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Understanding the Decision-Making Process for Hurricane Evacuation Orders: A Case Study of Florida County Emergency Managers

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Abstract: This study aims to provide a more robust understanding of the elements involved in emergency managers' decision-making processes when issuing hurricane evacuation orders. We used the principles of the theory of bounded rationality to formulate research questions for understanding decision-making during uncertain times (i.e., hurricane evacuation orders). We then conducted 20 semi-structured interviews with county emergency managers in Florida to understand how this decision-making process unfolds. Results showed that emergency managers consider two primary factors in their decision-making process, including fixed and random factors. Fixed factors refer to elements and information that are known to emergency managers and do not change drastically from one hurricane to another (e.g., homeless population, poor housing structure). Random factors, on the other hand, refer to elements involved in hurricane decision-making that cannot be precisely predicted (e.g., storm surge). Random and fixed factors then blend in with other elements (planning, collaboration, and information assessment) during the response phase of an emergency. The interplay among these elements can ultimately influence emergency managers' hurricane evacuation decisions. Although the existing research has made significant strides in studying many aspects of emergency managers' decision-making processes, there have been limited discussions about the various factors that emergency managers consider for issuing hurricane evacuation orders. Our study highlights the broader implications of information interpretation, situational uncertainty, and collaboration for emergency management organizations responsible for making decisions about hurricane evacuation orders. Using the theory of bounded rationality, this study dissects both fixed and random factors influencing evacuations. In doing so, it has the potential to assist emergency managers in developing more sustainable hurricane evacuation plans in the future.

Keywords: hurricane evacuation; decision-making; bounded rationality; county emergency managers; Florida

1. Introduction

In recent decades, population growth, socioeconomic disparities, and rapid urbanization have created pressing issues for emergency managers (EMs) [1], often exacerbated by uncertainty. Uncertainty, which is an element of the emergency management decision-making process [2], "refers to the discrepancy between the actual state of the world at any time and the information available to the decision maker" [3] (p. 109). It can be viewed as gaps in knowledge about the current and future state of emergencies [4]. In this study, we focus on uncertainty in the form of various factors that EMs consider when issuing

hurricane evacuation orders. According to the National Oceanic and Atmospheric Administration (NOAA), hurricanes have resulted in the most damage (more than USD 1.3 trillion) and contributed to more deaths (6890 individuals) since 1980, compared with any other weather-related disaster [5]. Our study primarily focuses on the elements preceding the issuance of an evacuation order for hurricanes to understand how EMs' experience from past events and their collective decision-making process translate into evacuation orders. Since the nature of an emergency necessitates that decision-makers consider many factors in a relatively short period, leading to stressful conditions for EMs [6], our findings can contribute to an improved understanding of the elements that EMs and their collaborators (e.g., policy groups, fire departments) consider when making complex decisions about hurricane evacuations. More importantly, our study adds to existing research by highlighting the importance of collaboration among members of policy groups as well as different jurisdictions in overcoming challenges in decision-making under uncertainties. Broadly speaking, the findings of this research could contribute to the planning literature and promote sustainable hurricane disaster planning in the future.

1.1. Uncertainty in EMs' Decision-Making

Oftentimes, EMs face extreme events that they have not experienced before [7], which would require EMs to use discretion with some level of uncertainty in their decision-making process. In a more specific sense, uncertainty exists when existing emergency plans are not sufficient for decision-making, and the disaster situation is different from what an EM has experienced before [8]. While certainty in decision-making can lead to significant improvements and gains for communities [9], if faced with uncertainty in the early phases of decision-making, EMs' final decision can significantly diverge from its normal path [10].

In the context of natural hazards, League et al. [11] studied the multi-stage level of EMs' decision-making using tornado warning communication systems. They found that EMs' decision-making is complex and that EMs strive to overcome uncertainty using different sources of weather information available to them. The benefit of using multiple sources of information is that it allows EMs to verify an event before issuing any public warning [11]. One source of information provided to EMs is the National Weather Service (NWS) forecasts [12]. While both short-term and long-term forecasts can alleviate the cognitive burden on EMs, the use of such forecast information can create a state of uncertainty in decision-making for EMs. This is especially true if EMs utilize long-term forecast information that inherently has higher levels of uncertainty [13].

Some experts believe that uncertainty in emergency management systems refers to the lack of or insufficient information, but Longford [14] suggests otherwise. The author argued that both ends of an information dissemination continuum (having no information or too much information) can create conditions of uncertainty and confusion for the decision-maker [14]. Furthermore, EMs mostly rely on resources already available to them, such as monitoring teams and pre-recorded data for decision-making, thereby minimizing the value of forecast data [12]. In recent years, the NWS has invested in steps to improve probabilistic forecasts by integrating uncertainty metrics into its forecast models. Such forecast information is vital for EMs dealing with complex and uncertain conditions on the ground. However, the complex nature of decision-making in emergency management, even with the availability of advanced forecast data, does not necessarily lead to appropriate or optimal decision-making [12].

1.2. Theoretical Framework

This study incorporates the main principles of bounded rationality proposed by Simon [15,16] to understand the central construct of uncertainty in decision-making as experienced by EMs and formulate research questions. Simon's [16] Theory of Bounded Rationality postulated the constraints of rational choice theory in economics. He argued that a decision-maker (i.e., individual or institutional) has limited knowledge about the risk and uncertainty associated with the cost or function in an economic decision, has

"incomplete information about alternatives" [16] (p. 163), and deals with other complexities and environmental constraints when making a decision [16]. In general terms, bounded rationality is the speculation that individuals' decisions are satisfying (i.e., imperfect), though they are not entirely irrational. This theory incorporates a more realistic way of how people make choices and explains that:

The choices people make are determined not only by some consistent overall goal and the properties of the external world but also by the knowledge that decision-makers do and do not have of the world, their ability or inability to evoke that knowledge when it is relevant, to work out the consequences of their actions, to conjure up possible courses of action, to cope with uncertainty (including uncertainty deriving from the possible responses of other actors), and to adjudicate among their many competing wants [15] (p. 25).

The application of this theory can be seen in the public administration discipline, where bounded rationality was applied to explain the behavior of public managers with respect to performance and aspiration [17]. Bounded rationality has also been discussed in the work of emergency management scholars (see [18–22]). Rivera [19] utilized bounded rationality to investigate why some individuals decided to apply for FEMA assistance and why others did not. Parnell and Crandall [18] explained the importance of bounded rationality in emergency decision-making by arguing that due to the lack of time in an emergency, a decision-maker cannot spend time assessing every possible decision. Therefore, decision-makers should have established criteria that help them evaluate different criteria-based decisions, and ultimately, allow them to make a satisfying decision given the time constraints. We use four main principles of bounded rationality, meticulously described and explained by Jones [23], to understand how bounded rationality can be applied in the current study.

Table 1 applies principles of bounded rationality theory, as explained by Jones [23], to the current study. It is noteworthy that we mainly focused on the principles of adaptation, uncertainty, and trade-offs (see [23] for further details). We address intended rationality at the surface level as a careful examination of this principle requires complex cognitive and physiological evaluation of EMs' behavior, which is simply beyond the scope of this paper. From the literature review and principles of bounded rationality, we developed the following research questions (RQs).

Table 1. An application of bounded rationality in the study of EMs' decision-making under uncertainty.

Principle	Application in Current Study
Intended rationality	Understanding how EMs' personal characteristics (e.g., personal bias, previous experience in issuing evacuation orders) influence their decision about issuing an evacuation order
Adaptation	Understanding EMs' examination of the social environment (i.e., community, organization) in which a disaster event is expected to occur and how it influences their decision about an evacuation order
Uncertainty	Understanding how EMs deal with uncertain elements around which hurricane evacuation orders are issued
Trade-offs	Understanding the nature of a "satisfactory" decision in the context of issuing hurricane evacuation orders

RQ 1. What are the community factors that county EMs in Florida consider when making decisions for hurricane evacuation orders?

RQ 2. What are the institutional factors that county EMs in Florida consider when making decisions for hurricane evacuation orders?

RQ 3. What are the main factors that create uncertainty for county EMs in Florida when considering the issuance of a hurricane evacuation order?

1.3. The Role of EMs' Personal Characteristics in Decision-Making

While EMs' decisions are often influenced by external elements (e.g., policies and storm characteristics), internal elements (e.g., how EMs interpret information based on past experience or perception) should not be underestimated. EMs' decision-making is double-faceted. On one hand, EMs' skills and characteristics can limit their decision-making [24]. On the other hand, external factors can influence and complicate the circumstances in which EMs' decisions are made [25]. Focusing on the personal traits of EMs, research shows that local EMs' decision-making is informed by the decision-making of EMs in neighboring jurisdictions. For example, overpreparation and miscalculation by one EM for an event that did not occur are less likely to take place by another EM for the same event in the future [13,24]. Peerbolte and Collins [1] showed that local EMs' ability to manage risk was lower compared with managers in other locations. However, the level of education and years of experience positively affected an EM's critical thinking. There are, still, other elements that come into play with EMs' level of experience. Similar to the general population, EMs, especially those with seniority and experience in the field, are likely to use their personal judgment and act with bias [13,24]. Therefore, understanding how EMs respond to certain information can help weather forecasters provide more tailored information to EMs.

While the availability of information is vital for EMs' decision-making, their ability to comprehend and understand information is even more critical [26]. Organizations have put forward decision-making training with sensemaking for EMs, but overall, little attention has been paid to underlying cognitive behaviors, such as personal bias [27]. How forecast information is presented and framed can affect EMs' decision-making. For instance, EMs prefer forecast outcomes that are presented to them as gains compared with when they are portrayed as a loss [13,24]. Another form of forecast presentation is concerned with the numeracy apprehension of EMs, requiring forecasts to provide information in formats most frequently seen and used by EMs. For instance, EMs are more likely to take action if the information is presented in frequency format rather than in proportion format [13,24]. While this finding holds for the EMs who participated in Wernstedt et al.'s [13] study, it is imperative that all EMs have access to information expressed in a variety of forms (probabilities, frequencies, graphs) to avoid interpretation bias by EMs.

1.4. Evacuation Decision-Making

Thus far, we have highlighted the role of uncertainty, theory, and EMs' personal characteristics in the emergency management decision-making process. Looking at all these variables is essential for determining how evacuation decisions are made. In emergency management, decision-making is a multi-actor process, requiring information sharing and coordination among multiple actors [28], as well as collaboration between different levels of government, with government in other areas, and with organizations in different sectors [29]. Evacuation is the act of moving individuals from a threat zone to a safe area to protect people's health and lives and prevent damage to property [30]. Existing research on events such as volcanic eruptions has shown that how evacuation decisions are communicated to residents and the way these messages are constructed are of paramount importance [31]. In the context of hurricane evacuations, previous studies have mainly focused on evacuation from residents' point of view (see [32], where the authors discussed the evacuation behavior of the vulnerable population during Hurricane Irma), with a few studies mentioning the role of EMs [33]. Evacuation decisions are complex and require a more holistic approach by EMs than a mere assessment of weather reports. While such weather information is necessary for emergency management decision-making, EMs' substantial use of non-weather sources highlights the importance of contextual factors in decision-making [34]. For instance, emergency operations centers' decisions are framed around the threat and technological resources available to EMs to address the threat, but the social context of disasters also plays a key role in emergency management [25]. Population characteristics, such as people's level of mobility (i.e., access to transportation) and pet

ownership, are among the logistics that EMs consider when ordering evacuations [35]. Vulnerability is another critical factor that EMs consider in their decision-making. Particularly, the evacuation of vulnerable populations [36], including but not limited to hospital patients [37] and senior citizens [38], requires careful planning by EMs. Additionally, the setting (urban vs. rural) also plays an important role in EMs' general decision-making [39]. In general, how EMs manage evacuations can depend on "the size of the risk area and its population" [35] (p. 123).

Hoekstra and Montz (2017) [34] interviewed local EMs in two metropolitan areas after Superstorm Sandy to understand the components that EMs consider when making the ultimate decision to recommend/order evacuation. The study identified several factors, including "characteristics of the municipality, factors involving the individual EM, and weather information and storm characteristics" [34] (p. 457). Using mandatory or voluntary orders, EMs often notify jurisdictions prone to disasters to take necessary actions to save lives and reduce financial damage [40]. The observable factors that influence EMs' decision-making are "storm size, clearance time, time of day, potential storm surge, and time to landfall" [40] (p. 87); and unobservable factors revolve around bureaucratic and political elements and other counties' decisions, as well as previous history of evacuation orders [40].

2. Methods and Results

We collected data using semi-structured phone interviews (the interview protocol was reviewed and approved by the Institutional Review Board (IRB)) with Florida county EMs who were invited via email to participate in this study. Out of all the 67 counties in the State of Florida that were contacted, 20 county EMs from 19 counties participated in this study, for a response rate of 28%. Phone interviews took place from June 2018 to December 2018, and interviews were recorded with the interviewees' verbal consent.

All phone interviews were transcribed and imported into NVivo software (version 1.7) for content analysis. The first approach to analyzing the qualitative data was deductive coding, using the main findings of Wernstedt et al. [13], Chang [29], Hoekstra and Montz [34], and Gudishala and Wilmot [40]. Given [41] noted, "deductive discovery is a conscious, intentional, and systematic process" [41] (p. 221). Except for one coding category (i.e., bias in decision-making), most predefined categories were discussed frequently by EMs although the variable EMs' experience can be an element contributing to bias [13], we coded it as a separate variable of knowledge/experience, as introduced by Hoekstra and Montz [34]. The reason for such coding was that we asked the interview question about EMs' experience mainly to understand how long EMs have been in their current position. The second step in the data analysis was inductive coding and interpreting the interviews for creating new nodes (i.e., codes). According to Creswell and Poth [42], "the logic that the qualitative researcher follows is inductive, from the ground up, rather than handed down entirely from a theory or from the perspectives of the inquirer" [42] (p. 19). Using inductive reasoning was imperative in this study as certain information contained in the interview transcripts did not fall under the predefined categories. Therefore, new categories as well as subcategories were added to predefined coding schemes in our codebook.

The initial findings from deductive and inductive coding implied that uncertainty in decision-making is an underlying aspect of evacuation decision-making. Although ascertaining what contributes most to this uncertainty was a challenge, interviewees' responses to the question of how their evacuation decision-making unfolded during the most recent hurricane helped to understand the steps EMs take before issuing an evacuation order. Figure 1 shows the process of EMs' evacuation decision-making derived from the analysis of the interview data. Collaboration in decision-making, decision-making timeline, emergency plans and preparations, and shelters were the four most frequently mentioned categories/subcategories in the interviews. After carefully reviewing codes that were frequently mentioned across interviews, we grouped factors that could potentially influence EMs' decision-making into two main categories of fixed and random factors.
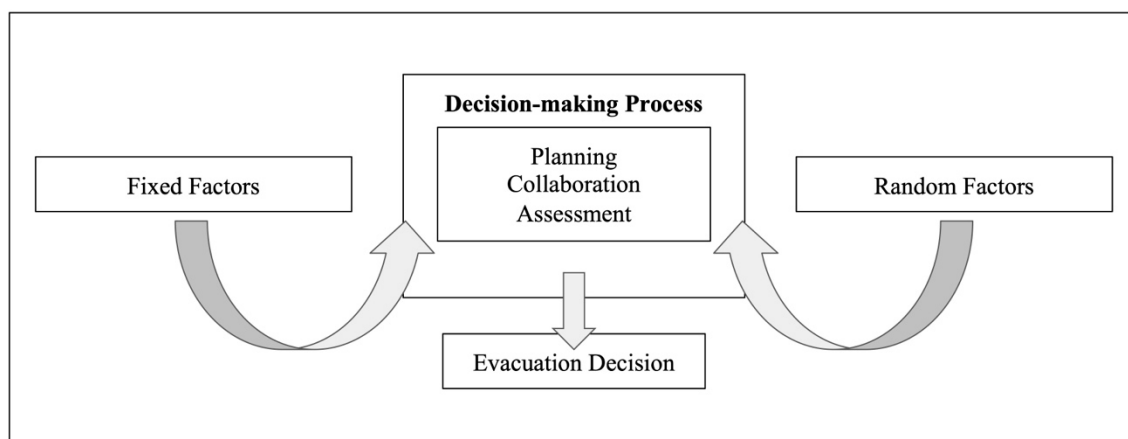
Figure 1. EMs' evacuation decision-making process.

2.1. Fixed Factors

The interviews revealed that fixed factors are the characteristics of a community that are known to EMs, can be planned for, and do not change drastically from year to year. Municipality factors such as the retiree population, homeless population, poor housing structure, registered special needs persons, and limited road capacity are some examples of fixed factors. EMs discussed these certain vulnerabilities in their communities and explained how they take them into account in the planning process. For instance, counties have strategies for people with special needs to register themselves as the special-needs population before a hurricane. Doing so will provide this vulnerable population group safe access to shelters when evacuation orders are issued. Infrastructural challenges, such as limited road capacity and existing road conditions (e.g., construction, maintenance), were also discussed by the interviewees as potential factors impacting their decision-making. Moreover, understanding the geographic characteristics of the county, such as topography, can help EMs plan for evacuation logistics accordingly for potential storms or hurricanes. For instance, EMs from coastal counties talked about being at risk of flooding and storm surges, while EMs from inland counties were mainly concerned about rainfall and storm winds. Interviewees noted the following concerns.

> "That puts some serious challenges, but when you look at the overall, overall of the county of its topography and how many mobile homes we have. We have many mobile home parks, we have lots of RV campgrounds, things like that. All of those people are very susceptible, and you make that to the fact that you have a senior population."

> "And we also have, you know, we don't have many, but we do have a lot of manufactured homes, neighborhoods, you know with hundreds or even a thousand manufactured homes."

2.2. Random Factors

These variables can be defined as evacuation decision-making circumstances that cannot be predicted precisely. According to the qualitative data analysis results, random factors can range from storm-related possibilities (e.g., storm surge) to human behavioral uncertainties (e.g., evacuate vs. not evacuate). An interviewee described storm-related uncertainty as follows.

> "We evacuated over 300,000 people in that mandatory evacuation area and fortunately, we didn't get the storm surge that was possible. We really didn't have any storm surge versus the 10 to 15 feet storm surge possible."

What the same interviewee mentioned on the topic of human behavioral uncertainties was as follows.

"I think the most important thing is the difficulty of the decision. It's not a... it's not a science as much as we would love to be able to just... you know... get data in and make a decision. It's based on... you know local <inaudible> local, past history of flooding events, it's based on what we think people are gonna do...the behavioral piece of people listening to us. It's definitely not a 100% scientific decision. There's art to it, there's politics to it, there's jurisdictional issues with it, all sorts of things like that make it... um..., you know... evacuation decisions are in my opinion the hardest decision that emergency managers make."

While fixed and random factors play a critical role in evacuation decision-making, as Figure 1 shows, the interplay between fixed and random factors can complicate circumstances in which EMs decide whether to evacuate. The analysis revealed three steps most EMs take that lead them to final decisions for evacuation. These steps are planning, collaboration, and assessment, which are discussed in the following.

2.3. Planning

Overall, preparedness and planning activities are somewhat similar across counties in the State of Florida. Planning for hurricanes starts months before the hurricane season, and the planning team in the overall emergency management team becomes more focused when there is a new hurricane development. To mitigate the impact of uncertainties in evacuation decision-making, most counties are proactive in planning for and monitoring potential hurricanes. Emergency plans, evacuation matrices, and constant communication with weather forecast professionals were common approaches for making informed decisions. A few counties referred to the State of Florida's hurricane evacuation behavioral studies (since 2006, the State of Florida has been continuing its Statewide Regional Evacuation Study Program [43]. An example of these planning councils is the East Central Florida Regional Planning Council, which is currently updating its hurricane evacuation behavioral survey studies. For more information, please visit https://www.ecfrpc.org/sres), which could help counties predict human behavior during a hurricane and potentially reduce the uncertainty related to random factors. Other counties mentioned the application of HURREVAC software (https://www.hurrevac.com/) that considers various weather-related factors and helps the county managers decide the time and location to which they need to be evacuated. While EMs and their team continuously monitor hurricane activities, they start rigorous planning 7–10 days before a hurricane is expected to hit their counties. One interviewee noted the following:

"We have a notebook that we have developed in house, called the Tropical Planning Workbook and that starts when we are about 7 days out from a storm or tropical cyclone. We whiteboard it all out and determine three different scenarios. We plan for if the storm stays on its forecasted path, if it moves to the left, and if it moves to the right. And so, we come up with those different scenarios and plan for each of them."

2.4. Collaboration

Most, if not all, interviewees emphasized the importance of their partners, such as the police or fire department, in evacuation decision-making. The importance of policy groups and their involvement in the decision-making process in times of disaster was mentioned several times. For instance, one interviewee mentioned the following:

"Our evacuation response requirements are the executive policy group making the decision and the mandatory evacuation. However, the mandatory evacuation order was not issued for this facility [an assisted living facility]. The county and the executive policy group strongly recommended that we and the ownership of the property evacuate the people from that facility, and we assisted with that."

While the interviewees implied the existence of a vertical organization collaboration system or a horizontal inter-organizational collaboration system before an evacuation deci-

sion is made, only a few of them mentioned that they communicate with their neighboring counties for evacuation purposes to improve coordination efforts. For instance, one of the study participants noted the following:

> "In any evacuation, there are other decisions that have to be made to coincide with evacuation. So, our decision to evacuate has to coincide, one with other evacuations, so if we call for an evacuation, County A, County B, County C, and County D, which are our bordering counties, have not called for an evacuation. Then we need to have that discussion. So, there are decision making discussions that take place across county lines. Especially with a hurricane."

Some counties discussed the inter-jurisdictional relationship among adjacent counties, which helped them collaborate on the evacuation order and avoid confusion among residents who live and work in different counties, or among visitors in central Florida who may be scattered across several adjacent counties. Failure to collaborate may result in major challenges to protective actions like evacuation. One EM mentioned that before a recent hurricane, southern counties in the state had received fuel sooner than other counties. The interviewee described the processes as follows:

> "The highway patrol was escorting tankers to the south, to get people evacuated from south Florida. What they did not take into consideration in the state, is that you do not escort fuel everywhere else, you are not going to have anywhere to go, and that was the problem. None of our stations had fuel."

Therefore, not only collaboration among neighboring counties with residents that often commute to these adjacent counties for work, school, or shopping is necessary for evacuation decisions, but all counties in the state should act as a connected network of counties. Although residents in these southern counties traveled northward to evacuate, they were forced to stop in other counties when they ran out of fuel along the way, which created challenges for other areas experiencing an influx of evacuees.

2.5. Information Assessment

The final step in the decision-making process is assessing available information and making decisions about whether an evacuation order is needed. Constant communication with weather forecast professionals, such as meteorologists at the NWS and National Hurricane Center (NHC), and the use of HURREVAC and other applicable software systems help EMs better understand the severity and impacts of a storm and act accordingly. Based on the recommendation from policy groups (In email communications with one of the emergency management planners working in an inland county in the State of Florida, policy groups were defined as follows: "Most of the 67 counties in Florida have some sort of Policy Group that meets to decide the overall direction of the incident. Typically, this group is made up of agency administrators and it supports the Emergency Management Director in decision making and alleviating some day-to-day restrictions. This will include calls for evacuation. Being that our county is not coastal, we typically call for evacuations in a voluntary manner for low-lying areas and mobile/manufactured homes. This is due to the nature of being a host county for a number of coastal counties evacuating inland. The language for local emergency management powers can be found in Florida Statute 252.38. Additionally, the Governor can call for an evacuation; however, historically this has only happened if the local agency fails to act in a manner that protects the locals. Mandatory evacuations are few and far between due to a number of resources and laws affecting those, things like road patrols, open carry of firearms, and the long-term business impacts of a mandatory evacuation. These laws for the Governor are defined in Emergency Management powers of the Governor in Florida Statute 252.36."), the information available, county emergency plans, and lessons learned from previous hurricanes, as well as behavioral, evacuation, and other regional studies in the State of Florida, EMs decide whether to issue a curfew and ultimately an evacuation order before a hurricane makes landfall. Two

interviewees noted their experience in seeking and processing weather forecast information for hurricanes:

> "We listen very heavily to the National Weather Service, and then we also analyze HURREVAC."

> "We about 7–10 days out, the state starts coordinating conference calls with at least one a day with the local emergency management authorities and the National Hurricane Center as well as the local weather service field offices to determine our course of action, protective actions."

From a logistical standpoint, such orders are issued 72 h before a hurricane is predicted to hit a county, allowing enough time for people to evacuate. Most counties have evacuation zones prioritizing evacuation actions based on fixed factors or characteristics of the area (e.g., geographical typology, special needs population). The time at which EMs issue the evacuation order is also of great importance. County EMs repeatedly discussed how evacuation orders are issued in the daylight to reduce the number of people traveling during the dark:

> "Being that it so our regional evacuation study says that we have 15 h to complete it, so when we get our surge notice and we get our information from the National Weather Service, we compare it with our matrix, and then we make a decision of when we're going to pull that trigger and we always want people to be evacuating during daylight hours."

Overall, the EM interviews implied uncertain circumstances before a hurricane (including Hurricanes Irma and Matthew) and suggested that ensuring the public receives accurate and timely information about a hurricane is vital for transparency and a proper evacuation. This is consistent with the findings of Huang et al. [44], suggesting that the uncertainty about Hurricane Irma resulted in "over-evacuation" [44]. One factor discussed during the interviews was public trust in the county when it comes to hurricane evacuation. A county EM mentioned that in the instance that an evacuation order is issued and residents are asked to evacuate, if the hurricane changes its path and does not impact the evacuated area, residents may lose their trust in the county and decide not to listen to the evacuation orders in the future. Therefore, county managers should continually consider the element of public trust when deciding to order a mandatory evacuation. The "cry wolf syndrome" may be a concern, but may not be realized, as repeated evacuations during the same hurricane season have found approximately the same people evacuated from the same area for both hit and missed hurricanes [45]. Residents may search for alternative information about evacuation traffic and storm updates using social media and other non-governmental sources, but official evacuation notices (recommendations and orders) disseminated by EMs and local governments affect evacuation rates the most [46].

3. Discussion and Conclusions

Several implications flow from the data analysis. While personal characteristics of EMs were frequently mentioned in the literature as a factor in evacuation decision-making, our results revealed that other fixed factors are also influencing this process. For instance, the importance of geographic characteristics (e.g., location, topography, or retiree population) was evident in the data analysis section, which is consistent with the findings of Kapucu et al. [39] on the role of settings in EMs' decision-making. The personal characteristics of EMs were seldom mentioned in the interview responses, partly due to the nature of our interview protocol, which mainly focused on decision-making and hurricane evacuation processes rather than EMs' personal characteristics. Another personal characteristic mentioned in the literature was how EMs think and interpret different information. Our findings indicated that EMs' decision-making process is the result of collaboration with the entire team to interpret available information and to pursue the best possible action.

Another implication is how situational uncertainty, as one of the challenging elements, influences EMs' decisions. In our analysis, we explained uncertainties as random factors

because their prediction could be associated with a large margin of error. Although eliminating random factors is nearly impossible, educating the public [47], especially in areas experiencing social and economic inequalities [1], and ensuring that there are resilient evacuation methods are critical for proper emergency response. Preparing for worst-case scenarios, as mentioned by the interviewees, is an important strategy for developing adequate response and evacuation strategies. Nonetheless, many worst-case scenarios evolve close to the onset of a hurricane. Therefore, the logistical aspects of existing emergency plans may not fully address the magnitude of upcoming disasters. Although emergency plans are updated regularly to reflect changes in the community, preparing longitudinal analyses of worst-case scenarios using storm-related uncertainty factors can empower EMs to project future worst-case scenarios. Adding the temporal trend in these scenarios to other community information, such as a change in population demographics, recent environmental studies, and community needs assessment studies can provide a better outlook on future hurricanes and the best evacuation strategies for the community as a whole (i.e., people, environment, or organizations).

The central pieces of hurricane evacuation decision-making were planning, collaboration, and information assessment. What was evident in the interviews with EMs was the level of work that went into planning and constant monitoring of potential hurricane developments. Many EMs discussed how emergency plans are executed with a rough timeline. While planning for hurricanes is completed throughout the year, specific planning for a hurricane response starts roughly ten days before it is expected to hit a region. It is within this timeframe that EMs start to have more conversions with policy groups and weather professionals for evaluating the situation at hand. Overall, EMs heavily rely on information they receive from the NHC and NWS. Software packages, such as HURREVAC, were also mentioned as powerful tools for decision-making, which demonstrates the importance of technological advancements in emergency management. Decision-making uncertainty was more evident in the context of storm characteristics than a lack of information. Although the findings can, to some extent, be subjective, it appeared that EMs received the right amount of information (neither too little nor too much), which placed them in the middle of the information dissemination continuum [14].

This study adds to the existing literature about EMs' decision processes (see [13,24]) and provides more insights regarding the extent to which characteristics of EMs, as a group, influence evacuation decision-making processes. This finding not only confirms the importance of collaboration in emergency management as discussed by previous studies (see [48]) but also emphasizes the presence of emergent and informal groups (such as policy groups). Collaboration with policy groups for hurricane decision-making appears to be a common practice in Florida counties. In fact, collaboration for reviewing hurricane information and issuing evacuation orders was integral in the decision-making process. While working with policy groups may not be as common in other states as it is in Florida, the current study sheds light on the collective nature of hurricane evacuation decision-making. Although there are power imbalances in collaborative efforts, both inter-jurisdiction and intra-jurisdiction collaborations play an important role in hurricane evacuation decision-making. Furthermore, since EMs' decisions are collaborative, rather than individual processes, it is imperative to acknowledge the collective influence of the four principles of bounded rationality (see Table 1) on evacuation order decisions. However, our findings cannot explain how such collaborative work among EMs and multiple stakeholders can influence "satisfactory" decisions (i.e., evacuation orders). Therefore, further research is needed to examine the impact of collaboration on complex governmental decisions in the context of emergency management.

Overall, this study corroborated numerous factors that can complicate the decision-making process, which is consistent with the findings of Kowalski-Trakofler et al. [6]. EMs use their experience, plans, tools, and other information sources available to make the best decision to save lives and properties. Their evacuation decisions are the results of continuous preparation, monitoring, and analysis of emergency events. Oftentimes, EMs

learn from past experience and use existing behavioral studies to improve their response to future events. What the public should understand is that evacuation decisions are issued as the result of the interplay among fixed factors and random factors. Ordering an evacuation does not put a stop to the constantly changing nature of random factors. As a result, in hindsight, evacuation orders may seem unnecessary or irrational to the public. Following such events, as mentioned in our data analysis, the public trust in evacuation decisions may be lessened. Educating the public about how evacuation decision-making processes work and encouraging them to act as advocates of evacuation decisions are vital for restoring public trust and ensuring the timely response of the public to emergency evacuation orders in the future. This finding has the potential to add to the existing body of planning literature and foster sustainable disaster planning strategies.

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