

Prioritization of disaster-related requests in an IT-enabled public service system

Duygu Pamukcu

Virginia Tech
duygu@vt.edu

Christopher W. Zobel

Virginia Tech
czobel@vt.edu

Yue “Gurt” Ge

University of Central Florida
yue.ge@ucf.edu

ABSTRACT

The local government’s continuous support is critical for the well-being of a community during disaster events. E-Government systems that establish and maintain ongoing connections with the community thus play a vital role in supporting crisis response and recovery. Such systems’ ability to adapt to the crisis circumstances and to address emergent needs helps them continue their fundamental functions during disasters. Considering various services might require different amounts and types of resources, prioritization strategies are helpful in determining the processing order of requests. This paper discusses the role of prioritizing services within an e-Government system, to better understand how such a system can be managed to best utilize available resources. The study examines how a well-functioning e-Government system, the Orange County, Florida 311 non-emergency service system, responded to the COVID-19 pandemic and how the changes in service operations requirements can affect service provision, specifically with respect to assigning or re-assigning priority levels.

Keywords

311, Public Services, Prioritization, Capacity Management, Non-Emergency System.

INTRODUCTION

Information and Communication Technology (ICT)-enhanced government systems offer many benefits to a community, including easy and timely access to government services, greater availability of important information, higher-quality interactions between stakeholders, and, ultimately, improved service delivery and more efficient and transparent public administration (Yang et al., 2004; Axelsson, Melin, & Lindgren, 2013; Wang, Zhang, Li, & Ruan, 2016). Such e-Government systems thus bring many advantages to cities, such as improving the life quality of citizens, strengthening the local economy, transportation, and traffic management, and enhancing overall interaction with the government (Hartmann, 2019; Ismagilova et al., 2019). As their familiarity with such systems increases, citizens are more and more likely to become co-producers of relevant information with the government through their ongoing interactions and communication (Pitogo & Magno, 2021).

In addition to their everyday role in civic life, it is increasingly being recognized that e-Government systems can also play a critical part in collecting and addressing the information and service needs of people impacted by a disaster because of the persistent communication that has already been established with the community prior to the onset of such an event. Some of these systems, such as the 911 system for emergency calls in North America, can provide actionable information useful for emergency managers involved in the time-critical immediate response to the crisis (Seeman et al., 2013; Seeman et al., 2018). Others, such as the 311 system for non-emergency day-to-day service requests (Pamukcu et al., 2022) and the 211 system for handling requests for social services (Mathias et al., 2022), can instead be used to help municipal service providers gain a better understanding of the community's changing crisis-related needs during the more extended phases of disaster preparedness and recovery. Continuity of the fundamental functions of such systems in these contexts, however, depends on their ability to

adapt to the disaster's impacts and to address emergent needs. Ensuring the ongoing effectiveness and efficiency of service operations requires making the best possible use of the resources that are available, but providing assistance related to a disaster event may also necessitate reallocating available resources or extending system capacities to maintain reasonable levels of efficiency and equity in the service provision process.

E-Government service systems are typically accessible by phone, as well as via other technologies such as online forms, smartphone apps, text messaging, and email. This increases the ease of accessibility but also enables multiple inquiries to be submitted at effectively the same time, resulting in the need for service systems to implement strategies to prioritize the service inquiries that they receive. First-come, first-served (FCFS) is a well-known approach in scheduling and queuing that is common practice in systems seeking to ensure fairness in service delivery (Hathaway et al., 2022). Depending on the service center's operational policy, however, and the service being provided, other queuing disciplines might apply, such as last-come, first-served (LCFS), or a policy based on expected waiting time (Bassamboo et al., 2016). Because various services might also require different amounts and types of resources, however, a simple queuing approach may not be sufficient to directly determine the scheduling of inquiries, especially with simultaneous request arrivals. In such cases, prioritization strategies can help the system categorize inquiries based on the relative urgency of the required response in order to determine the order in which requests are processed.

There recently has been a fair amount of research on the role of e-Government public service systems in helping to manage disaster events (Shan et al., 2012; Lv et al., 2018; Roztocki et al., 2023; Zobel et al., 2023). The body of work focuses on systems that have been implemented in a number of cities (Madkour et al., 2020; Pamukcu and Zobel, 2021; Pamukcu et al., 2021) and it looks at systems within a variety of different crisis contexts (Zobel et al., 2017; Roztocki et al., 2021; Kianmehr et al., 2022). However, although this existing literature has already examined some of the critical aspects of such public systems, it lacks a discussion about the impacts of prioritization on system performance during the different phases of a crisis. This work-in-progress paper seeks to begin addressing this gap by taking an initial look at prioritization within a well-functioning e-Government system, the Orange County, Florida 311 (OCFL311) non-emergency service system. We focus on the system's response to the COVID-19 pandemic, as a specific type of disaster, and investigate how changes in service operations requirements can affect service provision, specifically with respect to assigning or re-assigning priority levels. We aim to investigate, in particular, how different priority levels relate to the system response behavior for both services and information-seeking requests during and after a disaster event.

BACKGROUND

There are a wide variety of different e-Government systems in place in the United States and Canada, through which government agencies collaborate, communicate and coproduce value with the general public (O'Brien, 2016). One of the most well-recognized systems is the 911 system (which is equivalent to the 112 system in Europe and other locations) for emergencies, but in many places, there also exists a 511 system for information about traffic conditions, an 811 system for information about utilities, a 211 system for social services requests, and a 311 system to manage information and service requests related to non-emergency municipal service needs, such as cleaning up damaged trees or fixing broken street lights. Such systems are designed to collect service and/or information requests from residents and to distribute those requests, as necessary, to responsible local agencies for response (Zobel and Pamukcu, 2023). They thus serve both as an information provider and as an interface for partnering with agencies that provide the actual services.

Although responses to information-seeking types of requests can often be automated, or immediately addressed by a human operator, service requests typically need to be forwarded to an appropriate agency for response. In each case, there can be value in prioritizing the requests in order to address more urgent needs in a timely manner (Seeman et al., 2018). This is particularly true if there is a significant increase in requests to such a system due to the onset of a crisis event.

Our discussion below specifically addresses the role of 311 non-emergency service systems in supporting the public, under everyday circumstances as well as during such crises. Although the many different 311 systems that are currently active share the same common purpose and basic structural elements, they each independently serve a particular metropolitan area. In this study we focus, in particular, on the 311 system for Orange County, Florida (OCFL311), which has played an integral role in e-Government services provision in central Florida since 2002.

OCFL311 system functioning during an emergency

The OCFL311 system provides area residents with information and with access to various local government services through multiple access channels, including the telephone, web chat, an online form, and a smartphone app. All service and information requests are handled by human 311 operators, who either provide the requested

information or forward the service request to the appropriate responsible agency. Because the system needs to continue providing services even during a crisis, OCFL311 operators and other personnel are trained and certified through the Federal Emergency Management Agency (FEMA) so that they can help in the County's emergency management operations (OCFL311 Managers, personal communication, December 17, 2021). When a disaster threatens the region, the OCFL311 activates an "emergency mode", which establishes special protocols to help facilitate working closely with the Emergency Operations Center of the County in all phases of emergency management (Orange County Government, Florida, 2018).

Particularly during a long-term slow-onset crisis like the COVID-19 pandemic, OCFL311 continues to support non-emergency information and service requests because it is necessary and important to maintain the ongoing relationship between the residents and the county. Depending on the service being requested, however, a crisis may impact the number of requests being made, leading to either an increase or a decrease in particular types of calls to the service center, even if they are not directly related to the crisis. Residents can also get assistance, however, with matters that are specifically related to the ongoing crisis (Orange County Government, Florida, 2022). During COVID-19, for example, the *Coronavirus Aid, Relief and Economic Security (CARES) Act* established the Coronavirus Relief Fund, which provided payments to state and local governments to help families and organizations navigate the immediate impacts of the COVID-19 outbreak. In response to this change, the OCFL311 system added several new information sub-categories under the category of "Public Safety" to help address anticipated questions about the new programs that this funding would support. These adjustments were made a couple of days before the start of the application period for each funding program. Furthermore, along with other adjustments, the 311 system was also updated to assist residents with making appointments to get tested and vaccinated, as well as to set up rides to the Orange County Convention Center vaccination site (Fox 35 Orlando, 2021).

DATA DESCRIPTION

The Orange County, Florida 311 request data are highly structured and standardized, with a list of attributes for each request instance that were defined in collaboration with the set of responding government agencies. These attributes include, among others, the time the request was made and when it was resolved, the address of the requestor, the pre-defined service category (and sub-categories) to which it was assigned, the priority level of the request, and the access mode used when submitting the request (Pamukcu et al., 2021). Each service category is associated with a specific agency (Department of Transportation, Police Department, etc.), and the priority level, which is defined as *Critical*, *Important*, or *Routine* in decreasing order of urgency, is established by that agency in collaboration with OCFL311 management (OCFL311 Managers, personal communication, December 17, 2021). Information-seeking requests, which tend to be much simpler and quicker to address, are most often handled directly by OCFL311 personnel and not forwarded to a specific agency partner.

In order to examine the impact of adding new crisis-related service categories to the system, and the effect of prioritizing different types of requests on response behavior during COVID, we leveraged an ongoing partnership with OCFL311 to obtain the complete set of service requests in CSV format, from 03/13/2019 until 03/12/2021. This covers the time frame from one year before to one year after March 13th, 2020, which was the day that the Mayor of Orange County declared a State of Local Emergency due to the COVID crisis. The OCFL311 system entered *Emergency Mode* on this date, as an automatic response to the emergency declaration, and this immediately increased its capacity and service performance capabilities (OCFL311 Managers, 2021). In the following analysis, we refer to the year prior to the emergency declaration (03/13/2019 until 03/12/2020) as the "pre-pandemic period", and the year after the declaration (03/13/2020 until 03/12/2021) as the "pandemic period". After excluding requests with missing information and requests that were not resolved by the end of the selected time period, the resulting dataset includes 489,061 unique service and information requests for 370 different service categories.

PRELIMINARY ANALYSIS AND DISCUSSION

Service requests by priority level

The priority levels assigned to each service category indicate the relative importance of the different types of requests. This can help service responders schedule tasks more effectively and more efficiently utilize their available capacity. Although one might initially expect higher priority requests to be associated with quicker response times, the relative difficulty of the service being provided might also be greater for the higher priority requests, which could lengthen the response instead. This implies that low priority service requests could often be simple to address and require only minimal effort to resolve. Keeping this in mind, we begin the preliminary analysis of our data by exploring the service demand behavior and the corresponding response performance for

service requests with varying priorities.

Our initial observations of the data clearly indicate that there is a clear distinction between different types of requests received by the 311 system with respect to how long it takes to respond to them. In particular, there are a very large number of information-type requests which can be directly addressed by a 311 operator without needing to forward them to a specific municipal agency for further attention. These information requests generally take only seconds to resolve, and the vast majority of them are prioritized as *Routine* rather than *Critical* or *Important*. Although each of these simple requests imposes relatively less burden on the system because of how quickly it can be responded to, the sheer number of such requests received can have an impact on the system's overall efficiency. In contrast to these simple information requests, there are also both service and information requests that must be entered into the system by a 311 operator and forwarded to the appropriate agency to be resolved. These types of requests can stay in the system for minutes or days, or even weeks, as they are being processed and responded to.

Because the simplest information-seeking requests are recorded in the data set as having a response time of zero minutes, we differentiate between the two types of requests based on this response time. As shown in Table 1, all *Critical*, *Important* and *Routine* priority level requests that have a zero response time are thus labeled as "...-by-operator", indicating that these calls were directly addressed and closed by a 311 operator. All the other service requests are labeled as "...-by-agency" since they are typically handled by a responsible municipal agency.

Table 1 provides summary statistics for the one-year periods both before and after the emergency declaration on March 13th, 2020. Differentiating between the different priority levels, it specifically provides the yearly total number of requests, the mean response time (in hours), the median response time (in hours), and the standard deviation of the response time (in hours) in each column. The data for the total number of service requests indicate that the majority of the requests received were classified as *Routine* - the least urgent level of service response – and that this is 74.9% of the total request volume during the period being analyzed. Furthermore, 77.7% of the total *Routine* requests received were addressed in seconds by the 311 operators.

Table 1 also shows that after the emergency declaration the system experienced a significant change in daily request volumes (Student's *t*-test p -value<0.001), resulting in an increase of 66.5% of the total volume. There was also a 7.5% decrease in the daily service demand for requests identified as *Critical* and a 16.2% decrease for those identified as *Important*. In contrast to this, however, there was a corresponding 75.3% increase for *Routine* service requests. These changes indicate that residents' daily activities and needs evolved with the onset of the COVID-19 crisis, at least in part due to the restrictions, changes, and regulations put in place to control the virus' spread.

These shifts in demand also influenced the response performance of the service providers. Table 1 further compares the response speeds from before and after the emergency declaration, for both the mean and the median

Table 1. Number of service requests and corresponding response time statistics by priority level

Priority	Period	Total Requests (#)	Mean Response (hours)	Median Response (hours)	Stdev Response (hours)
Critical-by-agency	Pre-pandemic	8347	153.9	19.6	500.9
	Pandemic	7550	108.3	12.1	332.8
Critical-by-operator	Pre-pandemic	18	0.0	0.0	0.0
	Pandemic	183	0.0	0.0	0.0
Important-by-agency	Pre-pandemic	9889	200.3	17.9	813.3
	Pandemic	8224	73.7	12.6	213.9
Important-by-operator	Pre-pandemic	17	0.0	0.0	0.0
	Pandemic	77	0.0	0.0	0.0
Routine-by-agency	Pre-pandemic	49913	329.0	36.2	902.1
	Pandemic	51520	179.9	15.6	562.1
Routine-by-operator	Pre-pandemic	115159	0.0	0.0	0.0
	Pandemic	237787	0.0	0.0	0.0

response, and shows that the response performance improved during the pandemic across all priority levels. Moreover, the included standard deviation values show that the service speed deviates less during the pandemic period for each priority level than it does in the pre-pandemic period. The system's switch to "emergency mode" helps to explain this improvement in response performance because it enhanced its service capacity by increasing daily operating hours and personnel capacity and by implementing additional regulations from the 311 system emergency protocol.

As discussed above, one might expect to see an overall decrease in mean resolution times when comparing higher priority requests to lower priority requests. Indeed, the summary statistics for the different priority levels show that *Routine-by-agency* requests received the slowest (i.e., longest) mean response, both before and during the pandemic. On the other hand, however, although the *Critical-by-agency* requests had the fastest mean response before the pandemic, the response to these requests became slower than that of the lower priority *Important-by-agency* requests during the COVID-19 period. This behavior may signal a mismatch between the intended response performance and the actualized response performance for requests with different pre-determined urgency levels, and we will discuss it further below.

Figures 1 and 2 illustrate the changes in service request volumes and in response performance for each priority level over the analysis period. The dashed line on each graph marks the date that the COVID-19 emergency was declared by the Mayor of Orange County. Echoing our observations from the summary statistics, the pattern of daily service requests in Figure 1 indicates that most requests were classified as *Routine*. After the pandemic outbreak, service demand clearly increased at specific times, such as when the OCFL311 started accepting calls related to the Orange County CARES Act funding applications, beginning on June 8, 2020. This was followed by a series of announcements about reopening the funding application portal on October 24, November 16, and December 8, 2020, and by the creation of new request categories related to vaccines and testing, starting from December 2020.

Further supporting the observations about the summary statistics in Table 1, Figure 2 shows the daily average service response performance during both periods. The response performance was improved, for each priority

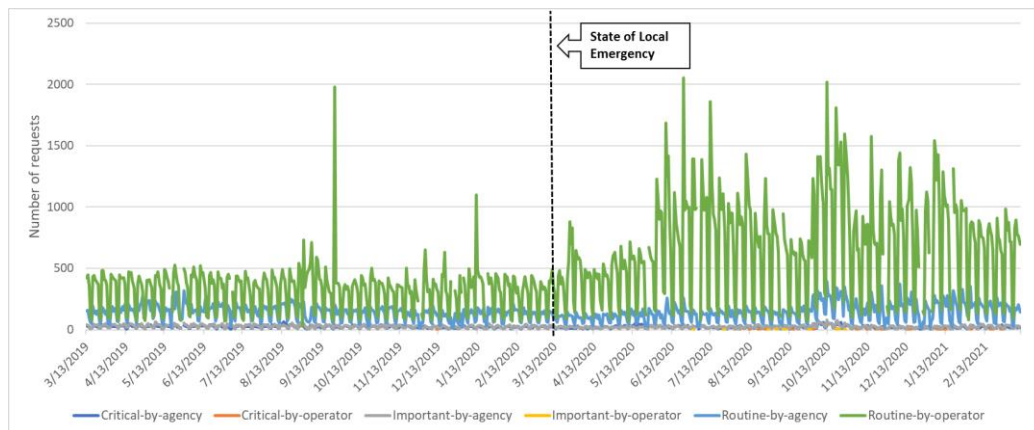


Figure 1. Daily number of service requests for each priority level

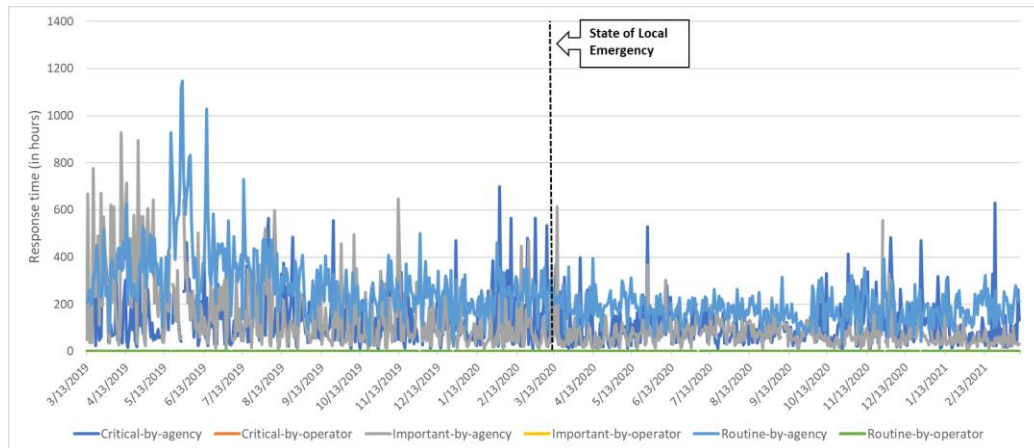


Figure 2. Daily average service response times for each priority level

level, from before the crisis to during the crisis despite a couple of sudden peaks at various times. In terms of the variability of the response, the *Critical-by-agency* requests are a bit less stable than the others after the emergency declaration, with slightly higher volatility in the response speed and a larger number of significant peaks.

Information versus non-information request categories

The second part of our analysis focuses on the difference between information requests (with both zero and non-zero response times) and requests for other types of services to be provided, within the OCFL311 system. The information requests were identified according to the “Information” indication in the service category. Table 2 expands on Table 1 by differentiating between these two general types of requests, and it summarizes the analytic results for both the pre-pandemic and the during-pandemic periods.

As can be seen in Table 2, the information requests are a significant portion of the total number of requests received. During the analysis period, 61.8% of the total requests were identified as information-seeking requests, and a majority of these requests (99.9%) were prioritized as *Routine*. Furthermore, most of the *Routine* information requests were able to be addressed directly by 311 operators, rather than requiring assignment to a service response agency. Even though the information request volume nearly doubled for the agency-referred requests after the emergency was declared, the speed of the response for those requests got almost three times faster than it had been before the emergency declaration. Figure 3 on the next page illustrates the changes in the *Routine* information requests from before to after the emergency began. Note, in particular, that much of the decrease in response time appears to be associated with the relative absence of outliers in the *Routine-by-agency* data after the start of the pandemic, which is also reflected in the standard deviation of the results.

If we now look at the statistics for the other types of service requests (i.e., the “Non-information requests”), we see that the number of requests served by the different agencies is greater than the number addressed by the 311 operators alone. We once again observe that *Routine* service requests are in the majority and except for the *Routine* non-information requests that are directly addressed by 311 operators (*Routine-by-operator*), non-information requests tend to take many hours to resolve, on average.

Table 2. Number of service requests and corresponding response time statistics per priority level

Request Type	Priority	Period	Total Requests (#)	Average Response (hours)	Median Response (hours)	Stdev Response (hours)
Non-information	Critical-by-agency	Before	8346	153.9	19.6	500.9
		After	7550	108.3	12.1	332.8
	Critical-by-operator	Before	18	0.0	0.0	0.0
		After	7	0.0	0.0	0.0
	Important-by-agency	Before	9889	200.3	17.9	813.3
		After	8223	73.7	12.6	214.0
	Important-by-operator	Before	17	0.0	0.0	0.0
		After	6	0.0	0.0	0.0
	Routine-by-agency	Before	47083	346.1	42.9	923.1
		After	46329	198.2	18.3	589.2
	Routine-by-operator	Before	26977	0.0	0.0	0.0
		After	32227	0.0	0.0	0.0
Information	Critical-by-agency	Before	1	24.2	24.2	-
		After	0	-	-	-
	Critical-by-operator	Before	0	-	-	-
		After	176	0.0	0.0	0.0
	Important-by-agency	Before	0	-	-	-
		After	1	93.7	93.7	-
	Important-by-operator	Before	0	-	-	-
		After	71	0.0	0.0	0.0
	Routine-by-agency	Before	2834	45.5	0.3	300.6
		After	5194	16.3	0.3	84.3
	Routine-by-operator	Before	88182	0.0	0.0	0.0
		After	205560	0.0	0.0	0.0

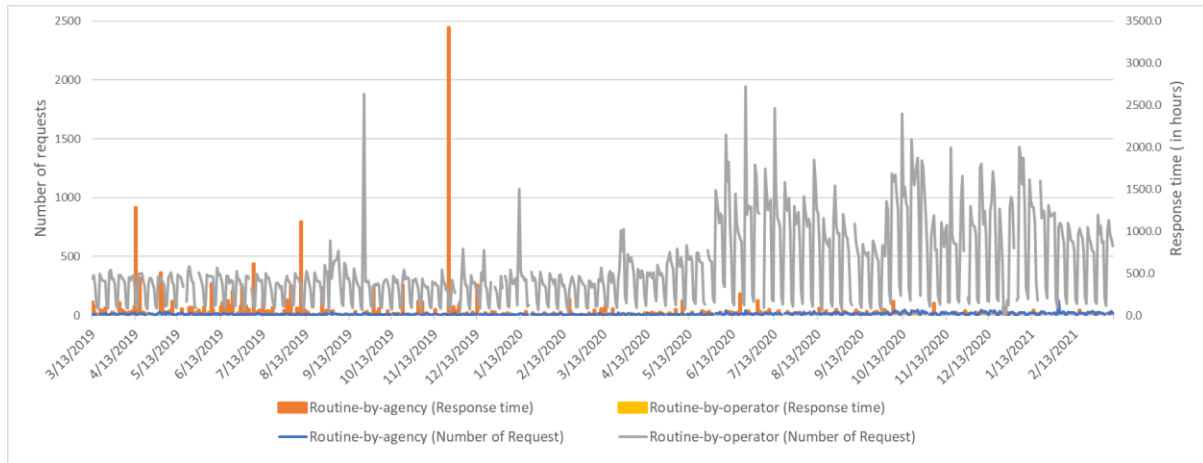


Figure 3. Number of Routine-Information requests and corresponding response times

The numbers from the pre-pandemic period indicate that the system provided the fastest response to the Critical-by-agency requests and the slowest response to the Routine-by-agency requests. However, after the emergency declaration the order of the speed changes where the Important-by-agency receives the fastest response. Because even the information requests that are forwarded to municipal agencies require less response time than the full-service requests, separating them out from the service requests allows us to more effectively analyze this service request behavior.

With this in mind, there could be several explanations for the change in the order of the different priority levels, with respect to the response time. First of all, as noted above, the system made an overall improvement in service speed once the “Emergency Mode” was activated and daily working hours and personnel capacity were increased. This freed up additional resources to help improve response times at all priority levels. This does not explain, however, why the least amount of improvement was observed in the *Critical* requests, which led them to fall behind the performance of the *Important* requests.

The relative lack of improvement for the *Critical* priority requests may be because the system is already taking care of these high priority requests as quickly as possible, so that there is simply less room for improvement. Another possibility is that the public health restrictions implemented to prevent spreading of the COVID-19 virus made it more difficult for agencies to physically send personnel to check in with the client about the issue and to perform physical tasks to resolve that issue. A closer look thus should be taken at the different tasks labeled as *Critical* and *Important*, in order to determine if this could be a differentiating factor between them. It is also possible that there are internal, rather than external factors that are leading to the suboptimal allocation of resources. Despite the great effort put into increasing capacities with the emergency activation, perhaps the limited resources are simply not utilized as effectively as possible.

A different possibility for the apparent change in the *Critical* priority request behavior is that a change was made in the actual priorities of several different request types and this change was simply not applied within the underlying structure of the information system. Because the priorities are pre-determined and agreed upon by the 311 managers and the service response agencies, they may be difficult to change dynamically within the system, particularly because the call center operators are prevented from taking the initiative to correct the prioritization of specific requests based on their own individual judgement. However, in this case, because OCFL311 is a public agency and it works closely with both the service agencies and the Office of Emergency management, one would expect the process of making disaster-related updates and additions to categories to be facilitated. In fact, the dynamic addition of new categories related to the *CARES Act* at several different times during the first year of the pandemic suggests that such changes are, in fact, well-supported by the system.

CONCLUSION

The continuous support of the local government is critical for the well-being of a community during a disaster event, particularly a slow-onset and long-lasting event like the COVID-19 pandemic. E-Government systems like 311 non-emergency service systems that establish and maintain ongoing connections that provide support to the community thus play an extremely important role in supporting crisis response and recovery. This work-in-progress paper provided an initial look at the role of prioritizing services within such a system, in order to support building a better understanding of how such a system can be managed to best utilize the resources available to it.

Much of the discussion above focused on the behavior of the 311 system requests labeled with *Critical* and *Important* priorities, during the period after the COVID-19 emergency was declared. The actual relationship between these two priorities is less important than the indication that labeling a service request type as being of higher priority doesn't automatically lead to quicker response times, particularly in the uncertainty of a crisis. Changes in otherwise consistent behavior often occur due to the onset of a disaster event, and there are a variety of reasons why a system might experience a mismatch in its assigned priority labels as a result. By expanding on preliminary work such as this and taking a closer look at such unexpected or non-intuitive behaviors exhibited by a crisis management system, we ultimately can help to better understand that system and thus to improve both the system and the critical operations that it supports.

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