Continuity of Operations Planning in Public-Safety Answering Points during the COVID-19 Pandemic

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ABSTRACT

Continuity of Operations (COOP) planning helps ensure that municipal agencies maintain essential functions when disasters threaten critical infrastructures. COOP planning is especially important for Public-Safety Answering Points (PSAPs), which must continue to answer 911 calls and dispatch first responders during crises. However, COOP planning guidelines often focus on threats to cyber-physical infrastructures rather than outbreaks of infectious disease that threaten the human work arrangements—social infrastructures—agencies rely on to perform essential functions. This study reports preliminary findings from interviews with U.S. PSAP officials who developed plans to decentralize 911 facilities, networks, and personnel to maintain essential functions during the COVID-19 pandemic. These findings suggest revisions to COOP planning guidelines that consider requirements for redundant, diverse, and interdependent cyber-physical-social infrastructures.

Keywords

Emergency management, Business continuity planning, Critical infrastructure, Resilience.

INTRODUCTION

A Continuity of Operations (COOP) plan "details how an individual organization will ensure it can continue to perform its essential functions during a wide range of emergencies" that can include "localized acts of nature, accidents, and technological or attack-related emergencies" (FEMA, 2000, p. J-2). While federal, state, and local agencies routinely create and update all-hazards continuity plans that address threats to cyber-physical infrastructures (i.e., facilities, networks, power sources, transportation systems, etc.), outbreaks of infectious disease threaten social infrastructures: work arrangements that centralize essential personnel in shared physical spaces to perform agencies' essential functions.

This study reports preliminary findings from interviews with 15 911 officials representing 10 Public-Safety Answering Points (PSAPs) from across the U.S. whose existing COOP plans left them unprepared for the COVID-19 pandemic. Our interviews highlight gaps in general and pandemic-specific COOP guidelines published by the Federal Emergency Management Association (FEMA) (2018) and National 911 Program (2020) that focus on disruptions to cyber-physical infrastructures and require the *transfer* of essential functions to alternative facilities. In contrast, our interviews focus on disruptions to social infrastructures that require the *decentralization* of essential functions across primary and alternative facilities to reduce the risk of essential personnel contracting infectious diseases such as COVID-19. Learning from the ad hoc planning of PSAPs attempting to decentralize 911 facilities, networks, and personnel during the pandemic, our preliminary findings offer implications for all-hazards COOP planning by PSAPs and other municipal agencies.

Below we briefly review research on continuity planning and general and pandemic-specific COOP guidelines available to PSAPs. Next, we introduce our interview method and findings to describe the COOP plans created by PSAP officials during the pandemic. Lastly, we discuss limitations of existing cyber, physical, and social infrastructures identified across these interviews, and suggest guidelines for assessing the redundant, diverse, and interdependent infrastructures PSAPs will likely require for future public-health crises.

BACKGROUND

Studies of continuity planning address processes of organizational resilience: "the intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions" (Hollnagel, 2011, p. 275). The extensive literature on organizational resilience is expanding with studies that assess the resilience of critical infrastructures during the COVID-19 pandemic (Galbusera et al., 2021). These include public-safety communications that PSAPs manage by answering 911 callers' requests for assistance and dispatching appropriate first responders, including public health workers.

However, few studies address COOP planning by PSAPs (Oliver et al., 2012), or assess the utility of all-hazards continuity planning guidelines provided to 911 officials during outbreaks of infectious disease such as COVID-19. These resources include guidelines by FEMA (2018; 2020) and National Emergency Number Association (NENA) (2018), which organize COOP planning around four phases:

1. **Readiness and preparedness***:* warnings initiate planning and mitigation activities that prepare for potential disruptions to essential functions (i.e., continuity events).
1. **Activation**: continuity events activate continuity operations which may involve relocating and/or transferring essential functions to alternate locations or agencies per mutual aid agreements.
2. **Continuity operations**: essential functions are resumed at an alternate location or transferred to another agency; long-term continuity operations may require the acquisition of additional resources.
3. **Reconstitution**: normal operations resume once conditions stabilize; essential functions return to the primary facility, remain at the alternative facility, or resume at a new primary location.

These guidelines tend to focus on disruptions to cyber-physical infrastructures (e.g., damage to facilities, electrical outages, loss of connectivity, network intrusions, etc.) that require the *transfer* of essential functions to alternative facilities, networks, or nearby agencies in the case of devolution (i.e., transferring essential functions to other agencies) or the activation of mutual aid agreements.

In contrast, outbreaks of infectious disease disrupt social infrastructures: "the arrangements of organizations and actors that must be brought into alignment in order for work to be accomplished" (Lee et al., 2006, p. 484). Disruptions to social infrastructure occurred when essential personnel could not report to work after contracting or contacting someone with COVID-19, or when organizations implemented mitigation measures such as social distancing and remote work during the pandemic. Significantly, pandemic-specific guidelines published by FEMA, NENA, and other authorities acknowledge the vulnerability of essential functions when centralized among collocated people in a primary or alternative facility but overlook the interdependent cyber-physical-social infrastructures required to *decentralize* operations across multiple facilities to ensure that agencies can maintain essential functions during outbreaks of infectious disease.

These gaps appear in FEMA's (2018) *Continuity Planning for Pandemics and Widespread Infectious Diseases*, which recognizes that "Essential functions… will continue to be people dependent" but does not specify the interdependent infrastructures required to facilitate "human interactions [which] may be remote or virtual, resulting in the employment of appropriate teleworking and other approved social distancing protocols" (p. 5). Similarly, COVID-19-specific guidelines published by the Association of Public-Safety Communications Officials (APCO), NENA, and European Emergency Number Association (EENA) (CC:IPS, 2020; National 911 Program, 2020; EENA, 2020), advise 911 and 112 officials to "consider dividing personnel between the backup and primary facility," but do not outline the cyber-physical-social infrastructure requirements that officials must consider when planning to decentralize facilities, networks, and essential personnel.

METHODS

We interviewed 15 officials representing 10 U.S. PSAPs to learn how they maintained COOP during the early stages of the COVID-19 pandemic (Table 1). Semi-structured interviews were conducted via web conference software in the summer of 2020. We recruited 911 officials from our existing contacts and referrals from a public-safety consulting firm (Grace, 2021). Each interview lasted between 1-1.5 hours, was audio/video recorded after obtaining participants' consent, and then transcribed. Inductive analysis was performed by iteratively identifying and refining themes observed across the interview data. These were then compared with the COOP framework outlined by FEMA (2020) and NENA (2018) to organize the presentation of findings and draw implications for discussion.

Table 1. Interview participants' PSAP location, position, and jurisdiction characteristics

Participant	Location	Position	Jurisdiction Size/Type
1	Texas	Supervisor, 911 operations	Large, suburban counties
2	Oklahoma	Director, 911 communications	Small; rural county
3	Illinois	Director, 911 communications	Large; Suburban County
4	Texas	Supervisor, 911 operations	Small; rural County
5	Virginia	911 systems manager	Large; urban county
6	Virginia	Deputy Administrator, Systems	Large; urban county
7	Virginia	Deputy Administrator, Operations	Large; urban county
8	New York	Director, Emergency management	Medium; suburban county
9	Pennsylvania	Director, Emergency management	Medium, suburban county
10	Pennsylvania	Director, Emergency communications	Medium, suburban county
11	South Carolina	Director, Consolidated 911 center	Large; urban county
12	South Carolina	Deputy director, Consolidated 911 center	Large; urban county
13	Oklahoma	Supervisor, 911 operations	Large; urban county
14	Oklahoma	911 training analyst	Large; urban county
15	Oklahoma	Director, Communications center	Small; rural county

FINDINGS

Beginning in February 2020, PSAP officials discovered that existing COOP plans focused on threats to cyber-physical infrastructures did not prepare them for social infrastructure disruptions caused by the outbreak of the COVID-19 pandemic. In response, officials developed pandemic-specific COOP plans to maintain essential functions by *i*) transferring essential functions to backup call centers, *ii*) distributing essential functions across multiple call centers, and *iii*) allowing staff to work from home.

Transferring Essential Functions to Backup Call Centers

PSAPs planned to transfer 911 operations to backup call centers in the event of COVID-19 exposes among personnel within primary facilities. Initially, PSAPs sought to adapt existing continuity plans which included provisions for transferring operations to PSAPs in nearby jurisdictions linked through mutual aid agreements:

> Prior to covid our backup center was [nearby agency] police dispatch… We have been working with [adjacent] counties. However, as we moved into covid we looked at that and saw that each one of them had drawbacks when trying to use them as a backup center because they are dealing with the same problem: what would happen if someone got exposed in the 911 center? What would we do? There was not a whole lot of back up abilities there. (P7)

> We had a COOP plan on the shelf … which involved sending our telecommunicators to two other centers and, in the heat of the moment, we were like, "Do we really want to send potentially contaminated people to one of our partner centers and potentially contaminate them?" (P3)

Transferring operations to neighboring PSAPs did not address the "same problem" created by the pandemic: the risk of losing essential functions if the disease were to spread among essential personnel collocated in the call center or those of neighboring PSAPs. Consequently, rather than transfer operations and/or personnel to a call center in another jurisdiction, officials planned to decentralize their own facilities and not rely on facilities provided through mutual aid agreements included in existing continuity plans.

PSAP continuity planning therefore involved standing up backup call centers where essential functions could be transferred as long as primary call centers remained unavailable. Adapting existing continuity plans, backup 911 centers were set up at alternative facilities:

> In our options plan we looked at where we could dispatch from. We have a primary dispatch center where we work in our building now and we have a backup dispatch center that is fully functional. So, one of the plans was to leave one area as a clean area. In case we have an outbreak at the primary center, we can move people and operate from the second facility. (P8)

PSAPs also created clean backup centers at the primary facility that could support continuity operations during

the pandemic:

> For covid we decided to leverage our technology and set up a temporary backup center here [at the primary facility]... We rented a job trailer like they use at construction sites, ran network cables out there, got a backup generator to power the site, and moved three complete workstations with CAD, radio, and phone from our main center out there. We also brought in our mobile command vehicle, stationed it beside it, and hooked up an intercom system between the two. (P7)

These backup facilities were intended as short-term solutions: "if someone got sick and we could come in and clean the existing center while continuing operations in the backup" (P7). Small PSAPs in rural areas acted similarly within the resources they have available: "this office is a dark station so… if someone were to get sick on shift, I need to leave for the other person to come in and dispatch while we disinfect that room" (P2).

Distributing Essential Functions across Multiple Call Centers

After preparing to transfer essential functions to backup centers, officials planned to distribute essential functions across multiple call centers to perform concurrent 911 call taking and dispatch operations. This required splitting and separating the shifts of essential personnel across existing and new workspaces established at primary and alternative facilities during the pandemic. As officials explained:

> Another option was for workers with underlying conditions to find a separate work site. So instead of having them on the floor exposed to multiple people, we set up another 911 center in our primary building, but in a different location, so we could separate them out so that they would not be affected. (P8)

Rather than transferring centralized operations to alternative facilities as described in FEMA guidelines, pandemic COOP plans attempted to decentralize essential functions across multiple workspaces and facilities.

However, these attempts revealed limitations of existing cyber-physical infrastructures. PSAP's primary facilities often lacked sufficient space to accommodate multiple dispatch centers and featured open-office designs that could not be remodeled to restrict interaction and possible exposures among personnel. Smaller PSAPs with less resources most often encountered these constraints:

> I would like to have more options for dispatchers as far as places to be more remote… but I feel like we've been very fortunate that our city manager and our chief have really been supportive and getting things that have helped them to do their jobs and to be confident to come to work each day…hand sanitizer, toilet paper, Clorox wipes, things like that. (P2)

The disparity between large and small PSAPs was a theme across the interviews: the former had the administrative autonomy and resources to create and staff decentralized facilities while the latter, in this example, had to settle for additional cleaning supplies.

Technology, particularly network access points, also introduced challenges for officials planning to decentralize 911 operations:

> We looked at different options. We have a backup center and we looked at splitting staff. Logistically, however, that was not possible because our 911 trunks are not geo-diverse, they are separate, so a separate set of trunks come into the primary center and a separate set of trunks go into the backup center and they cannot be live at the same time. So, basically, if we split our staff only one center could take 911 calls. (P6)

Instead, the PSAP transferred administrative staff to the backup center to lower the risk of exposure for essential personnel—911 dispatchers— who would continue to work in the primary facility. Another PSAP, located in a large metropolitan area, made use of its substantial technical and personnel resources when planning to isolate shifts and concurrently staff both its primary and backup center: "we have talked about splitting our shifts so… first and third shift report to the backup facility which means the first shift would go home and later the third shift would arrive so there would be no overlap" (P9). Overall, officials' attempts to decentralize 911 operations revealed limitations of existing cyber-physical-social infrastructures that only PSAPs with redundant and diverse resources were able to overcome.

Allowing Staff to Work from Home

Lastly, PSAPs explored and implemented remote work arrangements to further decentralize 911 operations. Most of these efforts involved administrative and IT staff working from home and away from 911 dispatchers who remained collocated in primary and backup call centers:

> We had been experimenting with "bunny slipper" project before covid… When it came time all of our admin and support staff worked from home. I [director of the 911 center] am in the office alone. We found we have the capability to do that. (P8)

> Out of all 43, maybe 5-6 of those PSAPs, as far as the communications manager, worked from home. But the rest, their manager and supervisors were in there working with them like nothing had changed. It depended on the administration's decisions whether administrative staff work from home or if key individuals could still work in the building. (P1)

Only one PSAP created remote workstations by connecting mobile 911 dispatch systems, i.e., VESTA CommandPost, with FirstNet hotspots and then adding on additional capabilities:

> Due to COVID-19, we purchased twelve [remote call taking systems]. Soon we will have the ability not just to take calls but dispatch [to first responders]… For what we accomplished there was zero playbook… We are the early builders who are leading the trend in the county.

For most PSAPs, however, multiple barriers precluded the ability to create at-home dispatch solutions. These barriers included the inflexible, often legacy, technologies in many PSAPs:

> We would have loved to let people work from home. But we didn't have a) the number of computers on the CAD system, or the number of licenses for CAD or the mapping solution that sits behind CAD to be able to deploy that elsewhere. We've built our system on a model of shared workstations so our vendors (P3)

> We are technologically unable to do that and still function. Basically, the computer networks, IT and connectivity, the CAD, the radio, the admin computers they use on a regular basis—all are separate domains. It would be impossible to have the dispatchers function remotely from home because of the separate networks they work on. There would be no way to give them that capability… (P7)

Other barriers include the lack of reliable internet connectivity:

> The internet is not reliable enough at home for emergency communication. Some agencies turned to the FirstNet. Terrible coverage in that area. Without that we are not able to send people home. They should not lose a 911 caller…We are spread out and many people live outside our county. Geographic diversity will make it difficult. Some have home telephone company (P8)

Lastly, PSAP officials in some rural areas perform multiple roles, e.g., jailer, that require collocated work. For these PSAPs, essential functions involve more than 911 call taking and dispatch: "I think it would be an amazing option. I just don't know that we would be able to close the center here because we do so many other things as well" (P2). While many officials we interviewed investigated options for remote work, few were able to implement these arrangements due to a lack of available networks, potable technologies required for at-home dispatch work, and limited access to network-based services.

DISCUSSION

Our interviews with 911 officials reveal limitations of existing cyber-physical-social infrastructures that constrained PSAP COOP planning during the COVID-19 pandemic. Officials identified the following limitations:

- ***Limited space*:** PSAPs lacked extra or reconfigurable workspaces to socially distance personnel or create new call centers at their primary facilities. Some PSAPs whose continuity plans involved call routing and mutual aid agreements with neighboring PSAPs also lacked alternative facilities that could serve as backup or additional call centers.
- ***Limited access:*** PSAPs lacked redundant and geo-diverse networks which restricted the number and location of call centers that could be set up to decentralize 911 operations. PSAPs also lacked additional software licenses to cloud-based platforms, e.g., CAD, that prevented the creation of new workstations at primary and alternative facilities. Officials also faced challenges acquiring and transporting hardware to alternative locations.
- ***Limited collaboration:*** PSAPs lacked flexible, hybrid work environments that could support collaboration among personnel working across primary, alternative, and at-home workspaces. For redundancy, PSAPs require that each call center is capable of operating independently. However, PSAPs also require distributed collaboration across personnel collocated in call centers and personnel working remotely, including administrators, IT staff, and at-home dispatchers.

PSAPs also confronted challenges related to external conditions created by the COVID-19 pandemic:

- ***Uncertainty**:* Like most organizations, PSAPs were forced to respond to scientific uncertainties related to the transmission, symptoms, and complications of COVID-19, effective public health measures to stop the spread of the disease, and political uncertainties related the adoption and adjustment of public health mandates. Officials were forced to make ad hoc plans to address multiple contingencies and adopt incremental, temporary solutions.
- ***Limited authority:*** All PSAPs operate under local government control, however, larger, consolidated PSAPs often exercise greater control over operations, facilities, and resources than smaller PSAPs incorporated within public-safety agencies, i.e., police departments. Consequently, 911 officials who lacked independent authority to repurpose agency facilities, reassign staff, and acquire resources also lacked the authority to implement COOP plans that decentralized 911 operations.

These limitations suggest requirements for redundant and diverse infrastructures that can help PSAPs prepare for disruptions to existing social infrastructure: "one big room" where collocated essential personnel answer 911 calls and dispatch information to first responders. These limitations also suggest that planning to decentralize 911 operations requires addressing the interdependence of cyber-physical-social infrastructures in revised guidelines for all-hazards continuity planning.

Future Work: Guidelines for PSAP Continuity Planning

The implementation of continuity plans created by officials during the pandemic—transferring essential functions to backup call centers, distributing essential functions across multiple call centers, and enabling remote work among (non-)essential personnel—each require interdependent cyber-physical-social infrastructures. Our preliminary findings motivate further investigation of guidelines and diagnostic criteria for COOP planning in PSAPs and other municipal agencies (CISE, 2020). However, we begin by offering a set of deceptively simple questions that can help officials assess the redundancy, diversity, and interdependence of PSAP infrastructures (Table 2).

Table 2. Key questions for ensuring redundant and diverse PSAP infrastructures

Infrastructure	Redundancy	Diversity
Physical	Do we have backup facilities?	Can we repurpose our facilities?
Cyber	Do we have backup networks?	Can we access multiple networks at each facility?
Social	Do we have backup staff?	Can staff work together across our facilities?

Redundancy refers to the functional duplication of primary cyber-physical-social infrastructures available to the PSAP. In our interviews, officials, especially those from small PSAPs in rural jurisdictions, often reported lacking backup facilities, networks and network access points, and personnel. Answering the three questions addressing redundancy in Table 2 requires officials to take stock of agency resources under their authority, identify needs, and make plans for acquiring additional assets and personnel needed to activate continuity operations during a crisis. However, ensuring redundancy is a necessary but insufficient first step in COOP planning.

Diversity refers to the functional variation of primary and alternative cyber-physical-social infrastructures available to PSAPs. For example, diverse physical infrastructures can be repurposed to support different essential functions. However, repurposing facilities requires redundant and diverse cyber- social infrastructures. While officials from one PSAP repurposed their training room to create an additional call center, other officials could not do the same because they lacked the requisite network access points, portable equipment to create additional workstations, and enough personnel to split shifts between a primary and backup call center. For redundancy, staff at each call center needed to be able to operate independently but, whenever possible, also collaborate with personnel in other call centers or working from home. Diversity of social infrastructure thus refers to the variety of distributed work arrangements that allow staff to perform essential functions. Our interviews show these arrangements involve a mix of collocated and remote work (Olson & Olson, 2000), and require interdependent cyber-physical-social infrastructures that can support hybrid collaboration among dispatchers working together at call centers, between dispatchers working at separate call centers, and, at the same time, various personnel working from home.

CONCLUSION

Beginning in February 2020, PSAPs began planning for disruptions caused by the COVID-19 pandemic. Unique to outbreaks of infectious disease, these disruptions threatened the social infrastructure of public-safety communications: arrangements of essential personnel that allow PSAPs to answer 911 calls and dispatch information to first responders. This study reports COOP planning among U.S. PSAPs that attempted to decentralize 911 operations by *i*) transferring essential functions to backup call centers, *ii*) distributing essential functions across multiple call centers, and *iii*) enabling remote work among (non-)essential personnel. These attempts highlight limitations of existing cyber-physical-social infrastructures when called on to support decentralized 911 operations, and suggest all-hazards COOP planning requirements for redundant, diverse, and interdependent infrastructures that can make PSAPs and other municipal agencies more resilient during future crises.

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