factors are for apparatus. As ACF and call concurrency increase, zone reliability decreases.

When first-due apparatuses are assigned to incidents and concurrent calls for service arise, second-due apparatuses are dispatched to assist. While many fire stations in Pinellas County have secondary and even tertiary apparatus that can respond, some stations are staffed with a single apparatus. Additionally, there are times when several concurrent incidents occur within the same zone or multiple apparatuses respond to the same incident (as occurs with structure fires), which can consume all of the available apparatuses at a particular fire station. In this case, the next closest appropriate apparatus is dispatched to the incident. Since these apparatuses are typically responding from further away, their response times are often longer than if the first-due apparatus was dispatched, which can potentially have adverse effects on patient outcomes (Goto, Funada, & Goto, 2018) and, in the case of structure fires, property damage (Thiel & Jennings, 2012).

As the number of available apparatuses at fire stations increases, so does response zone reliability. Historically up to this point, in an attempt to bolster zone reliability, additional apparatuses have been added to the Pinellas County EMS System to handle concurrent calls for service. At present, call concurrency and zone reliability do not present an extensive problem as outlined in Figure 3. However, this research is intended to determine whether the Medical Priority Dispatch System (MPDS) could be implemented in an effort to prevent a significant issue in the future, as the annual number of calls for service is expected to continually grow.

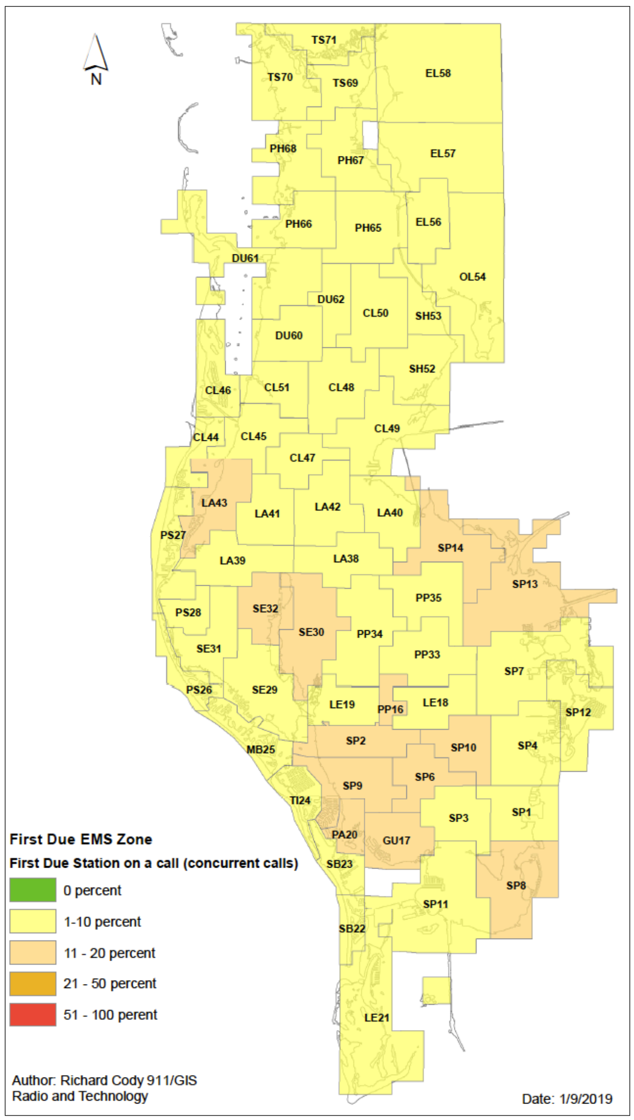

Figure 3. Call Concurrency, Calendar Year 2018. Retrieved from the Pinellas County Radio and Technology Department.

Prolonged response times to high-priority public safety incidents can have a multitude of adverse consequences. Concerning structure fires, modern households contain more synthetic materials than ever before. These materials burn faster, with more intensity and ferocity, and produce higher concentrations of toxic, flammable gasses than the more natural materials used in previous generations. Hostile fire can grow at tremendous speed resulting in "flashover" within 10 minutes of ignition (Thiel & Jennings, 2012). Flashover is a condition where the majority of the exposed combustible surfaces in an enclosed area ignite almost simultaneously, causing an imminent threat to life and further fire spread (Thiel & Jennings, 2012).

In 2018, there were 1,302 structure fires in Pinellas County. According to the Pinellas County Computer-Aided Dispatch (CAD) system, 90% of the 911 calls for structure fires were processed by the call taker within 1 minute and 29 seconds or less. The mean response time for the first-arriving apparatus (the time from when the apparatus was dispatched to when it arrived on the incident scene) was 04:31 minutes. Therefore, on average, first arriving firefighting crews have only a few short minutes after arriving on scene of an incident to impact fire growth before flashover occurs.

Increased response times to structure fires are just one potential consequence of increased demand. Those medical patients in need of particular rapid medical interventions could also suffer. While the routine emergency response to 911 calls for service can potentially do more harm than good by disrupting traffic and increasing the likelihood of traffic incidents, some patients have shown to benefit (Turner, Dixon, Warren, & Nicholl, 2006). Sudden death due to out-of-hospital cardiac arrest (OHCA) remains a major health issue and improving care for these patients through early recognition and quicker prehospital provider response times has been the focus of many EMS systems over the last two decades (von Vopelius-Feldt, Powell, Morris, & Benger, 2016).

It is generally accepted that early cardiopulmonary resuscitation (CPR) and defibrillation improve the outcome of patients suffering OHCA (Bürger et al., 2018; Goto et al., 2018; Stiell et al., 1999). According to Larsen, Eisenberg, Cummins, and Hallstrom (1993), the chances of survival decrease between 7% and 10% for every minute that passes after witnessed cardiac arrest where CPR is withheld. Turner et al. state that survival from sudden cardiac arrest is dependent on several key factors including:

- Early recognition and access to treatment
- Early cardiopulmonary resuscitation (CPR)
- Early defibrillation
- Early advanced cardiac care (2006, p. 3).

In a study published by the American Heart Association, Goto et al. (2018) found that increased response times were independently associated with decreased survival. They found the upper limits of EMS response time associated with one-month neurologically intact survival to be 13 minutes with bystander CPR and defibrillation and 11 minutes with bystander CPR but without defibrillation. In another study involving 6,331 OHCA patients, those who received defibrillation within eight minutes experienced a 33% relative increase in the survival to hospital discharge rate (Stiell et al., 1999).

In 2018, Bürger et al. published "The Effect of Ambulance Response Time on Survival Following Out-of-Hospital Cardiac Arrest," which revealed that the rate of resuscitation success decreased with an increase in ambulance response time. When the mean ambulance response time rose from 1:04 to 9:47 minutes, the hospital discharge rate declined from 22% to 14% if patients received bystander CPR. However, if no bystander CPR was performed, the discharge rate dropped from 12.9% to 6.4% (Bürger et al, 2018). Furthermore, in their 2006 study, Turner et al. reviewed 1,154 patients who suffered an OHCA. They found that the estimated chances of hospital discharge increased by 19% for each minute response time was reduced (2006).

Regarding reimbursement from Pinellas County for cities and fire districts providing emergency medical services, the Pinellas County Code of Ordinances states, "where EMS are already being provided, full reimbursement shall be made by the authority to the EMS provider for the reasonable and customary cost of said services, such cost to be defined by the authority" (Chapter 54, Sec. 54-28). In 2009, the County enacted resolution 09-37 that determined how first responder units would be funded based upon the volume of emergency calls for service in their respective areas (Appendix A).

Some elected officials and county and city administrators are concerned about what it will take to fund the fire department staffing and ALS units required to match the growing demand for service. While the citizenry and elected officials may prefer the current quick response to nearly every call for service (regardless of severity), the system's relative operational capacity is being consumed at an ever-increasing rate. In fact, many of the fire departments in Pinellas County have elected to fund additional advanced life support units at their own expense to meet demands for service, lessen workload, and help to ensure fire suppression apparatuses are available and not dedicated to low-priority medical incidents. Moreover, legislation was forwarded in 2018 to further increase Florida's homestead exemption which, if one day approved by voters, could restrict future tax revenue (Bousquet, 2017). Therefore, alternative deployment methods must be considered as a way to restrain the upsurge in calls for service for fire department apparatuses and the future cost of the EMS system.

Contribution of this Study

Pinellas County's 911 Center currently uses a commercially available form of emergency medical dispatch (EMD) called the Medical Priority Dispatch System (MPDS). This system, through a detailed series of questions, determines whether the reporting party's situation is a life-threatening condition that requires an urgent response by multiple apparatuses or a less critical circumstance which may be handled through a routine response from a single apparatus and crew (Pinellas County Board of Commissioners, 2013).

The criteria-based dispatch protocols are used to dispatch appropriate aid to medical emergencies through systematized caller interrogation as well as to provide pre-arrival instructions to callers (Fitch and Associates, 2013). These questions allow emergency medical dispatchers to categorize the call by the patient's chief complaint and then set a determinant level, ranging from ALPHA (minor) to ECHO (immediately life-threatening). Regarding determinant levels, Clawson and Dernocoeur state:

> That is, the C-D-E-B-A-Ω levels are not related in a linear sense of becoming progressively worse. Rather, they have to do with how many responders will go and (when there are tiers of capability), which levels of expertise are needed, and how rapidly they are needed. (2001, p. 3.25)

OMEGA determinant protocols are made up of codes that require a special response or referral. In Pinellas County, these codes include low-priority situations such as expected death, hiccups, or being unable to urinate.

Ultimately, EMD procedures aim to appropriately match response resources and response mode (emergency versus non-emergency) with patient needs (Figure 4). The Priority Dispatch System can be broken down into several basic components:

1. Case Entry – Basic information about the case (address of the emergency, phone number, what is happening on-scene, etc.)
2. Key Questions – Systemized interrogation questions specific to the patient's/victim's chief complaint.
3. Pre-Arrival Instructions (PAIs) – Scripted instructions given by trained emergency dispatchers that help provide necessary assistance to the victim and control of the situation prior to the arrival of field personnel.
4. Post-Dispatch Instructions (PDIs) – Scripted instructions given by the call taker/dispatcher to the caller/patient/victim that address the specific chief complaint until responders arrive on-scene.
5. Case Exit – Once the case's Determinant Code is dispatched to responders, the call taker either disconnects or stays online with caller depending on the circumstances of the case. (Priority Dispatch Corp., 2020, para. 3)

2 ALLERGIES (REACTIONS) / ENVENOMATIONS (STINGS, BITES) 2 2

KEY QUESTIONS

1. (Snakebite) **Where** is the **snake** now?
2. Is s/he **completely alert** (responding appropriately)?
3. Does s/he have **difficulty breathing** or **swallowing**?
   a. (Yes and Alert) Does s/he have **difficulty** speaking/crying **between** breaths?
4. (Allergy) Has s/he ever had a **severe allergic reaction** before?
   a. (Yes) Does s/he have any **specific injections** or **other medicines** to treat this type of reaction?
      i. (Yes) Have they been **used**?
      ii. (No) Tell her/him to **use them now**.

POST-DISPATCH INSTRUCTIONS

a. I'm sending the **paramedics** (ambulance) to help you now. **Stay on the line** and I'll tell you **exactly** what to do next.
b. (DELTA or CHARLIE) Tell her/him to **lie down** (**sit** if difficulty breathing) and **not to stand or walk**.
c. (Non-elapid snakebite) Keep her/him from **moving** around. Keep the bitten area **below heart-level** if possible. **Do not** apply **ice** or a **tourniquet**. **Do not** give her/him any **alcohol** to drink.

∗ **Stay on the line** with the caller if patient has a **history** of **severe allergic reaction** to the **same type** of insect or substance or if her/his condition seems **unstable** or is **worsening**.

DLS ∗ **Link to X-1 unless:**

Danger	X-9
Unconscious	NABC-1
INEFFECTIVE BREATHING and Not alert	NABC-1
Epinephrine (Adrenaline) Auto-Injector	P-1 pullout
Elapid Snakebite	AI-1
Stingray	AI-2
Jellyfish	AI-3

LEVELS	#	DETERMINANT DESCRIPTORS	CODES	RESPONSES	MODES
E	1	**INEFFECTIVE BREATHING** ∗ (to be selected from **Case Entry** only)	2-E-1		
D	1	Not alert	2-D-1		
	2	**DIFFICULTY SPEAKING BETWEEN BREATHS**	2-D-2		
	3	**SWARMING attack** (bees, wasps, hornets, etc.)	2-D-3		
	4	**Snakebite**	2-D-4		
C	1	**Difficulty breathing** or **swallowing**	2-C-1		
	2	History of **severe allergic reaction**	2-C-2		
B	1	**Unknown** status/**Other** codes **not** applicable	2-B-1		
A	1	**No** difficulty breathing or swallowing (rash, hives, or itching may be present)	2-A-1		
	2	**Spider** bite	2-A-2		

 AMPDS™ v13.0, NAE-std, 150529

Figure 4. MPDS Protocol 2 – Allergies (Reactions)/Envenomation (Stings, Bites), n.d. Used by permission of the International Academies of Emergency Dispatch. Copyright 2019 by IAED. Reprinted with permission.

Even though this EMD system is currently in place within Pinellas County, in calendar year 2018, over 96% of the requests for emergency medical services resulted in the dispatch of both an ambulance and a fire department ALS unit (G. Tyburski & J. Weinreich, personal communication, July 23, 2019). The method used to deploy emergency medical services in Pinellas County may be more a matter of tradition than functionality. At one time, it might have been feasible to send robust responses to minor incidents to make use of resources and always err on the side of caution. However, the number of calls for service are increasing each year and the overutilization of resources may mean that, at some point, there may not be enough to go around. Fitch argues the "use of a single priority response to every 911 request is like saying that all hospital patients need a CT scan or an enema on admission, regardless of condition" (Fitch, 2005).

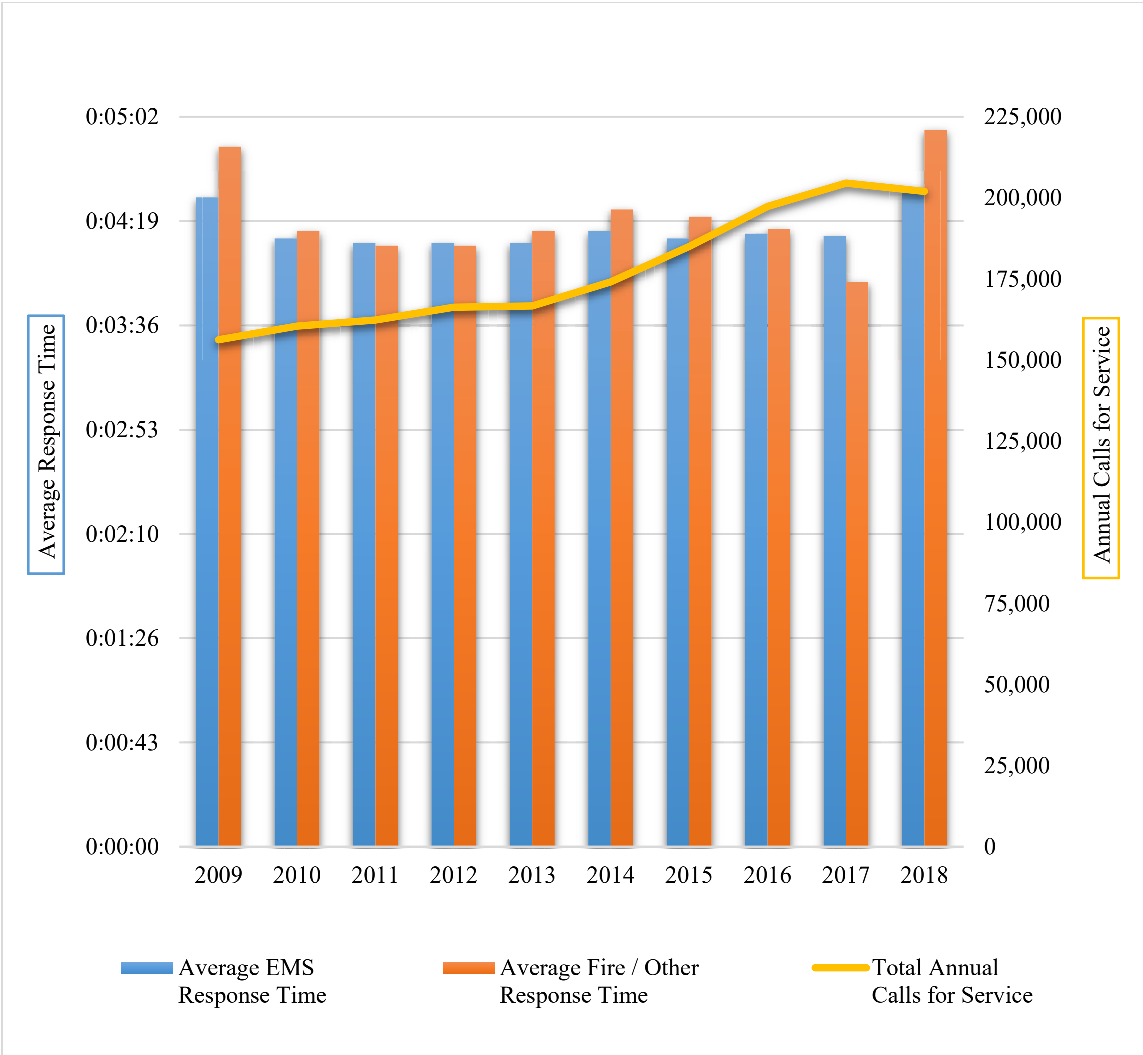

Figure 5. Pinellas County Annual Calls for Service and Response Times. Data provided by the Pinellas County Radio and Technology Department.

According to Hallman (2014), sending a dual response to all medical emergencies is not always necessary. Regarding the appropriate application of the Medical Priority Dispatch System, James Page states:

> In blunt reality, in many cities and communities, there is a gap in the typical emergency medical dispatch and response procedure. At its worst, it provides

> dying patients and their rescuers with too little help too late. At its least worst, it subjects rescuers and the public to unacceptable risks while delivering excess resources to the patient. (Clawson and Dernocoeur, 2001, p. ix)

For instance, in some EMS systems a basic life support (BLS) ambulance responding non-emergency may be adequate to handle minor ALPHA calls, and an ALS ambulance alone may be appropriate for most BRAVO determinant emergencies (Fratus, 2008).

The findings of this study lend insight into the current functionality of the Pinellas County EMS System and whether the utilization of MPDS to alter the deployment of emergency services will increase the relative capacity and performance of the system. From a managerial point of view, the results of this research might either provide an empirical basis for system change or reaffirm the efficacy of the current model. The study also contributes to the field of public administration and public safety through the utilization of Moore's public value theory, and specifically, the public value strategic triangle theoretical model. The research explores how public value can be created when a public policy strategy or initiative has democratic legitimacy, when it has the support of the authorizing environment, and when government has the relative operational capacity and resources to implement the strategy or action effectively (Kavanagh, 2014).

Problem Statement

The relative capacity of Pinellas County's EMS system is decreasing each year as a variety of factors cause the number of calls for service to outpace concomitant increases in allocated revenue and available resources. The future impact on the citizenry could include increased response times to high-priority 911 calls and an increase in current and future system costs. From a public value perspective, it is prudent public policy to assess current practices in order to determine if there are better, more efficient ways of providing service.

Research Questions

The purpose of this retrospective quantitative dissertation was to determine if the expanded implementation of the Medical Priority Dispatch System (MPDS) in calendar year 2018 would have increased relative capacity and improved the performance of the Pinellas County EMS System. Specifically, how the independent variable (expanding the implementation of MPDS) influenced the dependent variables (apparatus commitment factor, CHARLIE, DELTA and ECHO call concurrency, and response times), and how this could impact the Pinellas County EMS System. The research design applied a systematic, empirical approach. It did not randomly assign subjects to conditions because the events being studied have already taken place. The following questions and hypotheses guided this research:

1. Would the expanded implementation of the Medical Priority Dispatch System in the Pinellas County EMS System in 2018 have increased the system's relative response capacity?
    - H^1: Removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will reduce per apparatus commitment factors.
    - H^0: Removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will not reduce per apparatus commitment factors.
    - H^2: Removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will reduce per EMS zone call concurrency.
    - H^0: Removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical

incidents will not reduce per EMS zone call concurrency.

2. Would the expanded implementation of the Medical Priority Dispatch System in the Pinellas County EMS System in 2018 have improved the system's performance?
    - H^3: The per EMS zone response times for concurrent CHARLIE, DELTA, and ECHO (C-D-E) medical incidents are longer than response times for non-concurrent C-D-E medical incidents.
    - H^0: The per EMS zone response times for concurrent CHARLIE, DELTA, and ECHO (C-D-E) medical incidents are not longer than response times for non-concurrent C-D-E medical incidents.

Overview of Chapters

This dissertation includes five chapters: an introduction of the topic; a review of relevant literature; a description of methodology; an analysis of the data; and a discussion of the findings and future recommendations. The introduction provided background on Pinellas County, the Pinellas County Emergency Medical Services System, and an explanation of the problem being faced. The literature review covers previous empirical research on the topics of system deployment and design, emergency medical dispatch, priority dispatch, as well as relevant case studies. The review also includes Moore's public value theory and, specifically, the public value strategic triangle theoretical model, which is the theory base for this research. The methodology chapter describes in detail the techniques utilized to determine the operational impacts of the expanded implementation of MPDS in Pinellas County. The fourth chapter outlines the data that have been obtained as part of the research, along with an analysis of the data. Finally, the discussion section in the concluding chapter informs the reader of the meaning and value of the findings as well as suggests future research.

Chapter II

REVIEW OF LITERATURE

To better understand the subjects being researched, it is essential to conduct a review of the literature available on the topics of emergency medical services, emergency medical dispatch, and public value theory. Emergency medical services are an institution that has existed in various forms for over 200 years. In contrast, the framework known as emergency medical dispatch and the theory of public value have been developed rather recently.

Conceptual Framework

The theory of public value was advanced by Professor Mark Moore at the Kennedy School of Government in the 1990s. Public value is a term often used to describe the value of an organization's contribution to society. While this term was once confined to the public sector it is now more universally applied to the governmental, non-profit, and even the corporate sectors. According to Hartley, Alford, Knies, and Douglas (2017), there are several distinct elements of public value in modern public management thought. First, there is the idea of public value as a contribution to the public sphere. There is also a concept of public value as the accumulation of worth through actions in an organizational or partnership setting. Finally, there is the public value strategic triangle made up of the public value proposition, the authorizing environment, and the operational resources which a public manager can align to achieve public value (Benington & Moore, 2011).

The public value strategic triangle is a heuristic framework used to align three separate but related processes which are presumed to be essential for the formulation of public value (Figure 6). According to the strategic triangle, public value initiatives must accomplish three things. First, indubitably, they must strive to create public value. Second, they must marshal adequate support and be politically sustainable. Third, to be successful, public value initiatives must have access to the necessary resources (Benington & Moore, 2011). The three sides of the triangle include:

- Defining public value – clarifying and specifying the strategic goals and public value outcomes which are aimed for in a given situation.
- Authorization – creating the "authorizing environment" necessary to achieve the desired public value outcomes – building and sustaining a coalition of stakeholders from the public, private, and third sectors (including but not restricted to elected politicians and appointed overseers) whose support is required to sustain the necessary strategic action.
- Building operational capacity – harnessing and mobilizing the operational resources (finance, staff, skills, technology), both inside and outside the organization, which are necessary to achieve the desired public value outcomes. (Benington & Moore, 2011, p. 4)

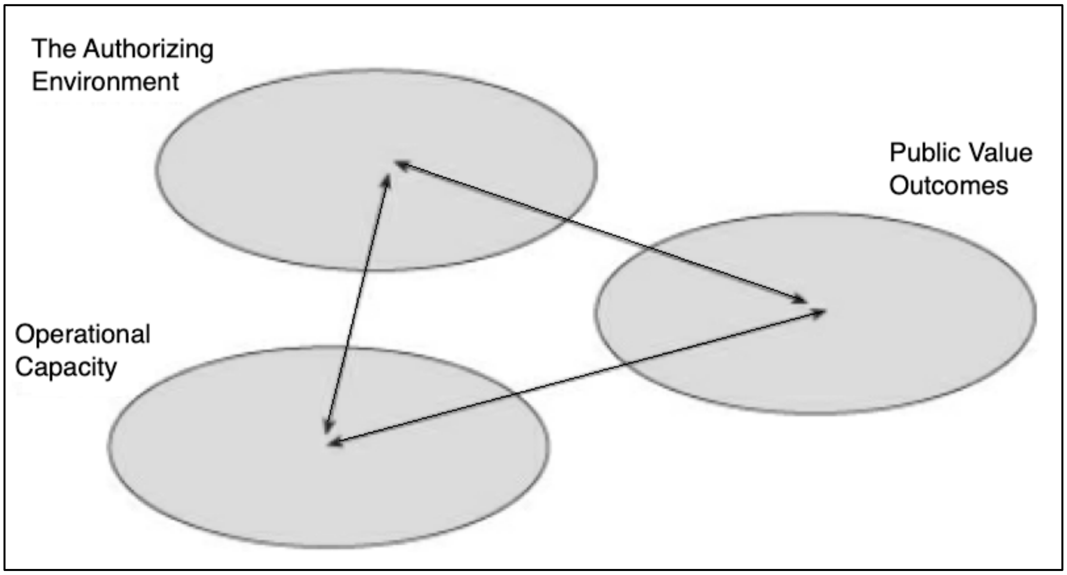

Figure 6. The strategic triangle of public value. Retrieved from *Public Value: Theory and Practice* (p. 6), by J. Benington and M. Moore, 2011, Palgrave Macmillan. Copyright 2011 by J. Benington and M. Moore. Reprinted with permission.

Government is often criticized for its bureaucracy, languorousness, and indifference to the wants and needs of the body politic. Hartley et al. (2017) contend that the notion of public value outcomes or added value leads to the question of what counts as valuable and what is value, which is sometimes exhibited in terms of the normative volitions for a "good society." In other words, public value is not just about what the public values, but what contributes overall to the public sphere (Benington & Moore, 2011). The former takes into account personal affinities and desires while the latter disregards individual preferences and encompasses more altruistic themes such as the environment, fiscal sustainability, and even contributions to current and future generations (Benington & Moore, 2011).

The authorizing environment contains an amalgamation of stakeholders from the public and private sectors, citizens, elected officials, and career bureaucrats. Each group, organization, and person has their own values, views, and causes. According to

Benington and Moore (2011), conflicts are relayed from the private and public sectors to the elected officials where they are disputed, debated, and deliberated upon, but rarely definitively resolved. Many times, public managers are challenged to make decisions amid conflicting interests with ambiguous direction. However, any single initiative to create public value is not dependent upon unanimous support, but instead requires only enough support to ensure the desired outcome is achieved (Benington & Moore, 2011).

Operational capacity refers to the resources that are needed to achieve public value. Once a public value initiative is identified, both the authorizing environment and operational capacity must exist to achieve a positive result. In some cases, the resources needed to achieve public value are outside the command of public managers. In these situations, the authorizing environment must include partners that possess the needed resources and who are willing to contribute them toward the initiative, thus, creating operational capacity (Benington & Moore, 2011).

Moore's book *Creating Public Value* (2011) drew attention to the role of public managers in coordinating public policy development. Moore describes the role of government managers:

> . . . not just as inward-looking bureaucratic clerks, and passive servants to their political masters, but as stewards of public assets with "restless value-seeking imaginations," who have important roles to play in helping governments to discover what could be done with the assets entrusted to their offices, as well as ensuring responsive services to users and citizens. (Benington & Moore, 2011, p. 3)

The policy creation Moore and Benington refer to is often done in concert with other stakeholders in ways that ensure that the right decisions are made in the public's best interest (2011).

According to Yotawut (2018), public value should be implemented in every public organization to enhance customer satisfaction and trust, as increased trust in public service delivery can create more sustainability for public services. Benington and Moore (2011) write:

> Just as a private sector executive had to be searching continuously for new technological breakthroughs which they could use to improve the performance of their organization, so [too] a public sector manager had to be searching continuously for innovative ways to accomplish their objectives efficiently and effectively. (p. 9)

The public value framework urges managers to push past mere "wants" into the more substantive question of what adds the most value to the public sphere, forcing the more arduous choices and compromises between opposing priorities (Kelly, Mulgan, & Muers, 2002).

The public value strategic triangle can be used to illustrate how the Pinellas County EMS model might accommodate the expanded implementation of the Medical Priority Dispatch System (Figure 7). The Pinellas County EMS System has been referred to as "world-class," but not necessarily highly efficient (Fitch and Associates, 2013). Quick responses to high-priority requests for service is something that is both valued by the public and something that adds value to the public sphere. The authorizing environment is made up of citizens, public managers, and elected officials who likely do not want to spend more in order to add relative operational capacity (more personnel and apparatuses) so the system can continue to have an equally quick response to both high-priority and low-priority calls for service. The authorizing environment is also made up of a portion of fire service personnel who understandably wish to see a decrease in workload (number of requests for service). Operational capacity may exist to redeploy the system using current resources so that quick response is maintained to high-priority calls for service without additional cost.

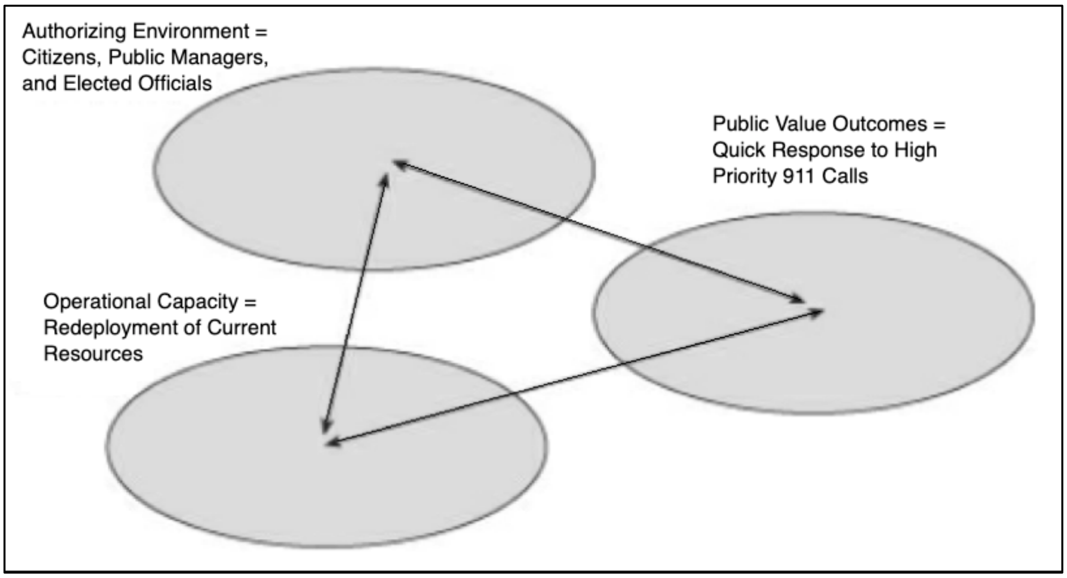

Figure 7. The public value strategic triangle illustrating the expanded implementation of the MPDS in Pinellas County. Adapted from *Public Value: Theory and Practice* (p. 6), by J. Benington and M. Moore, 2011, Palgrave Macmillan. Copyright 2011 by J. Benington and M. Moore. Adapted with permission.

Empirical Research

Pre-hospital emergency medical services can generally be categorized into two broad categories. The Franco-German model is grounded on the "stay and stabilize" philosophy while the Anglo-American model is based around a "swoop and scoop" doctrine (Al-Shaqsi, 2010). The Franco-German model is usually delivered in the field by emergency physicians who have the authority to make complex clinical decisions and treat patients in their homes or at the scene. Conversely, the Anglo-American model is usually allied with public safety services such as police or fire departments with the goal of rapidly bringing patients to the hospital with fewer pre-hospital interventions (Al-Shaqsi, 2010). The Anglo-American system is customarily operated by trained paramedics and emergency medical technicians (EMTs) with clinical oversight, generally provided by a physician (Al-Shaqsi, 2010). The Pinellas County EMS System most closely aligns with the Anglo-American model.

Attempts at Increasing Efficiency

Generally, EMS systems attempt to maximize patient survival rates while minimizing system costs and eliminating as much waste as possible. However, the way any particular system best accomplishes these objectives is often the topic of substantial debate, innovation, and experimentation. Many fire departments and emergency services systems around the country have developed new and inventive ways to increase efficiency and reduce cost.

Hanover County Fire and EMS in Virginia, for example, initiated a quick-response vehicle (QRV) pilot program in an attempt to decrease response times and increase patient outcomes. They replaced three of their ALS ambulances and fire engines with three sport-utility vehicles (SUVs). According to McLay and Moore (2012), the ambulances and fire engines require staffing of two and three people respectively. Conversely, the QRV's only require one paramedic (McLay & Moore, 2012). In a volunteer system such as theirs, this means that a first-response vehicle is staffed and equipped to respond faster and more often than when using ambulances and fire engines alone (McLay & Moore, 2012).

In an effort to decrease the number of 911 medical incidents, the City of San

Antonio has implemented a Mobile Integrated Healthcare (MIH) program. According to Fire Chief Charles Hood, fewer than 300 of the residents in San Antonio generate more than 4,000 calls for service each year (Baugh, 2014). The MIH program consists of fire department paramedics who carry out routine preventative welfare checks on chronically ill residents with the goal of reducing repeated 911 calls. The stated goal of San Antonio's MIH program is to reduce the repeat calls produced by these residents by 85% or more (Baugh, 2014).

Recently, as part of a strategic plan to better utilize facilities and resources, Volusia County, Florida launched an E-911 Redirect Nurse Triage program to reduce the number of resources sent to less-emergent 911 calls for service. According to lead EMS Triage Nurse Pam Cawood, "911 dispatchers now determine if a caller's situation is a true emergency. If the situation is deemed severe, the caller will never speak to a triage nurse and the dispatcher will immediately send emergency vehicles" (Looker, 2020, para. 4). However, if the situation is not severe, the caller will be transferred to the nurse triage line. Some non-severe cases could include rashes, flu-like symptoms, mild cuts or allergic reactions, and common cold symptoms (Looker, 2020).

In 2013, as a result of significant concern for the future long-term financial sustainability of the Pinellas County EMS System, the Pinellas County Emergency Medical Services Authority contracted with the consulting firm Fitch & Associates to conduct a review of two previously recommended EMS delivery proposals (Fitch and Associates, 2013). These proposals were analyzed in terms of operational performance and cost and were also compared to the current Pinellas County EMS System. Finally, the consultants were asked to design a plan with the goals of leveraging system efficiencies and ultimately providing for the long-term financial sustainability of the EMS system (Fitch and Associates, 2013).

The consulting firm found several problems with each of the two proposed plans and developed a new model called the Community-wide Alignment of Resources for Efficiency and Service (CARES) plan. This plan proposed to “streamline the current system, maintain performance, and reduce costs” (Fitch and Associates, 2013, p. 1). The CARES plan called for 19 fire department apparatuses to be removed from service for 10 hours each day. These apparatuses would become “peak load” units that would be available to respond to incidents during the day when the system experiences high demand. Overall, the CARES plan attempted to save money in the form of reducing vehicle maintenance and decreasing staff costs by removing apparatuses from service during times of the day with historically low call demand (Fitch and Associates, 2013).

The Pinellas County EMS System did not undergo any immediate systemwide changes as a result of the 2013 Fitch Report. Part of the reason was due to the majority of fire department staff in Pinellas County working a shift schedule that consists of 24 hours at work, followed by 48 hours off. The alteration of this schedule across 18 different fire departments was met with opposition by both fire department management staff and the various firefighter union organizations, and ultimately proved too challenging to implement at the time. Since then, Pinellas County has continuously looked for ways to reduce costs while maintaining the efficacy of its EMS system. Some of the difficulty lies with the lack of consensus among Pinellas County, the 18 fire departments, and the private ambulance company.

In the cities of St. Petersburg and Clearwater (FL), which are located within

Pinellas County, “peak units” were eventually placed in service during busy times of the week to alleviate the increase in call demand. According to Clearwater Fire Chief Scott Ehlers, this was the city of Clearwater’s attempt to relieve the pressure placed on the fire department by the increase in EMS incidents experienced each year (Varn, 2017). These units consisted of SUVs that carried all of the necessary medical equipment and were staffed by two paramedics working outside of their regularly scheduled shift on overtime (Varn, 2017). Ehlers suggested that these units were capable of responding to more than 12 to 15 incidents per shift, which allowed for other heavy-duty fire department vehicles (such as engines and ladder trucks) to remain available to respond to fire calls, vehicle accidents, or additional medical emergencies (Varn, 2017).

The peak units have had their own challenges, however. Peak units are usually only in service during regular business hours (peak times of the day). As aforementioned, firefighters in Pinellas County typically work 24 hours then have 48 hours off. Converting firefighter schedules to accommodate peak units can be challenging and could perhaps be part of the reason Clearwater’s peak units are no longer in operation.

Emergency Medical Dispatch

One of the most essential roles in any EMS system is that of the emergency medical dispatcher. Dispatchers can work for a variety of different agencies including law enforcement, public or private ambulance companies, or the fire department. Regardless of the system’s design, dispatchers are charged with speaking to the caller and ensuring the proper resources are sent expeditiously to the appropriate location. According to the International Academies of Emergency Dispatch (IAED), to become a certified emergency medical dispatcher a candidate must be CPR certified, complete an approved three-day emergency medical dispatcher course, and successfully pass a 50-question written exam with a score of at least 80% (n.d.).

In 2012, the leaders of first responder and transport agencies that serve the 200 most populated cities in the U.S. were surveyed. The results revealed that Emergency Medical Dispatch (EMD) was incorporated into many different types of organizations. The table below shows the presence of EMD within the various kinds of dispatch centers:

- Fire department systems: 35.1%
- Consolidated public safety dispatch centers: 29.7%
- Police departments: 13.5%
- Third-service providers: 12.2%
- Private ambulance companies: 8% (Ragone, 2012, para. 19).

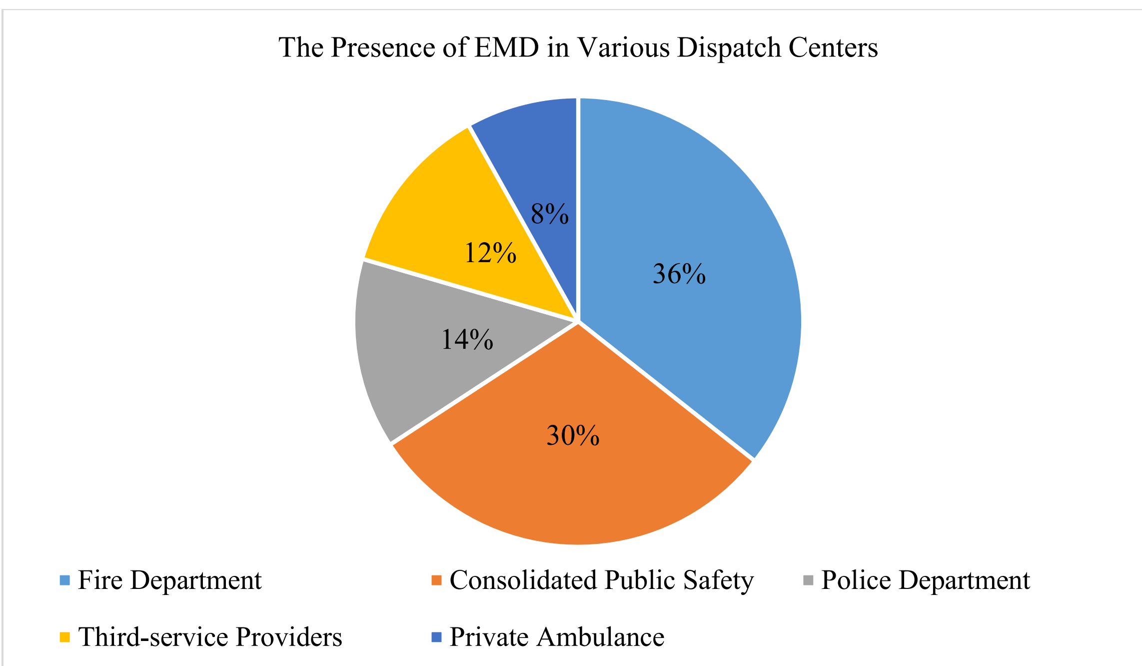

Figure 8. The Presence of Emergency Medical Dispatch among various dispatch centers. Information retrieved from Ragone, 2012, para. 19.

According to Ragone, the study also revealed that 5.2% of the dispatch centers require training in CPR and automated external defibrillators (AEDs), while 8.7% require an EMT or paramedic certification. In 31.5% of communications centers, an Association of Public-Safety Communications Officials (APCO) certification is necessary, and 54.4% require National Academies of Emergency Dispatch-level training (2012).

Emergency medical dispatch began in the 1970s in Phoenix, Arizona. By chance, a paramedic was visiting a local 911 dispatch center when a call was received involving a child who was not breathing. The paramedic gave impromptu instructions to the mother and the child recovered. This action led the then Phoenix Fire Chief Alan Brunacini to direct the dispatch center to routinely offer this service which was termed “medical self-help” (Zachariah, 1995). In 1977, Dr. Jeff Clawson began to develop procedures for use by dispatchers in Salt Lake City. The practice became known as Medical Priority Dispatching and, in 1978, it was implemented throughout the Salt Lake City Fire Department (Zachariah, 1995). The system included interrogation questions, pre-arrival instructions, and response determinants (whether lights and sirens were to be utilized).

In recent years, even some of the most unsuspecting agencies have waded into the emergency medical dispatch arena. For instance, OnStar is now acknowledged as a Medical Accredited Center of Excellence by the IAED, the first private company to receive the designation. According to Castillo (2013), OnStar employees are not only CPR certified, but are also IAED certified and receive ongoing OnStar emergency training so they can stay prepared for emergency situations. Like many traditional dispatch centers, OnStar’s First Assist emergency advisers utilize Medical Priority Dispatch System protocols.

System Design

Two fundamental variables in any EMS system are the design of its dispatch system and the protocols that the dispatchers follow. According to Andersen et al. (2013), emergency medical dispatch systems should aim to pair response resources with patient needs by assessing the urgency of the call to determine the priority level of the response. The different philosophies surrounding system design are often debated within the emergency services field. Furthermore, the differences between the innumerable types of dispatch and EMS systems are immense. Some agencies use closest-unit response, some use a tiered system, others utilize priority dispatch, and many use a combination.

Closest-unit response requires dispatchers to send the ambulance or fire truck that would arrive the quickest, regardless of whether the closest emergency vehicle is the most appropriate resource. This deployment model can be enacted using a Computer-Aided Dispatch (CAD) system to first measure the closest fire station or ambulance post to the address of the call and then dispatch the unit housed there. Unfortunately, fire trucks are frequently on the road returning from incidents or out training, and not in their respective station. These instances can cause the CAD system to occasionally send an apparatus that may not be the closest.

Conversely, some CAD systems do calculations based on the use of automatic vehicle location (AVL) systems which take into consideration the real-time Global Positioning System (GPS) location of the vehicle (Wallman, 2017). As part of a pilot program, in September of 2005, FDNY EMS apparatuses within Staten Island and Southern Brooklyn began being dispatched using AVL. The department witnessed a 33 second decrease in response times to the most serious medical emergencies ("New York City," 2006).

The Pinellas County Communications Center functions as the single primary public safety answering point (PSAP) for all 911 calls originating within Pinellas County. From there, calls can be shunted to the Pinellas County Sherriff's Office, Sunstar, or one of the many other local law enforcement agencies. Pinellas County currently uses a form of closest-unit response without AVL. The system assumes fixed deployment, that is, fire department apparatuses return to their fire station after completing a call for service (Bandara, Mayorga, & McLay, 2014).

Presently, the Pinellas County EMS System tends to err on the side of over triaging and defaults to sending more advanced life support apparatuses as opposed to basic life support apparatuses. Therefore, a fractured foot at a playground could receive the same fire department ALS unit and ALS ambulance response as someone who is choking or suffering from chest pain. This deployment method might become problematic in times of high demand when the EMS system becomes busy. Higher severity calls for service may potentially suffer longer response times because critical ALS resources become spread too thin, some of which could be committed to lower-priority incidents.

Another type of emergency medical system is the tiered response system. In many locations, tiered response refers to the existence of multiple types of medical units such as basic life support (BLS) and advanced life support (ALS) apparatuses (McLay & Moore, 2012). Instead of sending the closest available unit, the dispatcher sends the closest appropriate unit based on the severity of the call. The type of tiered system practiced in Pinellas County, however, consists of a combination of fire department ALS apparatuses and Sunstar ambulances. Both types of units are dispatched at the same time but, because of the distribution of fire department resources, the fire department is usually the first to arrive. After arrival, fire department EMTs and paramedics assess the situation, work to stabilize the patient, gather pertinent patient information, and then transfer the patient to Sunstar for transport to the hospital.

Priority Dispatch

Priority dispatch refers to a system that aims to correctly align providers with the severity of calls when available resources are limited (Sudtachat, 2014). While there are several commercial systems available, most have the same premise. The dispatcher uses a system of pre-determined questions to interrogate the caller and determine the severity of the medical emergency. If used correctly, this system can assist the dispatcher to determine if the situation warrants an emergency response from multiple ALS units, a non-emergency response from a single BLS unit, or anything in between. For example, a sprained ankle may warrant a non-emergency response from an individual BLS ambulance. While there may be an ALS fire department unit in a fire station nearby that could respond, this unit would stay available in the event a higher priority call for service occurs. However, there are concerns with this system as well. Over-triage of calls can lead to inappropriate use and the overload of EMS units, whereas under-triage may negatively affect patient survival rates (Hoikka, Länkimäki, Silfvast, & Ala-Kokko, 2016).

Benefits of priority dispatch systems can include improved provider skills, increased relative system capacity, improved system performance, and an overall cost savings (Clawson & Dernocoeur 2001; Nicholl, Coleman, Parry, Turner, & Dixon, 1999; Persse & Katarzyna, 2015). Additionally, utilizing priority dispatch can help to maximize the number of available ALS units and minimize the utilization of limited resources. According to Clawson and Dernocoeur (2001), after the Salt Lake City Fire Department adopted the priority dispatch system, EMS fire response decreased by 33% in the first year of full implementation. In this system, the private ambulance company was able to handle the majority of ALPHA determinant calls without any compromise to overall patient outcomes (Clawson & Dernocoeur, 2001).

Priority dispatch systems have the potential to achieve faster response times to life-threatening emergency calls by focusing critical resources where they are needed most, which ultimately benefits patients (Nicholl et al., 1999). Furthermore, according to Persse and Katarzyna (2015), under the priority dispatch system, ALS practitioners become more proficient at advanced skills because more of their time is spent practicing them on sick patients instead of responding to low-acuity calls for service. Clawson and Dernocoeur reiterate this by pointing out that priority dispatch has supplanted the conventional "more is better" concept. When a crew's training and staffing level corresponds to a particular situation, that crew can more efficiently handle the emergency (2001).

Emergency medical services personnel frequently encounter patients that do not require rapid transport to the emergency department. In 2017, emergency medical services systems in the United States transported more than 20 million adults and children to hospital emergency departments (National Center for Health Statistics, 2017). A study conducted in 2013 concluded that almost 35% of Medicare beneficiaries who were transported after a 911 EMS response but were not hospitalized, were deemed relatively low-acuity cases. This made them potential candidates for management at a location other than an emergency department (Alpert, Morganti, Margolis, Wasserman, & Kellermann, 2013). Annual payments for EMS and emergency department care for these patients have averaged approximately $1 billion per year, with one-third of this being paid to ambulance service providers (Alpert et al., 2013).

Priority dispatch systems have the potential to decrease the number of times unwarranted advanced life support resources are dispatched to 911 calls for service (Bailey, O'Connor, & Ross, 2000). Inappropriate emergency ALS responses to low-acuity calls for service not only consume limited and costly resources but also expose EMS providers and the general public to harm in the form of motor vehicle incidents (Hinchey, Myers, Zalkin, Lewis, & Garner, 2007). According to Hsiao, Chang, and Simeonov (2018), between 2004 and 2013, vehicle crashes resulted in 179 firefighter deaths in the United States. Similarly, between 1993 and 2010, ambulance collisions led to 97 EMS technicians being killed (Hsiao, et al., 2018). The potential for severe vehicle incidents is especially concerning in Pinellas County, which is not only a peninsula with limited ingress and egress but is also the most densely populated county in Florida.

Using the medical priority dispatch system, once the emergency medical dispatcher determines the level of severity using the answers to the caller interrogation questions, the proper dispatch determinant can be selected. As mentioned, priority dispatch uses different determinant levels depending on the gravity of the particular emergency. These determinant levels range from ALPHA (basic EMTs can handle anything within this category) to ECHO (patients are in imminent danger of death).

There is also an OMEGA level response that identifies situations that would be handled uniquely by each jurisdiction through non-traditional responses such as asymptomatic poisonings, toothache, cannot sleep, expected deaths, and animal bites (Clawson & Dernocoeur, 2001).

After the emergency medical dispatcher establishes the determinant level of the emergency, they establish the proper response level. The response level could refer to the type of response apparatus, the category of responders, or the responders' training or certification level. According to Clawson and Martin (1990), this usually means the difference between dispatching a BLS apparatus with EMTs or an ALS unit with paramedics. However, for incidents such as vehicle accidents, many agencies also choose to send additional fire apparatuses to perform vehicle extrication if needed or to abate any hazards that may be present such as fire or leaking fuel. Response levels are predetermined by the individual EMS agency, usually by the medical director, medical control board, or other stakeholders.

Finally, the emergency medical dispatcher determines the response mode. The response mode refers to the urgency of the response. Normally, this refers to an emergency (lights and sirens) or a nonemergency (routine) response (Clawson & Martin, 1990). Again, just as with the response level, the response modes are predetermined by the governing body of the individual EMS system. In the past, it was customary to respond emergency to nearly everything. Part of the underlying thought process was that if someone called 911, it must be an emergency (Clawson & Martin, 1990). Additionally, according to Clawson and Martin (1990), it was assumed best to always err on the side of caution and in the best interest of the patient. However, this thought process appears to be gradually changing.

According to Clawson and Martin (1990), “it is medically unsound and managerially unsafe to require a red-light-and-siren response to all incidents. This exposes crews to the additional hazards of a full emergency response, just to arrive one to two minutes earlier for a non-critical patient” (para. 18).

Additionally, there is increasing evidence suggesting that using emergency lights and sirens can worsen traffic conditions which can increase response times, cause motor vehicle crashes, and contribute little in terms of improving patient outcomes (Robbins, 2017). Clawson et al. reiterate this sentiment and state:

> Ideally, the use of lights and sirens should be reserved for those situations or circumstances in which response and transport times have been shown to improve a patient's chances for survival or quality of life. Examples of such situations include cardiac or respiratory arrest, airway obstruction, extreme dyspnea, critical trauma, childbirth and problems with pregnancy, drowning, and electrocution. (1994, p. 6)

In a New Jersey hospital-based EMS study, McDonald also determined that the use of emergency lights and sirens when transporting noncritical patients to a hospital emergency room is unnecessary (2013).

In many systems, there are protocols in place that allow emergency medical dispatchers to override the emergency medical dispatch system protocols and send a higher level of care. There has long been a belief that the information gathered from the reporting party, along with the call taker’s previous education and experience, may sometimes lead the dispatcher to conclude that the patient’s condition necessitates a faster or more advanced response than the priority dispatch system's structured coding logic has indicated (Clawson, Olola, Heward, Scott, & Patterson, 2007). However, a study completed in 2007 contradicts the belief that emergency medical dispatchers can intuitively distinguish when a patient or situation warrants more resources than the emergency medical dispatch system indicates. The study suggests that automated protocol-based call taking is more precise and reliable than the subjective determinations made by individual emergency medical dispatchers (Clawson et al., 2007).

Case Studies

Priority dispatch is capable of distinguishing the severity of the incident and matching it with the proper resources and response mode. In a 2008 prospective, experimental before-and-after study, Cone, Galante, and MacMillan (2008) determined that emergency medical dispatch protocols could safely reduce the number of fire department responses to non-priority 911 calls. According to Clawson and Dernocoeur (2001), after the Salt Lake City Fire Department adopted the priority dispatch system, EMS fire response decreased by 33% in the first year of full implementation. In that system, the private ambulance company was able to handle the majority of ALPHA determinant calls without any compromise to overall patient outcomes (Clawson & Dernocoeur, 2001).

In the late 1990s and early 2000s, the San Bernardino City Fire Department in California was experiencing an increase in EMS calls for service at an average of 7% annually (Fratus, 2008). At that point in time, the city operated very similarly to Pinellas County with fire department paramedics providing first response and a private ambulance company providing hospital transport. Fratus (2008) noted that the increase in demand for fire department resources contributed to an associated increase in apparatus commitment factor (ACF), call concurrency, and response times, as well as a corresponding decrease in zone reliability and overall service delivery.

Fratus (2008) found that the requests for service outpaced the department's available resources, even after adding additional fire stations and EMS assets. Fratus contended that the organization was at a crossroads, it could either continue to add resources or redeploy existing assets in a more effective manner (2008). In 2001, the San Bernardino City Fire Department decided to begin the implementation of the Medical Priority Dispatch System.

- ALPHA level calls would only elicit a BLS ambulance response with a response time goal of 20 minutes, 90% of the time.
- BRAVO determinant calls would receive an ALS ambulance in under 12 minutes, 90% of the time.
- CHARLIE, DELTA, and ECHO level calls would get an ALS fire department unit and an ALS ambulance with a response time goal of 8 minutes or less, 90% of the time (Fratus, 2008).

In 2007, the San Bernardino Fire Department dispatch center received over 22,000 calls requiring an EMS response (Fratus, 2008). Using the Medical Priority Dispatch System (MPDS), just over 2,000 of these calls for service were categorized as ALPHA and BRAVO determinant calls and only received an ambulance response (Fratus, 2008).

Fratus used the 90th percentile time on task duration of 33 minutes for the projected interval a San Bernardino Fire Department apparatus would have spent on each of the ALPHA and BRAVO determinant calls (2008). In doing so, Fratus determined that fire department ALS apparatuses gained an additional 10.2% of availability through the use of MPDS (2008). Additionally, Fratus calculated that, within a three-month timeframe in 2007, the utilization of MPDS resulted in 102 patients experiencing a response time that was 2.5 minutes faster than if MPDS had not been implemented (2008). This is because fire department units would have been occupied with lower priority medical incidents and these patients would have received resources from further away (Fratus, 2008).

Summary

This literature review examined Moore's public value theory and how Moore's public value strategic triangle theoretical model could be applied to the redeployment of resources within the Pinellas County EMS System. From an empirical standpoint, much has been written regarding EMS system deployment and design, emergency medical dispatch, and priority dispatch. The breadth of research, books, publications, and case studies composed thus far makes a compelling argument for how the expanded implementation of the medical priority dispatch system in Pinellas County, Florida could positively impact the system's relative response capacity and performance.

Chapter III

METHODOLOGY

Over the past several decades, international demand for emergency health services has increased considerably. Nawar, Niska, and Xu (2007) found that from 1997 to 2005, there was a 25% increase in all ambulance emergency department arrivals. The Pinellas County EMS System has also encountered a significant increase in calls for service, while the county itself has experienced an increase in population, tourism, homelessness, opioid-related 911 calls, as well as an aging baby boomer demographic.

According to Computer-Aided Dispatch (CAD) data obtained from the Pinellas County Radio and Technology Department, compared to calendar year 2009, there has been an increase of almost 45,000 calls for service yearly. The 201,986 incidents that occurred in calendar year 2018 were 30% higher than in 2009. The call growth experienced over the last decade has been relatively consistent at approximately 6%, per year. Meanwhile, the amount paid annually by Pinellas County to the 18 fire service agencies employed to provide ALS first response to Pinellas County citizens and visitors has increased by over 26% or $12 million (Pinellas County, 2019b).

The purpose of this retrospective quantitative dissertation was to determine the impact of expanding the implementation of MPDS within Pinellas County. The main purpose was to investigate how the independent variable (expanding the implementation of MPDS) influenced the dependent variables (apparatus commitment factor, CHARLIE, DELTA and ECHO call concurrency, as well as response times), and how this could impact the Pinellas County EMS System. The research design applied a systematic, empirical approach. It did not randomly assign subjects to conditions because the events being studied have already taken place.

Data for this project were extracted from the Pinellas County Computer-Aided Dispatch system with the assistance of the Pinellas County Department of Radio and Technology staff. Historical data, specifically the number and severity of 911 calls responded to (ALPHA through OMEGA) in calendar year 2018, were researched. Fire department response was then removed from the ALPHA, BRAVO, and OMEGA determinant calls. Completing this analysis determined what the overall impact of the expanded implementation of MPDS would have been on the performance of and first-response relative capacity in the Pinellas County EMS System in 2018. Calendar year 2018 data were used as it was the most current complete year of data available when this research commenced.

This research protocol was exempt from Valdosta State University Institutional Review Board (IRB) review because it only involved the collection and study of existing data, documents, and records, which are publicly available and through which subjects cannot be identified, directly or through identifiers linked to the subjects. The IRB exemption is attached (Appendix B).

Research Design

The first step of data collection in this retrospective quantitative study included contacting the Director of Radio and Technology at Pinellas County Safety and Emergency Services to collect countywide emergency incident data. The data set for this study consisted of reports containing all emergency incidents occurring in calendar year

2018 within Pinellas County which elicited a fire department response. Pinellas County provides several reports including a Concurrency, DSTATS, and TSTATS report. The Dispatch Statistics (DSTATS) Report contains data that are separated by each individual incident. The Truck Statistics (TSTATS) Report contains data that are separated by each individual apparatus. The Concurrency Report contains information on when two or more incidents occurred at the same time within the same response zone. These reports were all utilized as they each contain unique and useful data regarding the emergency incidents that occurred in Pinellas County in calendar year 2018.

Operationalization of Variables

Priority Code (ALPHA through OMEGA):

The data sets contain a column titled "EMD," which has the emergency medical dispatch (EMD) response determinant integrated. In order to simulate the expanded implementation of MPDS, part of this research included manipulating the data sets so that they include all but the ALPHA, BRAVO, and OMEGA determinant codes.

Response Time:

For the purposes of this study, response time is defined as the time interval that begins with the notification of emergency response personnel by either an audible alarm or visual annunciation (or both) and ends when personnel indicate their arrival at the location of the incident.

Apparatus Commitment Factor (ACF):

For the purposes of this study, ACF is defined as the percentage of time emergency response apparatuses (fire engines, rescue trucks, etc.) are assigned to or involved in a call for service or incident. This percentage can be arrived at by dividing the total amount of time an apparatus is committed to an incident in a year by the total amount of time in a year.

Call Concurrency:

For the purposes of this study, call concurrency is defined as the percentage of incidents in the total number of incidents within each EMS zone when the primary response apparatus was dedicated to an incident and another incident occurred within that same zone, eliciting a response from an apparatus outside of the primary EMS response zone. This analysis will focus primarily on call concurrency relating to the higher priority CHARLIE, DELTA, and ECHO medical incidents. Apparatuses that are not available for any reason other than being dedicated to another incident (training, mechanical service, public education, etc.) will not be included.

Research Procedures

Emergency medical dispatch (EMD) determinants ALPHA through OMEGA were isolated from the alphanumeric EMD string contained in the Pinellas County Department of Radio and Technology DSTATS report. The data were explored for normality several ways in order to guide the selection of a parametric test versus a non-parametric equivalent. A visual inspection of the histograms of all treated and finalized data revealed the distributions each have a single peak and appear roughly symmetric. In addition, all data were statistically measured for normality of distribution using Skewness and Kurtosis. A Skewness or Kurtosis value less than -2 or greater than +2 is considered a substantial departure from normality (IBM Corporation, 2012; Kim, 2013).

Comparisons between 2018 observed data and 2018 hypothetical data were made using paired sample t-tests. According to Burnham:

> paired-samples (correlated-samples or dependent-samples) is used when you have one sample of subjects who are tested several times, but under different conditions, that is, under different levels of an independent variable. Each subject is measured on the same dependent variable, but under different levels of an independent variable and you compare performance of the subjects between the different levels of this independent variable . . . (2015, p. 1)

Tests were two-sided, and p-values < 0.05 were considered statistically significant. Frequencies and percentages are reported for categorical variables. Normally distributed continuous variables are expressed as mean and standard deviation, with 95% confidence intervals reported for the mean.

The aforementioned detailed data analysis was used to answer the following research questions and hypotheses:

1. Would the expanded implementation of the Medical Priority Dispatch System in the Pinellas County EMS System in 2018 have increased the system's relative response capacity?
    - H^1: Removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will reduce per apparatus commitment factors.
    - H^0: Removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will not reduce per apparatus commitment factors.
    - H^2: Removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will reduce per EMS zone call concurrency.
    - H^0: Removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will not reduce per EMS zone call concurrency.

2. Would the expanded implementation of the Medical Priority Dispatch System in the Pinellas County EMS System in 2018 have improved the system's performance?
    - H^3: The per EMS zone response times for concurrent CHARLIE, DELTA, and ECHO (C-D-E) medical incidents are longer than response times for non-concurrent C-D-E medical incidents.
    - H^0: The per EMS zone response times for concurrent CHARLIE, DELTA, and ECHO (C-D-E) medical incidents are not longer than response times for non-concurrent C-D-E medical incidents.

Apparatus Commitment Factor (ACF):

Comparison of per apparatus commitment factors (baseline for overall incidents followed by all except ALPHA, BRAVO, and OMEGA medical incidents).

1. Using the "Involved" time column in the Pinellas County Department of Radio and Technology truck statistics (TSTATS) report, the Excel SUMIF function was utilized to total the amount of time an apparatus was committed to an incident in calendar year 2018. This number was used to calculate the ACF by using the formula = (hours committed per year * 86,400) / 31,557,600 or (hours committed per year * seconds in a day) / seconds in a year.
2. The ACF was first calculated using all priority codes. Afterward, a per apparatus ACF was calculated using the manipulated data set (which had all but the ALPHA, BRAVO, and OMEGA medical codes).

Call Concurrency:

Comparison of per EMS zone call concurrency for CHARLIE, DELTA, and

ECHO (C-D-E) incidents (baseline with all incidents included, followed by all except ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents).

1. The Pinellas County Department of Radio and Technology "Concurrency Report" was used to identify concurrent CHARLIE, DELTA, and ECHO medical incidents within each EMS response zone for calendar year 2018. That is, when a response apparatus was dedicated to an incident and a CHARLIE, DELTA, or ECHO medical incident occurred within that same zone, prompting a response from an apparatus outside of the primary EMS response zone.
   a. Utilizing the DSTATS report, the Excel COUNTIF function was used to identify the number of CHARLIE, DELTA, and ECHO incidents per response zone in the "EMS Area" column. Then, utilizing the Concurrency Report, the call concurrency percentage was calculated for CHARLIE, DELTA, and ECHO medical incidents for each EMS response zone by dividing the number of concurrent C-D-E medical incidents for that zone by the total overall number of C-D-E medical incidents for that EMS zone. This represents the call concurrency percentage for all CHARLIE, DELTA, and ECHO medical incidents within each response zone.
2. Afterward, call concurrency for each EMS response zone was calculated using all but the ALPHA, BRAVO, and OMEGA medical codes.
   a. That is, all ALPHA, BRAVO, and OMEGA medical codes were removed from the Concurrency Report. Then, the Excel COUNTIF function was used to identify the number of concurrent CHARLIE, DELTA, and ECHO

medical incidents in the Concurrency Report. The concurrency percentage was calculated for each response zone by dividing the number of concurrent C-D-E medical incidents for that zone by the overall number of CHARLIE, DELTA, and ECHO medical incidents for that response zone. This represents the CHARLIE, DELTA, and ECHO call concurrency for each response zone with the ALPHA, BRAVO, and OMEGA determinant incidents removed.

Response Time:

Comparison of per EMS zone response times to all CHARLIE, DELTA, and ECHO (C-D-E) medical incidents. First, all concurrent C-D-E medical incidents where the primary response apparatus was involved in an A-B-Ω medical incident and a more severe C-D-E medical incident occurred within the same response zone. Then, all non-concurrent CHARLIE, DELTA, and ECHO medical incidents.

Obvious outliers in response time were removed. In addition, a 5% trimmed mean was utilized for each response time analysis. As mentioned by the National Institute of Standards and Technology, "The mean can be heavily influenced by extreme values in the tails of a variable. The trimmed mean compensates for this by dropping a certain percentage of values on the tails" (2016, para. 4).

1. First, all of the non-medical incidents were removed from the DSTATS report. Then, the response times were sorted and then averaged by EMS response zone using the Excel AVERAGEIF function to report the calendar year 2018 average zone-specific medical incident response times.

2. Using the Pinellas County Department of Radio and Technology's Concurrency Report, concurrent CHARLIE, DELTA, and ECHO medical incidents were identified. Specifically, incidents where the primary response apparatus was involved in an ALPHA, BRAVO, or OMEGA medical incident and a more severe CHARLIE, DELTA, or ECHO medical incident occurred within the same response zone, eliciting a response from an apparatus from a different response zone. The zone-specific average response time for the "Responded" apparatus was used. These response times were sorted and then averaged by EMS response zone using the Excel AVERAGEIF function to report the calendar year 2018 average zone-specific response times for concurrent CHARLIE, DELTA, and ECHO medical incidents.
3. Afterward, all but the non-concurrent CHARLIE, DELTA, and ECHO medical incidents were removed from the DSTATS report. This was done by matching the incident numbers of the concurrent CHARLIE, DELTA, and ECHO incidents from the Concurrency Report. The response times were sorted and then averaged by EMS response zone using the Excel AVERAGEIF function to report the calendar year 2018 average zone-specific response times for non-concurrent CHARLIE, DELTA, and ECHO medical incidents.

Summary

This chapter has provided a review of the research design, operational definitions of the variables, and the research hypotheses to be tested. Additionally, this chapter detailed a comprehensive description of the data collection methods as well as the inferential statistical procedures used in the data analysis within this retrospective quantitative study to reach conclusions about associations between the dependent and independent variables.

Chapter IV

FINDINGS

As stated, the data set used for the research was obtained from the Pinellas County Radio and Technology Department and included every incident that occurred in calendar year 2018 that elicited a fire department response. The initial data set included 201,986 unique incidents.

The Pinellas County Department of Radio and Technology's Dispatch Statistics (DSTATS) report contains columns titled "Area Chief" and "EMS Area." According to Pinellas County Radio and Technology Department's Lead Programmer/Analyst, these columns indicate which fire station is first-due, depending on the nature of the incident (G. Tyburski, personal communication, January 22, 2020). Table 1 below depicts calendar year 2018 incident counts by dispatch code, delineated by nature. According to Tyburski, if the incident was medical in nature, the "EMS Area" column is referenced to determine the first-due station. However, if the incident is fire-related, the "Area Chief" column is referenced to determine which station was first-due (personal communication, January 22, 2020).

Table 1

Calendar Year 2018 Incident Counts by Dispatch Code, Delineated by Nature

Code	Fire Code Description	Count	Code	EMS Code Description	Count
4	Structure Response	1	7	Water Rescue	1
12	Single Engine	1	77	Motor Vehicle Collision	1
DU	Fire Unit Incident	1	MC1	Mass Casualty	1
TR	Tree Fire	1	WE	Water Extrication Upgrade	2
10	Brush Fire	2	R54	Rescue (Technical/Confined)	5
PA	Public Assist Call Dispatch	2	SA	SWAT Alert	6
TD	Training Drill	2	ST	STAR 1 Swat Call	7
A3	Alert Three	3	1	Medical	9
6	Hazardous Materials	5	R58	Extrication (Vehicle)	10
2	Single Engine	8	R62	Rescue (High Angle/Below)	10
A2	Alert Two	18	11	Technical Rescue	15
TS	Support Incident (Truck)	21	SW	SWAT Callout	33
BI	Brush Fire Incident	22	RIS	Rescue Incident Special	53
HOT	Hot Pit Refuel	23	3	Auto Crash	67
H	Code H	55	BA	Bridge Alert	71
HI	Hazmat Invest	68	8	Air Transport Incident	81
SE	Special Event	82	9	Extrication	111
LZ	Hospital Landing Zone	125	E77	MVC Possible Extrication	333
DS	Support Incident (DC)	415	M72	Water Rescue Response	355
F69	Unconfirmed Structure Fire	504	MES	Medical Incident Special	507
MI	Major Incident Response	609	MS	Support Incident (Medical)	1,220
FS	Support Incident (Fire)	877	ME9	Cardiac Arrest Response	1,559
M	Moveup - Coverage	1,170	TA	Trauma Alert	1,571
S	Special Event, Alarm Test	1,576	RI	Rescue Incident Response	12,783
FIS	Fire Incid. Resp. Special	1,609	ME	Medical Incident Response	161,717
M69	Structure Fire Response	1,922			
FI	Fire Incident Response	4,309			
F52	Fire Alarm	8,026			

Note: Calendar Year 2018 Totals (180,528 Medical and 21,457 Fire)

In addition to nature, the incidents were categorized and segregated by priority dispatch code. The following table contains a listing of the dispatch codes that occurred in Pinellas County in calendar year 2018. According to Clawson and Dernocoeur (2001), codes 1 through 37 are considered emergency medical services codes, while codes 51 through 83 are considered fire codes.

Out of the 201,986 total fire and EMS incidents that occurred in 2018, 22.4% or 45,246 did not contain any priority dispatch code (Table 2). Dispatch codes can be missing for several reasons including the 911 caller not being with the patient or if the request for EMS response is transferred from another agency, such as a local law enforcement dispatch center or medical alarm provider. The number of missing priority dispatch codes is significant as it potentially conceals the full impact of the expanded implementation of MPDS in Pinellas County, should priority dispatch codes become available for all incidents.

Table 2

Incident Counts by Priority Dispatch Code

Code & Description	Count	% of Total	Code & Description	Count	% of Total
1-Abdominal Pain	4,377	2.2%	31-Unconscious Person	13,292	6.6%
2-Allergic Reactions	1,103	0.5%	32-Unknown Problem	7,254	3.6%
3-Animal Bite	250	0.1%	34-Traffic Incident	3	0.0%
4-Assault	1,755	0.9%	51-Aircraft Emergency	1	0.0%
5-Back Pain	1,666	0.8%	52-Fire Alarm	7,944	3.9%
6-Breathing Problems	14,025	6.9%	53-Service Call	1,716	0.8%
7-Burns	91	0.0%	54-Confined Space/Collapse	71	0.0%
8-Inhalation Problems	57	0.0%	55-Electrical Hazard	590	0.3%
9-Cardiac Arrest	2,757	1.4%	56-Elevator Rescue	1,150	0.6%
10-Chest Pains	11,465	5.7%	57-Explosion	28	0.0%
11-Choking	673	0.3%	58-Extrication/Entrapment	16	0.0%
12-Seizures	5,312	2.6%	59-Fuel Spill	170	0.1%
13-Diabetic Problems	2,716	1.3%	60-Gas leak/Odor	469	0.2%
14-Drowning	63	0.0%	61-Hazmat	98	0.0%
15-Electrocution	34	0.0%	62-High Angle Rescue	7	0.0%
16-Eye Problems	142	0.1%	63-Lightning Strike Invest	24	0.0%
17-Falls	24,323	12.0%	64-Marine Fire	14	0.0%
18-Headache	939	0.5%	65-Mutual Aid	1	0.0%
19-Heart Problems	2,492	1.2%	66-Odor Investigation	38	0.0%
20-Exposure Problems	379	0.2%	67-Outside Fire	2,087	1.0%
21-Hemorrhage	4,619	2.3%	68-Smoke Investigation	260	0.1%
22-Inaccessible Incident	6	0.0%	69-Structure Fire	1,982	1.0%
23-Overdose/Poisoning	2,456	1.2%	71-Vehicle Fire	421	0.2%
24-Pregnancy Problems	579	0.3%	72-Water/Ice/Mud Rescue	252	0.1%
25-Psychiatric Problems	903	0.4%	73-Watercraft in Distress	47	0.0%
26-Sick Person	20,662	10.2%	74-Suspicious Package	3	0.0%
27-Stab/Gunshot	123	0.1%	76-Bomb Threat	2	0.0%
28-Stroke	3,751	1.9%	77-Motor Vehicle Collision	4,390	2.2%
29-Traffic Incident	4,273	2.1%	No EMD Code Available	45,246	22.4%
30-Traumatic Injuries	2,419	1.2%			

Note: Calendar Year 2018 Total Count = 201,986

The emergency medical services incidents that contained priority dispatch codes were further separated by dispatch determinant (Table 3). Clawson and Dernocoeur provide an explanation of dispatch determinants:

> That is, the C-D-E-B-A-Ω levels are not related in a linear sense of becoming progressively worse. Rather, they have to do with how many responders will go and (when there are tiers of capability), which levels of expertise are needed, and how rapidly they are needed. (2001, p. 3.25)

OMEGA determinant protocols are made up of codes that require a special response or referral. In Pinellas County, these codes include low-priority situations such as expected death, hiccups, or being unable to sleep or urinate.

Table 3

Medical Incident Counts by Priority Dispatch Codes, Delineated by Priority

Priority Code	Alpha	Bravo	Charlie	Delta	Echo	Omega
1 - Abdominal Pain	1,935	0	2,074	368	0	0
2 - Allergic Reactions	309	58	369	343	24	0
3 - Animal Bite	112	125	0	13	0	0
4 - Assault	168	1,329	0	258	0	0
5 - Back Pain	1,108	0	460	98	0	0
6 - Breathing Problems	0	0	2,814	8,391	2,820	0
7 - Burns	48	5	32	6	0	0
8 - Inhalation Problems	0	13	13	31	0	0
9 - Cardiac Arrest	0	496	0	361	1,851	49
10 - Chest Pains	257	0	3,418	7,790	0	0
11 - Choking	229	0	0	370	74	0
12 - Seizures	1,098	438	1,317	2,459	0	0
13 - Diabetic Problems	573	0	1,879	264	0	0
14 - Drowning	9	3	11	29	11	0
15 - Electrocution	0	0	11	23	0	0
16 - Eye Problems	112	25	0	5	0	0
17 - Falls	10,904	10,220	0	3,199	0	0
18 - Headache	264	18	657	0	0	0
19 - Heart Problems	84	0	1,194	1,214	0	0
20 - Exposure Problems	141	121	14	103	0	0
21 - Hemorrhage	680	1,683	118	2,138	0	0
22 - Inaccessible Incident	1	4	0	1	0	0
23 - Overdose/Poisoning	0	223	1,552	573	0	108
24 - Pregnancy Problems	17	82	159	310	0	11
25 - Psychiatric Problems	219	343	0	341	0	0
26 - Sick Person	9,166	521	6,400	3,991	0	584
27 - Stab/Gunshot Trauma	1	46	0	76	0	0
28 - Stroke	1	1	3,749	0	0	0
29 - Traffic/Transportation Incident	143	2,854	0	1,253	0	23
30 - Traumatic Injuries	1,181	938	0	300	0	0
31 - Unconscious Person	1,820	0	3,563	7,775	134	0
32 - Unknown Problem/Man Down	0	4,743	0	2,511	0	0
34 - Traffic Incident	0	3	0	0	0	0
Medical Incidents Per EMD Code	30,580	24,292	29,804	44,594	4,914	775
Percent of Total (134,959)	22.7%	18.0%	22.1%	33.0%	3.6%	0.6%

Data Analysis

The data were explored and measured for normality in order to guide the selection of a parametric test versus a non-parametric equivalent. A visual inspection of the histograms of all treated and finalized data revealed that the distributions each have a single peak and appear roughly symmetric. In addition, all data were measured statistically for normality of distribution using Skewness and Kurtosis. An absolute value of > 2 for Skewness or Kurtosis is considered a substantial departure from normality (IBM Corporation, 2012; Kim, 2013). The absolute value for Skewness and Kurtosis for each of the data sets analyzed for this research was < 1.

Comparisons between 2018 observed data and 2018 hypothetical data were made using paired sample t-tests which, according to Burnham (2015), are used when one sample of subjects are tested several times, but under different conditions. Tests were two-sided, and p-values < 0.05 were considered statistically significant. Frequencies and percentages are reported for categorical variables. Normally distributed continuous variables are expressed as mean and standard deviation, with 95% confidence intervals reported for the mean.

Apparatus Commitment Factor (ACF)

The unit of analysis used in this data set was "per apparatus." Any incidents that were clear outliers were removed, including several incidents with aberrant "involved" times of greater than 23 hours. Apparatuses that do not usually respond to EMS incidents as part of their primary function were removed, including brush trucks, marine units, dive units, district chiefs and supervisory personnel, basic life support (BLS) apparatuses, etc.

Additionally, apparatuses that were not in service for the majority of the year were also removed as ACF is calculated by assuming the apparatus is in service for the entire year.

Using the Pinellas County Department of Radio and Technology's Truck Statistics (TSTATS) Report and the Excel SUMIF function, the total amount of time an apparatus was committed to any incident (involved time) in calendar year 2018 was determined for each advanced life support (ALS) apparatus responsible for responding to EMS calls for service (N = 94). This number was used to calculate the ACF by using the formula = (hours committed per year * 86,400) / 31,557,600 or (hours committed per year * seconds in a day) / seconds in a year. The ACF was first calculated using all priority codes. Afterward, a per apparatus commitment factor was calculated using the manipulated data set, which contained all but the ALPHA, BRAVO, and OMEGA medical codes.

A paired sample t-test was used to compare the two population means (Appendix C). For 2018, the average apparatus commitment factor including all incidents and priority codes was significantly higher (M = 11.5%, SD = 5.4%) than the ACF using the manipulated data set, which conatined all but the ALPHA, BRAVO, and OMEGA medical incidents (M = 8.8%, SD = 3.8%), $t(93) = 16.5$, $p < .001$, r = .99, 95% CI [2.4%, 3.0%]. That is, the difference between the 2018 average ACF including all determinants and the average ACF with the A-B-Ω determinant medical incidents removed was -2.76%.

Therefore, hypothesis one (H^1), "removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will reduce per apparatus commitment factors," is accepted. The null hypothesis (H^0), "removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will not reduce per apparatus commitment factors," is rejected.

As mentioned, a one percent decrease in ACF is equal to a 14 minute 24 second increase in an apparatus' daily availability. Therefore, on average, apparatuses gained 39 minutes and 44 seconds of availability each day. As depicted in Table 4 below, out of the 94 advanced life support (ALS) apparatuses studied, the smallest change in ACF was -0.20% (2 min, 51 s) and the largest change was -6.64% (1 hr, 35 min, 40 s).

As discussed, out of the 201,986 incidents that occurred in 2018, 22.4% or 45,246 did not contain priority dispatch codes. The number of missing priority dispatch codes is significant as it obscures the full number of A-B-Ω determinant medical incidents as well as the potential impact of the expanded implementation of MPDS Pinellas County on apparatus commitment factor, if these priority dispatch codes were available for all incidents.

Table 4

2018 Apparatus Commitment Factor (ACF)

Apparatus	ACF All Incidents	ACF Non A-B-Ω	Difference	Apparatus	ACF All Incidents	ACF Non A-B-Ω	Difference
A	1.6%	1.4%	0.2%	AV	10.9%	8.7%	2.2%
B	3.3%	2.9%	0.3%	AW	11.8%	9.6%	2.3%
C	2.6%	2.2%	0.4%	AX	9.1%	6.8%	2.3%
D	4.1%	3.3%	0.7%	AY	10.7%	8.4%	2.3%
E	2.8%	2.0%	0.8%	AZ	8.6%	6.1%	2.4%
F	3.6%	2.8%	0.9%	BA	13.9%	11.5%	2.5%
G	6.9%	6.0%	1.0%	BB	10.3%	7.6%	2.6%
H	6.3%	5.3%	1.0%	BC	12.9%	9.9%	3.0%
I	8.7%	7.7%	1.0%	BD	12.3%	9.3%	3.0%
J	4.5%	3.5%	1.0%	BE	13.3%	10.3%	3.0%
K	3.7%	2.6%	1.1%	BF	11.2%	8.1%	3.0%
L	7.3%	6.2%	1.1%	BG	12.0%	9.0%	3.0%
M	7.6%	6.5%	1.2%	BH	12.7%	9.5%	3.3%
N	4.5%	3.3%	1.2%	BI	12.6%	9.3%	3.3%
O	5.0%	3.8%	1.2%	BJ	12.8%	9.4%	3.4%
P	6.2%	5.0%	1.3%	BK	17.9%	14.5%	3.4%
Q	8.9%	7.6%	1.3%	BL	14.2%	10.7%	3.5%
R	8.2%	6.9%	1.3%	BM	13.5%	9.9%	3.6%
S	8.5%	7.2%	1.3%	BN	14.1%	10.5%	3.6%
T	5.7%	4.3%	1.4%	BO	14.1%	10.4%	3.6%
U	8.8%	7.4%	1.4%	BP	14.4%	10.7%	3.7%
V	5.9%	4.5%	1.5%	BQ	15.3%	11.6%	3.7%
W	8.0%	6.5%	1.5%	BR	16.3%	12.5%	3.8%
X	11.8%	10.3%	1.5%	BS	18.3%	14.4%	3.9%
Y	7.1%	5.5%	1.5%	BT	16.3%	12.4%	3.9%
Z	10.4%	8.9%	1.6%	BU	17.6%	13.6%	4.0%
AA	7.6%	6.0%	1.6%	BV	17.2%	13.2%	4.0%
AB	5.9%	4.3%	1.6%	BW	16.2%	12.0%	4.2%
AC	8.0%	6.4%	1.6%	BX	17.7%	13.3%	4.5%
AD	6.9%	5.3%	1.6%	BY	14.7%	10.1%	4.5%

Table 4

2018 Apparatus Commitment Factor (ACF)

Apparatus	ACF All Incidents	ACF Non A-B-Ω	Difference	Apparatus	ACF All Incidents	ACF Non A-B-Ω	Difference
AE	9.3%	7.7%	1.7%	BZ	18.2%	13.7%	4.5%
AF	9.0%	7.3%	1.7%	CA	20.1%	15.4%	4.6%
AG	5.9%	4.2%	1.7%	CB	16.5%	11.9%	4.7%
AH	8.9%	7.1%	1.7%	CC	18.1%	13.4%	4.7%
AI	7.5%	5.7%	1.7%	CD	14.7%	9.9%	4.8%
AJ	8.6%	6.9%	1.8%	CE	17.7%	12.8%	4.9%
AK	11.3%	9.5%	1.8%	CF	18.5%	13.3%	5.2%
AL	10.8%	9.0%	1.8%	CG	18.9%	13.7%	5.2%
AM	6.7%	4.8%	1.9%	CH	19.5%	14.2%	5.3%
AN	7.4%	5.4%	1.9%	CI	20.3%	15.0%	5.3%
AO	8.4%	6.4%	2.0%	CJ	20.2%	14.8%	5.4%
AP	9.2%	7.2%	2.1%	CK	22.5%	16.6%	6.0%
AQ	8.5%	6.4%	2.1%	CL	22.5%	16.4%	6.1%
AR	7.9%	5.9%	2.1%	CM	20.1%	13.9%	6.1%
AS	7.6%	5.6%	2.1%	CN	23.2%	16.9%	6.3%
AT	10.0%	8.0%	2.1%	CO	21.7%	15.4%	6.4%
AU	11.4%	9.3%	2.1%	CP	22.5%	15.8%	6.6%
				Mean =	11.5%	8.8%	2.76%

Note: Apparatus column labels are strictly for notation purposes and do not correlate to any specific apparatus or information in any other table.

Concurrent CHARLIE, DELTA, and ECHO Incidents

Out of the 201,986 total fire and EMS incidents that occurred in 2018 within Pinellas County, 79,182 were determined to be medical in nature and also possess a CHARLIE, DELTA, or ECHO determinant. The Department of Radio and Technology's Concurrency Report indicated 5,847 or 7.3% of these incidents were concurrent (Table 5). That is, a response apparatus was dedicated to any 911 incident and a CHARLIE, DELTA, or ECHO medical incident occurred within that same zone, triggering a response from an apparatus outside of the primary EMS response zone.

The concurrency data utilized did not include instances when a concurrent incident was mitigated by apparatuses stationed within the same response zone as designed. An example of this is when Rescue 1 (which is normally deployed from Fire Station 1) responds to a medical call and a second call for service takes place in Station 1's response zone. If the second incident is mitigated by Rescue 5, there should not be a meaningful difference in response time as Rescue 5 is also typically deployed from Fire Station 1.

The Concurrency Report was then sorted by the dispatch determinant (C-D-E-B-A-Ω) of the primary incidents that occurred in each response zone, that is, the incident that occurred first, which caused the second (C-D-E) incident to become concurrent. The 1,588 primary incidents that had an ALPHA, BRAVO, or OMEGA determinant level were removed from the Concurrency Report. There were 4,259 concurrent CHARLIE, DELTA, or ECHO determinant medical incidents that remained. As stated, these remaining incidents were deemed to be concurrent due to a previously occurring non-ALPHA, BRAVO, or OMEGA determinant incident that occurred within the same zone.

Out of the 4,259 concurrent CHARLIE, DELTA, and ECHO determinant medical incidents that remained, 26.5% or 1,130 did not contain priority dispatch codes for the primary or first-occurring incident. The number of missing priority dispatch codes is significant as it masks the full potential impact of the expanded implementation of MPDS Pinellas County on C-D-E concurrency, should priority dispatch codes become available for all incidents.

Table 5

CHARLIE, DELTA, ECHO (C-D-E) Concurrency Per Response Zone

Response Zone	Medical C-D-E	Concurrent C-D-E	Concurrent C-D-E %	Concurrent: A-B-Ω Removed	Concurrent: A-B-Ω Removed %	Difference
A	411	10	2.4%	9	2.2%	0.2%
B	240	6	2.5%	5	2.1%	0.4%
C	356	17	4.8%	15	4.2%	0.6%
D	508	38	7.5%	35	6.9%	0.6%
E	793	26	3.3%	21	2.6%	0.6%
F	359	13	3.6%	10	2.8%	0.8%
G	1,074	40	3.7%	31	2.9%	0.8%
H	238	4	1.7%	2	0.8%	0.8%
I	4,044	144	3.6%	110	2.7%	0.8%
J	562	29	5.2%	24	4.3%	0.9%
K	1,881	85	4.5%	67	3.6%	1.0%
L	887	38	4.3%	29	3.3%	1.0%
M	379	18	4.7%	14	3.7%	1.1%
N	267	11	4.1%	8	3.0%	1.1%
O	1,905	100	5.2%	77	4.0%	1.2%
P	2,100	122	5.8%	96	4.6%	1.2%
Q	322	13	4.0%	9	2.8%	1.2%
R	461	23	5.0%	17	3.7%	1.3%
S	2,002	121	6.0%	94	4.7%	1.3%
T	2,462	111	4.5%	77	3.1%	1.4%
U	1,566	112	7.2%	90	5.7%	1.4%
V	564	24	4.3%	16	2.8%	1.4%
W	419	17	4.1%	11	2.6%	1.4%
X	2,216	103	4.6%	71	3.2%	1.4%
Y	200	8	4.0%	5	2.5%	1.5%
Z	1,705	90	5.3%	64	3.8%	1.5%
AA	2,536	157	6.2%	118	4.7%	1.5%
AB	3,162	230	7.3%	179	5.7%	1.6%
AC	310	11	3.5%	6	1.9%	1.6%
AD	2,229	179	8.0%	143	6.4%	1.6%
AE	2,098	121	5.8%	85	4.1%	1.7%
AF	614	42	6.8%	31	5.0%	1.8%
AG	555	34	6.1%	24	4.3%	1.8%

Table 5

CHARLIE, DELTA, ECHO (C-D-E) Concurrency Per Response Zone

Response Zone	Medical C-D-E	Concurrent C-D-E	Concurrent C-D-E %	Concurrent: A-B-Ω Removed	Concurrent: A-B-Ω Removed %	Difference
AH	1,886	119	6.3%	85	4.5%	1.8%
AI	721	42	5.8%	29	4.0%	1.8%
AJ	1,627	154	9.5%	122	7.5%	2.0%
AK	556	44	7.9%	33	5.9%	2.0%
AL	751	59	7.9%	44	5.9%	2.0%
AM	1,428	131	9.2%	102	7.1%	2.0%
AN	2,229	133	6.0%	87	3.9%	2.1%
AO	288	12	4.2%	6	2.1%	2.1%
AP	1,643	153	9.3%	116	7.1%	2.3%
AQ	591	44	7.4%	30	5.1%	2.4%
AR	2,544	206	8.1%	145	5.7%	2.4%
AS	1,444	126	8.7%	91	6.3%	2.4%
AT	1,932	119	6.2%	71	3.7%	2.5%
AU	2,417	248	10.3%	187	7.7%	2.5%
AV	776	69	8.9%	49	6.3%	2.6%
AW	1,524	162	10.6%	122	8.0%	2.6%
AX	2,167	201	9.3%	143	6.6%	2.7%
AY	2,620	238	9.1%	165	6.3%	2.8%
AZ	643	68	10.6%	50	7.8%	2.8%
BA	979	99	10.1%	70	7.2%	3.0%
BB	1,126	108	9.6%	73	6.5%	3.1%
BC	1,179	154	13.1%	117	9.9%	3.1%
BD	1,244	142	11.4%	101	8.1%	3.3%
BE	1,253	142	11.3%	100	8.0%	3.4%
BF	917	113	12.3%	79	8.6%	3.7%
BG	1,372	156	11.4%	105	7.7%	3.7%
BH	1,045	133	12.7%	92	8.8%	3.9%
BI	1,384	172	12.4%	117	8.5%	4.0%
BJ	874	99	11.3%	61	7.0%	4.3%
BK	597	104	17.4%	74	12.4%	5.0%
Totals & Means =	79,182	5,847	7.1%	4,259	5.1%	1.95%

Note: Response Zone column labels are strictly for notation purposes and do not correlate to any specific response zone or information in any other table.

A paired sample t-test was used to compare the two population means (Appendix D). For 2018, the average per EMS zone concurrency for CHARLIE, DELTA, and ECHO medical incidents was significantly higher (M = 7.1%, SD = 3.2%) than the average per EMS zone concurrency for CHARLIE, DELTA, and ECHO medical incidents with all ALPHA, BRAVO, and OMEGA medical incidents removed (M = 5.1%, SD = 2.3%), $t(62) = 15.0$, $p < .001$, r = .98, 95% CI [1.6%, 2.2%]. That is, the difference between the 2018 average concurrency for C-D-E medical incidents and the average concurrency for C-D-E medical incidents with all A-B-Ω medical incidents removed was -1.95%. Out of the 63 response zones studied, the smallest change in 2018 average concurrency for C-D-E medical incidents was -0.20% and the largest change was -5.03%.

Therefore, hypothesis two (H^2), "removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will reduce per EMS zone call concurrency," is accepted. The null hypothesis (H^0), "removing ALPHA, BRAVO, and OMEGA (A-B-Ω) medical incidents will not reduce per EMS zone call concurrency," is rejected.

Response Time

The unit of analysis used for this evaluation was "per response zone." First, all non-medical incidents, as well as incidents that did not contain EMD criteria or response zone information were removed. Incidents that were clear outliers, including 169 incidents with a response time of 00:00:00 and two incidents with a greater than a 23-hour response time were removed. Afterward, a 5% trimmed mean was utilized for this and each subsequent response time analysis. As mentioned by the National Institute of Standards and Technology, "The mean can be heavily influenced by extreme values in the tails of a variable. The trimmed mean compensates for this by dropping a certain percentage of values on the tails" (2016, para. 4).

In 2018, there were 13 response zones that experienced less than five concurrent CHARLIE, DELTA, and ECHO medical incidents, where the first-due apparatus was involved in an ALPHA, BRAVO, or OMEGA medical incident. These 13 response zones and the 31 corresponding incidents that occurred within them were removed from the analysis due to containing an insufficient sample size. The response time for the remaining response zones (N=50) and the corresponding 119,986 incidents ranged from 122 to 558 seconds. These times were sorted and then averaged per response zone using the Excel AVERAGEIF function. The results represent the average zone-specific response times for all medical incidents that occurred in 2018.

Table 6

Average Per Zone Response Times (All Medical Incidents)

Mean	290.39
Standard Deviation	21.44
Range	83.52
Minimum	247.21
Maximum	330.73
Count	50

Note: Response times displayed in seconds.

Using the Pinellas County Department of Radio and Technology's Concurrency Report, 5,847 concurrent CHARLIE, DELTA, and ECHO incidents were identified. Afterward, concurrent C-D-E incidents were identified where the primary response apparatus was involved in an ALPHA, BRAVO, or OMEGA medical incident within the same response zone. Specifically, those incidents where the concurrent C-D-E incident elicited the response of an apparatus that is typically stationed within a different response zone (Table 7). The response times for these 1,198 incidents were sorted and then averaged per response zone using the Excel AVERAGEIF function. The results represent the zone-specific average response time for all concurrent C-D-E medical incidents where the primary apparatus was involved in an A-B-Ω medical incident. It is possible that more of these specific concurrent C-D-E medical incidents existed as 19% or 1,130 of the associated primary incidents did not possess priority dispatch codes.

Table 7

Concurrent C-D-E Medical Incident Counts by Dispatch Codes, Delineated by Priority

Priority Code	Charlie	Delta	Echo
1 - Abdominal Pain	33	5	0
2 - Allergic Reactions	5	9	0
4 - Assault	0	1	0
5 - Back Pain	7	2	0
6 - Breathing Problems	62	133	30
7 - Burns	2	0	0
8 - Inhalation Problems	0	3	0
9 - Cardiac Arrest	0	5	28
10 - Chest Pains	49	99	0
11 - Choking	0	12	1
12 - Seizures	21	33	0
13 - Diabetic Problems	34	3	0
14 - Drowning	0	0	1
17 - Falls	0	41	0
18 - Headache	8	0	0
19 - Heart Problems	20	19	0
20 - Exposure Problems	0	5	0
21 - Hemorrhage	0	22	0
23 - Overdose/Poisoning	28	5	0
24 - Pregnancy Problems	3	5	0
25 - Psychiatric Problems	0	6	0
26 - Sick Person	97	67	0
27 - Stab/Gunshot Trauma	0	1	0
28 - Stroke	57	0	0
29 - Traffic/Transportation Incident	0	25	0
30 - Traumatic Injuries	0	3	0
31 - Unconscious Person	64	103	2
32 - Unknown Problem (Man Down)	0	39	0
Medical Incidents Per Determinant Code	490	646	62
Percent of Total Concurrent C-D-E Incidents	40.9%	53.9%	5.2%

Afterward, all but the non-concurrent CHARLIE, DELTA, and ECHO medical incidents were removed from the DSTATS report. This was done by removing all A-B-Ω as well as concurrent C-D-E incidents from the report by matching the incident numbers from the Concurrency Report to the DSTATS Report. The response times for these remaining 66,591 incidents were sorted and then averaged per response zone using the Excel AVERAGEIF function. The results represent the calendar year 2018 average zone-specific response times for non-concurrent CHARLIE, DELTA, and ECHO medical incidents.

Table 8

Average CHARLIE, DELTA, ECHO (C-D-E) Response Times, Delineated by Response Zone

Response Zone	Non-Concurrent C-D-E "Seconds"	Incident Count	Concurrent C-D-E "Seconds"	Incident Count	Difference "Seconds"
A	273	777	282	23	9
B	282	557	314	16	32
C	322	492	355	9	33
D	291	905	333	31	42
E	273	1,724	319	26	46
F	289	1,925	337	20	48
G	310	1,941	359	23	49
H	311	1,004	360	27	49
I	310	823	362	8	52
J	224	972	279	9	55
K	279	1,757	337	21	58
L	251	1,436	313	25	62
M	281	855	346	25	65
N	279	1,201	346	40	67
O	288	995	363	25	75
P	269	1,749	346	15	77
Q	250	1,868	328	34	78
R	247	2,841	325	39	78
S	239	1,311	318	30	79
T	248	2,336	328	59	80
U	250	1,282	330	30	80
V	259	1,974	339	28	81
W	304	701	385	15	81
X	257	2,022	339	25	82
Y	280	485	364	20	84
Z	239	3,698	324	24	85
AA	260	1,580	346	17	85
AB	276	516	364	5	88
AC	263	2,090	351	51	89

Table 8

Average CHARLIE, DELTA, ECHO (C-D-E) Response Times, Delineated by Response Zone

Response Zone	Non-Concurrent C-D-E "Seconds"	Incident Count	Concurrent C-D-E "Seconds"	Incident Count	Difference "Seconds"
AD	270	1,461	361	31	91
AE	275	1,423	366	17	91
AF	314	2,002	405	32	91
AG	278	1,167	370	44	92
AH	286	526	379	7	93
AI	230	1,750	323	20	93
AJ	298	1,252	394	23	97
AK	280	563	381	9	101
AL	252	2,281	353	28	101
AM	252	2,291	355	32	103
AN	277	1,788	381	38	104
AO	265	2,266	372	46	107
AP	270	1,080	378	31	108
AQ	278	530	396	12	119
AR	293	762	419	32	126
AS	289	293	431	5	142
AT	274	1,076	432	36	158
AU	297	665	459	8	161
AV	274	500	451	9	177
AW	231	671	411	13	180
AX	268	427	450	5	182
	Mean = 273	Total = 66,591	Mean = 361	Total = 1,198	Mean = 88

Note: Response Zone column labels are strictly for notation purposes and do not correlate to any specific response zone or information in any other table.

A paired sample t-test was used to compare the two population means (Appendix E). For 2018, the average zone-specific response times for non-concurrent CHARLIE, DELTA, and ECHO medical incidents was significantly faster (M = 273 s, SD = 22) than the average zone-specific response times for concurrent C-D-E medical incidents where the primary apparatus was involved in an ALPHA, BRAVO, or OMEGA medical incident (M = 361 s, SD = 40), $t(49) = -16.5$, $p < .001$, r = .40, 95% CI [77.4, 98.8]. That is, on average, the zone-specific response times for non-concurrent C-D-E medical incidents was 88 seconds, or 1 minute and 28 seconds faster than concurrent C-D-E medical incidents where the primary apparatus was involved in an A-B-Ω medical incident (4 min, 33 s versus 6 min, 1 s). Out of the 50 response zones analyzed, the smallest change in C-D-E medical incident response time was -9 seconds and the largest change was -182 seconds.

Therefore, hypothesis three (H^3), "the per EMS zone response times for concurrent CHARLIE, DELTA, and ECHO (C-D-E) medical incidents are longer than response times for non-concurrent C-D-E medical incidents," is accepted. The null hypothesis (H^0), "the per EMS zone response times for concurrent CHARLIE, DELTA, and ECHO (C-D-E) medical incidents are not longer than response times for non-concurrent C-D-E medical incidents," is rejected.

Consequently, based on the results of the response time, apparatus commitment factor, and the C-D-E concurrency analyses, it is determined that the expanded implementation of the Medical Priority Dispatch System in 2018 would have both increased the relative response capacity and improved the performance of the Pinellas County EMS System.

Chapter V

DISCUSSION AND SUGGESTED FUTURE RESEARCH

The relative capacity of Pinellas County's EMS system is decreasing each year as a variety of factors cause the number of calls for service to challenge allocated revenue and available resources. The future impact on the citizenry may soon involve increased response times to high-priority 911 incidents, an escalation in current and future system costs, or both. From a public value perspective, it is prudent public policy to regularly assess current practices in order to determine if there are better, more efficient ways of providing service.

The purpose of this study was to determine if the expanded implementation of the Medical Priority Dispatch System (MPDS) in calendar year 2018 would have increased relative capacity and improved the performance of the Pinellas County EMS System, which could prevent excessive future cost increases and/or response times based on demand. To that end, it has been determined that the expanded implementation of the Medical Priority Dispatch System in the Pinellas County EMS System in 2018 would have increased the system's relative response capacity. Removing fire department response to ALPHA, BRAVO and OMEGA determinant medical incidents would have decreased the average apparatus commitment factor (ACF) by 2.76 percentage points. Furthermore, the difference between the 2018 average concurrency rate for CHARLIE, DELTA, and ECHO medical incidents and the average concurrency rate for C-D-E medical incidents with all A-B-Ω medical incidents removed was negative 1.95

percentage points.

It has also been determined that the expanded implementation of the Medical Priority Dispatch System in the Pinellas County EMS System in 2018 would have improved the system's performance. On average, the zone-specific response times for non-concurrent CHARLIE, DELTA, and ECHO medical incidents were 24% or 1 minute and 28 seconds faster than concurrent C-D-E medical incidents where the primary apparatus was involved in an A-B-Ω medical incident.

Limitations and Key Assumptions

Out of the 201,986 incidents that occurred in 2018, 22.4% or 45,246 did not possess any priority dispatch code. There are a number of reasons dispatch codes can be missing including the 911 caller not being with the patient or if the request for fire department response is transferred from another agency, such as a local law enforcement dispatch center or medical alarm provider. The number of missing priority dispatch codes potentially obscures the full impact of the expanded implementation of MPDS. For example, given the number of missing dispatch codes, the number of concurrent CHARLIE, DELTA, and ECHO medical incidents resulting from a preceding ALPHA, BRAVO, and OMEGA medical incident was likely appreciably higher.

As mentioned, the various fire departments within Pinellas County use a fixed deployment response configuration consisting of strategically placed fire stations that limit driving distances and reduce response times. Response apparatuses are housed at these fire stations but are not necessarily at the fire station each time they are dispatched to an incident. Apparatuses and crews are occasionally in available status returning from incidents, out in the community, or training. Furthermore, these apparatuses are sometimes placed out of service for maintenance, crew training, public education and engagement purposes, and a variety of other reasons. These variables could all have an impact on response times.

The implications of this study assume that the ambulance company and 18 fire departments within Pinellas County maintain their current level of resources and deployment model. Additionally, it is anticipated that the growth rate of the calls for service within the Pinellas County EMS System will continue at a rate consistent with recent history, absent any intervention. However, the availability of health-care coverage, population growth, the rate of homelessness, substance abuse, widespread disease outbreak and pandemics, and many other factors could all impact the future number of calls for service to varying degrees.

The authorizing environment (political makeup) of Pinellas County, including the municipalities and special fire districts located within it, could make the systemwide implementation of priority dispatch a precarious venture. The call-volume-based funding model (Appendix A) has potentially created an environment where busyness (the number of 911 incidents responded to) is associated with funding levels. Therefore, city administrators and elected officials, fire chiefs, and labor unions may be hesitant to relinquish their ability to respond to A-B-Ω medical incidents. Additionally, some might call into question the idea that an advanced life support (ALS) fire apparatus should sit idle awaiting a higher-priority incident instead of responding to an ALPHA, BRAVO, or OMEGA medical incident close by.

As mentioned, the Pinellas County EMS System operates using a consolidated 911 dispatch and communications center, unified medical direction, and standardized medical operating procedures. The eventuality that some municipalities will want to participate in the expansion of MPDS while others may not will inevitably create policy challenges for the Pinellas County Communications Center and dispatch protocols.

Finally, if the fire departments were to discontinue responding to ALPHA, BRAVO, and OMEGA medical incidents, Sunstar could see a concomitant increase in workload. For instance, occasionally, when a patient refuses ambulance transport to the hospital, fire department crews cancel the Sunstar ambulance and facilitate the patient refusal process. Moreover, tasks such as collecting patient medications, interviewing family members, and preparing the patient for transport are often accomplished by fire department personnel before the ambulance arrives on scene. Sunstar would need to manage these processes should fire department resources cease to respond to A-B-Ω medical incidents. If the shifting workload were to rise to the level that necessitated additional ambulances to be in service at any given time, Pinellas County administrators would presumably have to renegotiate the contract with the private ambulance service provider.

Implications

It has been determined that the expanded implementation of the Medical Priority Dispatch System in the Pinellas County EMS System in 2018 would have increased the system's relative response capacity. On average, removing fire department response to A-B-Ω determinant medical incidents would have decreased apparatus commitment factor (ACF) by 23%, from 11.5% to 8.8%. As mentioned, a one percent decrease in ACF is equal to a 14 minute 24 second increase in an apparatus' daily availability. Therefore, the 94 advanced life support (ALS) apparatuses studied gained an average of

39 minutes and 44 seconds of availability each day. These results were similar to that of the San Bernardino City Fire Department, where Fratus found that ALS apparatus availability improved by 10.2% through the use of MPDS (2008).

According to Powers, an apparatus commitment factor of 25% indicates “System Stress.” At that system stress level, Powers contends that agency leaders must understand that commitment factors will continue to rise, and the community may begin to see progressively longer response times (2016). In 2018, the nine busiest ALS apparatuses in Pinellas County had an ACF above 20%, approaching the 25% “System Stress” threshold. After analyzing the results of this study, it has been determined that ceasing the response of fire department apparatuses to A-B-Ω determinant medical incidents would have decreased their ACF by an average of 5.9%. The corresponding 1 hour and 24 minutes of average daily availability (capacity) gained by each of these apparatuses could postpone the need for additional resources within these response zones for some time, which would also serve to defer the associated costs.

According to Computer-Aided Dispatch (CAD) data obtained from the Pinellas County Radio and Technology Department, the average 911 incident duration in 2018 was 28 minutes and 45 seconds. As mentioned, an ACF of 1% equates to spending 14 minutes and 24 seconds on an incident(s) in a 24-hour period (24-hours is a typical fire department shift or workday in Pinellas County). This means, an apparatus with an ACF of 25% (which is considered the system stress threshold) spends approximately 6 hours on incidents per shift (24-hours) which, in 2018, equated to roughly 12.5 incidents. Implementing MPDS and adding the 1 hour and 24 minutes of average daily availability to an apparatus with a commitment factor of 25% would reduce its ACF to just over

19.1%. Using the historical 6% average annual call volume increase experienced by the Pinellas County EMS System, implementing MPDS would essentially turnback the clock and undo over 3.5 years' worth of call volume growth. For this reason alone, MPDS could prove extremely valuable to administrators who may be otherwise forced to add resources to address those aforementioned nine apparatuses approaching the 25% ACF benchmark. According to one 2017 Pinellas County Emergency Medical Services Agreement, costs associated with adding just one 24-hour paramedic per shift (three total) can exceed $500,000 annually, with the cost of a rescue vehicle around $200,000. Therefore, adding nine full-time (24-hour) positions could cost well over $6 million.

The difference between the 2018 average concurrency rate for C-D-E medical incidents and the average concurrency for C-D-E medical incidents with all A-B-Ω medical incidents removed was -1.95%. In 2018, there were 13 response zones where the concurrency rate for C-D-E medical incidents was greater than 10%. This translates to more than one out of every ten CHARLIE, DELTA, or ECHO medical incidents eliciting a response from an apparatus stationed within a different response zone. This study indicated that these concurrent C-D-E incidents are likely to have significantly (32%) longer response times. However, discontinuing the response of fire department apparatuses to A-B-Ω determinant medical incidents would have changed the concurrency rate of the C-D-E medical incidents within these response zones from an average of 12% to an average of less than 8.5%. In other words, this change in deployment equates to a 29% improvement in the concurrency rate of the C-D-E medical incidents within these response zones.

It was also determined that the expanded implementation of the Medical Priority Dispatch System in the Pinellas County EMS System in 2018 would have improved the system's performance. On average, the zone-specific response times for non-concurrent C-D-E medical incidents was 24% or 1 minute and 28 seconds faster than the 1,198 concurrent C-D-E medical incidents (where the primary apparatus was involved in an A-B-Ω medical incident). These results were also similar to those experienced by the San Bernardino City Fire Department. Fratus (2008) calculated that, within a three-month timeframe in 2007, the utilization of MPDS resulted in 102 patients experiencing a faster response time (7.7 minutes versus 10.2 minutes) than if MPDS had not been implemented. This is because fire department units would have been occupied with lower priority incidents and these patients would have received resources from further away (Fratus, 2008).

Perhaps even more noteworthy, this study revealed that in 2018, there were 28 ECHO determinant cardiac arrests dispatched in Pinellas County where the primary apparatus was involved in an A-B-Ω medical incident (Table 7). These incidents initiated a response from an apparatus typically stationed outside of the primary EMS response zone. As mentioned, the average zone-specific response times for non-concurrent C-D-E medical incidents was 24% or 1 minute and 28 seconds faster than the concurrent C-D-E medical incidents where the primary apparatus was involved in an A-B-Ω medical incident (4:33 versus 6:01).

It is generally accepted that early cardiopulmonary resuscitation (CPR) and defibrillation improve the outcome of patients suffering Out-of-Hospital Cardiac Arrest (OHCA) Bürger et al., 2018; Goto et al., 2018; Stiell et al., 1999). In addition, Turner et al. state that survival from sudden cardiac arrest is dependent on a number of key factors including:

- Early recognition and access to treatment;
- Early cardiopulmonary resuscitation (CPR);
- Early defibrillation; and
- Early advanced cardiac care. (2006, p. 3)

Moreover, according to Larsen et al. (1993), the chances of survival decrease between 7 and 10% for every minute that passes after witnessed cardiac arrest where cardiopulmonary resuscitation (CPR) is withheld. Therefore, decreasing response times to incidents (like the 28 concurrent, ECHO determinant cardiac arrests which occurred in 2018) in an attempt to provide more rapid treatment to patients is advantageous.

From a financial perspective, a marginal utility analysis can be used to demonstrate the relevance of the 1 minute and 28 second (24%) faster response time average to C-D-E medical incidents obtained by redeploying resources using MPDS. According to the editors of Encyclopaedia Britannica (2016), marginal utility refers to the benefit or utility that a consumer gains from buying an additional unit of a service or commodity. “The concept implies that the utility or benefit to a consumer of an additional unit of a product is inversely related to the number of units of that product he already owns” (Encyclopaedia Britannica, 2016).

As a contribution to this research study, Steven Knight, PhD (business partner at Fitch & Associates, LLC) agreed to provide a marginal utility analysis using existing Pinellas County fire stations. The analysis used data from the Pinellas County Department of Radio and Technology Dispatch Statistics (DSTATS) and Truck Statistics

(TSTATS) Reports to determine how many stations would be needed to provide a six-minute drive time 90% of the time to the incidents that occurred in 2018. The model used actual posted speed limits, did not include turnout time (the time from when the apparatus was dispatched to when it leaves the fire station), and assumed that there would be enough apparatuses assigned to each station to handle concurrent incidents within each zone. The analysis indicated that, in 2018, only 33 of the current 65 existing stations would have been needed to respond to approximately 90% of the total 201,986 incidents within six-minutes (Table 9).

The analysis did not consider isolating these drive times for C-D-E medical incidents as Pinellas County does not currently distinguish separate response time goals for different types of incidents based on priority. In other words, using the current deployment model, decreasing response times to the subset of C-D-E medical incidents would require decreasing response times to all incidents. This is due to the current practice of sending advanced life support resources to all types of medical incidents, regardless of priority.

According to Fitch's marginal utility analysis, if public administrators and policy makers desired to increase performance by decreasing response time, additional stations would need to be utilized. In fact, decreasing the 2018 90^{th} percentile response time by just one minute (from six minutes to five minutes), would require using all of the existing Pinellas County fire stations. Furthermore, attempting this by almost doubling the amount of fire stations (from 33 to 65) would only achieve a five-minute response time approximately 89% of the time. Fitch's marginal utility analysis illustrates the immense financial investment required (in the form of additional capital and personnel) to "buy" a one-minute decrease in average response time to C-D-E medical incidents using the current deployment method. Conversely, MPDS accomplishes a 1 minute and 28 second faster response time average to C-D-E medical incidents by simply redeploying existing resources that are already available.

Table 9

Pinellas County Marginal Utility Analysis, Provided by Fitch & Associates, LLC

Six-minute Response Time (90th Percentile)				Five-minute Response Time (90th Percentile)			
Station	Station Capture	Total Capture	Percent Capture	Station	Station Capture	Total Capture	Percent Capture
1	26,604	26,604	13.3%	1	17,004	17,004	8.5%
2	16,989	43,593	21.7%	2	12,499	29,503	14.7%
3	15,393	58,986	29.4%	3	10,356	39,859	19.9%
4	12,464	71,450	35.6%	4	9,895	49,754	24.8%
5	9,464	80,914	40.4%	5	9,696	59,450	29.7%
6	9,123	90,037	44.9%	6	8,699	68,149	34.0%
7	9,115	99,152	49.5%	7	7,487	75,636	37.7%
8	9,095	108,247	54.0%	8	6,587	82,223	41.0%
9	6,540	114,787	57.3%	9	5,576	87,799	43.8%
10	6,457	121,244	60.5%	10	5,010	92,809	46.3%
11	5,759	127,003	63.4%	11	4,471	97,280	48.5%
12	5,417	132,420	66.1%	12	4,207	101,487	50.6%
13	4,666	137,086	68.4%	13	4,148	105,635	52.7%
14	4,171	141,257	70.5%	14	4,024	109,659	54.7%
15	3,923	145,180	72.4%	15	3,948	113,607	56.7%
16	3,202	148,382	74.0%	16	3,203	116,810	58.3%
17	3,163	151,545	75.6%	17	3,005	119,815	59.8%
18	2,860	154,405	77.0%	18	2,995	122,810	61.3%
19	2,814	157,219	78.4%	19	2,671	125,481	62.6%
20	2,152	159,371	79.5%	20	2,663	128,144	63.9%
21	2,104	161,475	80.5%	21	2,657	130,801	65.2%
22	2,091	163,566	81.6%	22	2,529	133,330	66.5%
23	1,990	165,556	82.6%	23	2,475	135,805	67.7%
24	1,695	167,251	83.4%	24	2,464	138,269	69.0%

Table 9

Pinellas County Marginal Utility Analysis, Provided by Fitch & Associates, LLC

Six-minute Response Time (90th Percentile)				Five-minute Response Time (90th Percentile)			
Station	Station Capture	Total Capture	Percent Capture	Station	Station Capture	Total Capture	Percent Capture
25	1,654	168,905	84.3%	25	2,249	140,518	70.1%
26	1,617	170,522	85.1%	26	2,151	142,669	71.2%
27	1,599	172,121	85.9%	27	2,022	144,691	72.2%
28	1,547	173,668	86.6%	28	1,991	146,682	73.2%
29	1,443	175,111	87.3%	29	1,927	148,609	74.1%
30	1,418	176,529	88.1%	30	1,717	150,326	75.0%
31	1,409	177,938	88.8%	31	1,672	151,998	75.8%
32	1,295	179,233	89.4%	32	1,612	153,610	76.6%
33	1,106	180,339	90.0%	33	1,607	155,217	77.4%
34	996	181,335	90.5%	34	1,513	156,730	78.2%
35	886	182,221	90.9%	35	1,479	158,209	78.9%
36	852	183,073	91.3%	36	1,473	159,682	79.7%
37	832	183,905	91.7%	37	1,372	161,054	80.3%
38	798	184,703	92.1%	38	1,328	162,382	81.0%
39	784	185,487	92.5%	39	1,213	163,595	81.6%
40	730	186,217	92.9%	40	1,106	164,701	82.2%
41	723	186,940	93.2%	41	1,095	165,796	82.7%
42	717	187,657	93.6%	42	1,063	166,859	83.2%
43	660	188,317	93.9%	43	1,042	167,901	83.8%
44	644	188,961	94.3%	44	1,001	168,902	84.3%
45	533	189,494	94.5%	45	916	169,818	84.7%
46	420	189,914	94.7%	46	806	170,624	85.1%
47	396	190,310	94.9%	47	773	171,397	85.5%
48	369	190,679	95.1%	48	768	172,165	85.9%
49	334	191,013	95.3%	49	657	172,822	86.2%
50	327	191,340	95.4%	50	605	173,427	86.5%
51	323	191,663	95.6%	51	586	174,013	86.8%
52	185	191,848	95.7%	52	578	174,591	87.1%
53	153	192,001	95.8%	53	561	175,152	87.4%
54	94	192,095	95.8%	54	526	175,678	87.6%

Table 9

Pinellas County Marginal Utility Analysis, Provided by Fitch & Associates, LLC

Six-minute Response Time (90th Percentile)				Five-minute Response Time (90th Percentile)			
Station	Station Capture	Total Capture	Percent Capture	Station	Station Capture	Total Capture	Percent Capture
55	92	192,187	95.9%	55	435	176,113	87.8%
56	86	192,273	95.9%	56	365	176,478	88.0%
57	44	192,317	95.9%	57	297	176,775	88.2%
58	41	192,358	96.0%	58	272	177,047	88.3%
59	36	192,394	96.0%	59	271	177,318	88.4%
60	36	192,430	96.0%	60	249	177,567	88.6%
61	9	192,439	96.0%	61	175	177,742	88.7%
62	8	192,447	96.0%	62	116	177,858	88.7%
N/A				63	42	177,900	88.7%
N/A				64	37	177,937	88.8%
N/A				65	7	177,944	88.8%

Note: Station column labels are strictly for notation purposes and do not correlate to any specific response zone or information in any other table.

Recommendations

The public value strategic triangle can be used to illustrate how the Pinellas County EMS model might accommodate the expanded implementation of the Medical Priority Dispatch System within the Pinellas County EMS System. According to the strategic triangle, public value initiatives must accomplish three things. First, they must strive to create public value. Second, they must marshal adequate support and be politically sustainable. Third, to be successful, public value initiatives must have access to the necessary resources (Benington & Moore, 2011).

Quick response to high-priority calls for service is something that is both valued by the public and something that adds value to the public sphere. The authorizing environment is made up of citizens, public managers, and elected officials who would undoubtably prefer to not spend more in order to add relative operational capacity (more personnel and apparatuses) so the system can continue to have an equally quick response to both high-priority and low-priority calls for service. The authorizing environment is also made up of many fire service personnel who wish to see a decrease in workload (number of requests for service). The additional availability gained could be used for firefighter health and wellness initiatives, public outreach, and training. Operational capacity exists to redeploy the system using existing resources so that quick response is maintained to high-priority calls for service without additional cost.

Given the results of the study, the expanded implementation of the Medical Priority Dispatch System in the Pinellas County EMS System should be adopted by special district, city, and county decisionmakers as a method of increasing the relative capacity and efficiency of Pinellas County's EMS System. Otherwise, the future impact on the citizenry could include increased response times to high-priority 911 calls and an increase in current and future system costs.

Furthermore, the Pinellas County EMS Authority should invest funds toward increasing the availability of fire and EMS system data. Pinellas County should work to acquire software and personnel able to extract and analyze data to determine system capacity, performance, costs, and trends. This data should be transparent and made available to the various municipalities, special fire districts, and labor unions on a consistent basis in an effort to demonstrate the efficacy of the expanded implementation of the Medical Priority Dispatch System in Pinellas County and to promote sound and responsible decision-making. The cost of such software and the personnel needed to conduct analyses would be money well spent considering the system efficiencies that are likely to be gained as a result.

Suggested Future Research

While the expanded implementation of MPDS within the Pinellas County EMS System would be impactful, it should not be considered the terminal solution for system optimization. In many locations, tiered response deployment methods exist which use multiple types of resources such as both basic life support and advanced life support apparatuses (McLay & Moore, 2012). Instead of sending the closest available unit, the dispatcher is able to deploy the closest, most appropriate apparatus based on the severity of the call. Further research should focus on the efficiencies that might be gained if the Pinellas County EMS System implemented basic life support ambulances (perhaps on ALPHA determinant medical incidents). Doing so would allow the more limited ALS ambulances to be reserved for higher priority incidents.

As mentioned, some Computer-Aided Dispatch (CAD) systems determine which apparatus to dispatch based on the use of automatic vehicle location (AVL) systems which take into consideration the real-time Global Positioning System (GPS) location of the vehicle (Wallman, 2017). Conversely, the Pinellas County EMS System currently uses a form of closest-unit response without AVL. The system assumes fixed deployment, where fire department apparatuses return to their fire station after completing a call for service (Bandara et al., 2014). While response apparatuses are housed at these fire stations, crews are occasionally in available status returning from incidents, at the grocery store, out training, or in the community conducting public education. Nevertheless, the CAD system invariably assumes they are at their respective station occasionally resulting in apparatuses being dispatched to an incident, even though they may not be the closest or the quickest to respond.

As part of a pilot program in September of 2005, FDNY EMS apparatuses within Staten Island and Southern Brooklyn began being dispatched using AVL. The department witnessed a 33 second decrease in response times to the most serious medical emergencies ("New York City," 2006). Future research should consider whether the Pinellas County EMS System could leverage automatic vehicle location (AVL) to reduce response times, increase efficiency, and ensure the closest and most appropriate apparatus is always dispatched to a call for service.

Many cities have implemented Mobile Integrated Healthcare (MIH) or Community Paramedicine Programs in an effort to decrease the number of 911 medical incidents. For instance, a MIH program was enacted in the City of San Antonio where fewer than 300 residents were contributing to more than 4,000 calls for service each year (Baugh, 2014). Mobile Integrated Healthcare Programs typically consist of paramedics, nurses, or other healthcare providers who carry out routine preventative welfare checks on chronically ill residents in an attempt to prevent repeated 911 calls for service. Future research should set out to determine if an MIH program would be a cost-effective way to quell recurring calls for service from chronically ill residents or high system users or locations within Pinellas County.

Recently, as part of a strategic plan to better utilize facilities and resources, Volusia County, Florida launched an E-911 Redirect Nurse Triage program to reduce the number of resources sent to less-emergent 911 calls for service. According to lead EMS Triage Nurse Pam Cawood, "911 dispatchers now determine if a caller's situation is a true emergency. If the situation is deemed severe, the caller will never speak to a triage nurse and the dispatcher will immediately send emergency vehicles" (Looker, 2020, para. 4). However, if the situation is not severe, the caller will be transferred to the nurse triage line. Some non-severe cases could include rashes, flu-like symptoms, mild cuts or allergic reactions, and common cold symptoms (Looker, 2020). In Pinellas County, such incidents would currently get a scene response from one or more ALS crews. Future research should investigate whether a nurse triage line, similar to that in Volusia County, would be a cost-effective way to preserve Pinellas County's valuable ALS resources.

This study concentrated on the expanded implementation of MPDS with a particular focus on EMS. However, future research should explore how criteria-based dispatch protocols could work for other areas of public safety. This is especially important considering that most ALS fire apparatuses in Pinellas County respond to both fire and EMS calls for service. According to Clawson and Dernocoeur (2001), priority dispatch codes 1 through 37 are considered emergency medical services codes, while codes 51 through 83 are considered fire codes.

Though not a large portion, in 2018, dispatch codes 51 through 83 made up approximately 11% of the 911 calls for service that occurred in Pinellas County. Incidents such as fire alarms, vehicle accidents, structure fires, and outside fires made up the majority of these calls for service. As with medical incidents, criteria-based dispatch protocols can help to ensure the proper type and quantity of apparatuses are dispatched to these incidents, and that these apparatuses are using the appropriate response mode (emergent versus non-emergent). The ultimate public administration goal is to reduce waste and ensure rapid response to high-priority 911 calls for service.

Conclusion

This research sought to determine the impact of expanding the implementation of the Medical Priority Dispatch System (MPDS) in the Pinellas County EMS System. A wide range of external influences is driving the number of 911 calls for service to contest currently allocated revenue and available resources. With the relative capacity of Pinellas County's EMS system decreasing each year, the future impact on the citizenry will likely include increased response times to high-priority 911 calls and/or an increase in current and future system costs. This research has demonstrated that the expanded implementation of MPDS in Pinellas County is a viable solution and would increase both system capacity and performance, though other solutions should also be explored.

From a public value perspective, it is prudent public policy to continually assess current practices to determine if there are better, more effective ways to utilize resources and provide services in order to increase efficiencies and stave off excessive future cost increases based on demand. To this end, it is perhaps Moore who most articulately describes the role of government managers:

> . . . not just as inward-looking bureaucratic clerks, and passive servants to their political masters, but as stewards of public assets with "restless value-seeking imaginations," who have important roles to play in helping governments to discover what could be done with the assets entrusted to their offices, as well as ensuring responsive services to users and citizens. (Benington & Moore, 2011, p. 3)

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APPENDIX A

Pinellas County Resolution 09-37, Pages 5-6

PINELLAS COUNTY EMERGENCY MEDICAL SERVICES AUTHORITY
STANDARDS REGARDING LEVEL OF SERVICE

Definitions:

ALS unit: A vehicle that is equipped as an ALS vehicle in accordance with Florida Law which is staffed, at a minimum, with one county authorized paramedic.

Authority: The Pinellas County Emergency Medical Services Authority.

Emergency means a dispatched response where the emergency vehicle utilizes its emergency lights and sirens in accordance with Florida law.

Response numbers shall include only those responses originating with emergency medical dispatches from the Pinellas County public safety answering point.

Response time: The length of time between dispatch and arrival at the scene. Response time does not include call processing by dispatchers prior to dispatch.

Rescue Unit: A vehicle staffed with a minimum of one paramedic and one emergency medical technician used primarily for emergency medical response which is equipped as an ALS vehicle as required by Florida Law as supplemented by Pinellas County regulations.

Service Area: The EMS district of the Provider as determined by the Authority.

Response Zone: The primary geographic area in which an authorized ALS unit responds as determined by the Provider and EMS Administration.

I. AMBULANCE TRANSPORT STANDARD

Response Time of the Ambulance is longer by design in Pinellas County because we have an ALS First Responder Program. The standard accounts for customer service and when transport capability is needed to arrive. Ambulance emergency (10 Minutes) and downgraded emergency (20) minutes, 90% or greater.

II. ALS FIRST RESPONDER STANDARD

A. ALS first responders shall arrive at the scene within 7 minutes & 30 seconds at least 90% of the time calculated for each district on an annual basis. This standard shall be determined on a district-wide basis if the district is served by one provider, or across all the response zones of that provider if the district is served by multiple providers.

B. Those calls where a response is initially dispatched as an emergency call, but is subsequently downgraded to non-emergency shall not be included in the calculation of response times.

III AREAS EXCLUDED FROM STANDARD

Remote Areas such as: off shore, Caladesi Island, Booker Creek Preserve, Fort Desoto Park, Courtney Campbell Causeway, Howard Frankland Bridge, Gandy Bridge, and the Sunshine Skyway Bridge or any other area where the EMS Administration finds that the time standards should be waived based upon response distance and low volume of calls.

Provider agencies may request that other areas be excluded from the response time standard for good cause. Any such waiver may be granted by EMS administration.

Any waivers issued by the EMS Administration shall be reported, no less frequently than on an annual basis to the Authority.

Response time standards may be suspended by the County Administrator or his designee during periods of declared emergency.

IV DETERMINATION OF STAFFING

Volume of responses per response zone		Type of unit/staffing
A.	0-5 Responses per Day	Single Paramedic ALS Unit only in Limited Access Areas
B.	6-10 Responses per Day	Single Paramedic ALS Unit
C.	11-15 Calls per Day	Rescue Unit or two Single Paramedic ALS Units
D.	16-20 Calls per Day	Rescue Unit and Single Paramedic ALS Unit
E.	21+ Calls per Day	Two ALS Rescue Units

In evaluating the need for additional ALS units the call volume shall be based upon all EMS responses and not shall not be limited to those in the ALS unit's response zone or service area.

In assessing the need for additional units, the calculation of calls per day is determined from annual statistics and are not to be based upon any other time frame unless otherwise approved by the Authority.

APPENDIX B

Institutional Review Board Approval

VALDOSTA STATE UNIVERSITY

Institutional Review Board (IRB)
For the Protection of Human Research Participants

PROTOCOL EXEMPTION REPORT

Protocol Number: 03896-2019 **Responsible Researcher:** Joseph Pennino

Supervising Faculty: Dr. Robert Yehl

Project Title: *The Implementation of Criteria-based Dispatch Protocols in Pinellas County: A Public Value Perspective.*

INSTITUTIONAL REVIEW BOARD DETERMINATION:

This research protocol is **Exempt** from Institutional Review Board (IRB) oversight under Exemption **Category 4**. Your research study may begin immediately. If the nature of the research project changes such that exemption criteria may no longer apply, please consult with the IRB Administrator (irb@valdosta.edu) before continuing your research.

ADDITIONAL COMMENTS:

- *Upon completion of this research study all data (data list, email correspondence, etc.) must be securely maintained (locked file cabinet, password protected computer, etc.) and accessible only by the researcher for a minimum of 3 years.*

☒ ***If this box is checked, please submit any documents you revise to the IRB Administrator at irb@valdosta.edu to ensure an updated record of your exemption.***

Elizabeth Ann Olphie *09.03.2019*
Elizabeth Ann Olphie, IRB Administrator

Thank you for submitting an IRB application.
Please direct questions to irb@valdosta.edu or 229-253-2947.

Revised: 06.02.16

APPENDIX C

Paired Samples Statistics for Apparatus Commitment Factor (ACF)

	ACF for All Incidents	ACF with A-B-Ω Determinant Medical Incidents Removed
Mean	0.115650247	0.088091343
Variance	0.002926756	0.00151421
Observations	94	94
Pearson Correlation	0.992528513	
Hypothesized Mean Difference	0	
df	93	
t Stat	16.50437756	
P(T<=t) one-tail	1.10601E-29	
t Critical one-tail	1.661403674	
P(T<=t) two-tail	2.21203E-29	
t Critical two-tail	1.985801814	

Note: This table compares the difference between the 2018 average ACF including all incidents with the average ACF after all A-B-Ω determinant medical incidents were removed.

APPENDIX D

Paired Samples Statistics for CHARLIE, DELTA, ECHO Concurrency

	Concurrent C-D-E	C-D-E Concurrency, A-B-Ω Removed
Mean	0.071101051	0.051551539
Variance	0.001028922	0.000533602
Observations	63	63
Pearson Correlation	0.982434	
Hypothesized Mean Difference	0	
df	62	
t Stat	15.02763512	
P(T<=t) one-tail	1.21543E-22	
t Critical one-tail	1.669804163	
P(T<=t) two-tail	2.43086E-22	
t Critical two-tail	1.998971517	

Note: This table compares the difference between the 2018 average concurrency for C-D-E medical incidents against the average concurrency for C-D-E medical incidents with all A-B-Ω medical incidents removed.

APPENDIX E

Paired Samples Statistics for CHARLIE, DELTA, ECHO Response Times (Seconds)

	Non-Concurrent C-D-E	Concurrent C-D-E
Mean	273.0915641	361.2103118
Variance	516.5222605	1639.000512
Observations	50	50
Pearson Correlation	0.40368117	
Hypothesized Mean Difference	0	
df	49	
t Stat	-16.57802944	
P(T<=t) one-tail	4.95128E-22	
t Critical one-tail	1.676550893	
P(T<=t) two-tail	9.90256E-22	
t Critical two-tail	2.009575237	

Note: This table compares the difference between the 2018 zone-specific response times for non-concurrent C-D-E medical incidents with concurrent C-D-E medical incidents where the primary apparatus was involved in an A-B-Ω medical incident.