Potential of Improving Incident Respond Times in Water Rescue using Drones - A Case Study

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Presented at International Conference on Innovative Practices in Management, Engineering & Social Sciences (IPMESS-24), Singapore, 3-6 January 2023.

https://doi.org/10.37082/IJIRMPS.IPMESS-24.8

Published in IJIRMPS (E-ISSN: 2349-7300), IPMESS-24

Abstract

The time-sensitive nature of water rescue operations demands effective strategies to reduce response times. This paper presents a comprehensive case study focused on improving incident response times in water rescues through the integration of water rescue drones. By analyzing existing response systems and evaluating the potential of drone technology, the study sheds light on the critical need for timely intervention in drowning incidents. The results highlight the challenges associated with current emergency response mechanisms in Germany and the promise of drone-assisted water rescue efforts. The findings emphasize the significance of this technology in enhancing incident response times, ultimately contributing to the reduction of drowning-related fatalities on a global scale.

Keywords: Drowning Prevention, Emergency Response Efficiency, Water Rescue Drones

1. Introduction

According to the World Health Organization (WHO), drowning is defined as "The process of experiencing respiratory impairment from submersion/immersion in liquid" [1]. Worldwide, drowning is one of the ten most common causes of death among children and young people up to the age of 24 and is the third most common cause of injury-related death. Every year, around 236,000 people (as of 2019) lose their lives to drowning worldwide [2]. At least 355 people fall ill in Germany (as of 2022) [3]. The drowning process is an extremely time-critical situation. An analysis of international video recordings of drowning people of different ages shows that the average time until a person was last seen above the surface of the water was around 106 seconds, and therefore less than two minutes. Due to the small sample size and the small number of camera recordings of drowning people worldwide, it is not possible to provide a representative and generalizable time estimate [4]. In order to shorten the time until the arrival of the water rescue service and thus the rescue of the drowning person, the Guardian research project investigated an overall system for the semi-autonomous rescue of drowning persons using UAVs and holding boxes near the shore. Important components of the project are a process analysis of the emergency response, the integration of specifically adapted drones for water rescue and the shortening of the therapy-free interval through the prompt rescue of the drowning person [5].

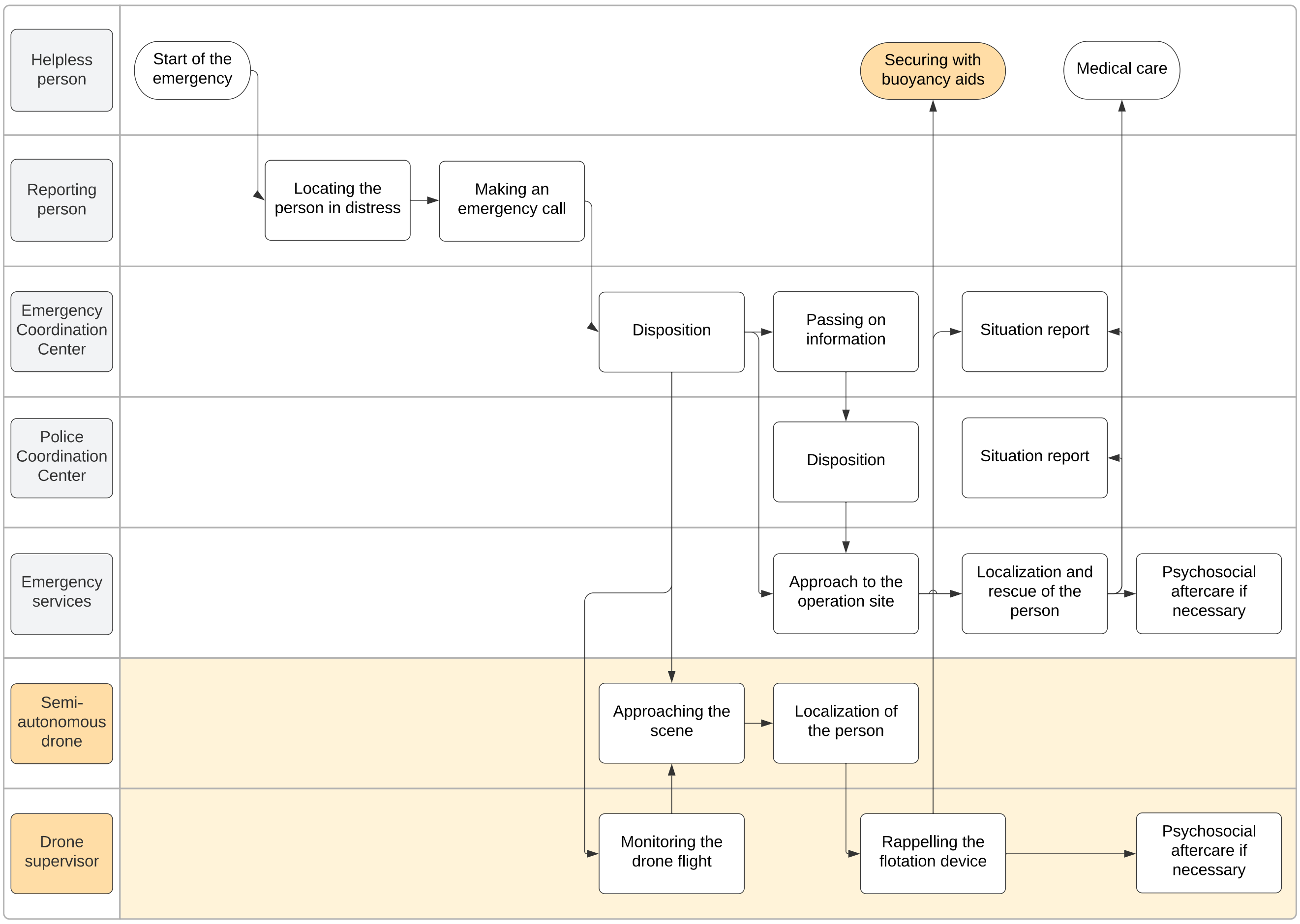
2. Problem Identification and Basic Principles

In Germany, there is an aid time limit to ensure prompt patient care. Due to the federal system of incident response in Germany, this response time does not apply uniformly to all federal states but is set individually. In Germany, the response time is based on the first suitable rescue vehicle to arrive at the scene. The first suitable means of rescue are ambulances and emergency medical vehicles, but not water rescue units [6, 7]. Water rescue units in Germany are predominantly organized in voluntary structures. In some federal states, such as the largest federal state in Germany, water rescue has been legally transferred to the voluntary water rescue organizations "Wasserwacht im Bayerischen Roten Kreuz" and "Deutsche Lebens-Rettungs-Gesellschaft" in accordance with Art. 18 Para. 1 Sentence 1 of the Bavarian Rescue Service Act. According to the working group of the heads of the professional fire departments, the duration of an emergency call and its dispatch can be expected to take around 90 seconds. In addition, ten seconds must be taken into account for the call set-up time and the acceptance of the emergency call [8]. In order to improve the bridging of the therapy-free interval and the time until the person in distress is found, the deployment and time data of water rescues in the rescue service area of a major German city were evaluated as part of a case study. To check whether a water rescue drone has the potential to improve processes in this context, the processes were analyzed accordingly.

3. Methodology

The structure of the methodology is divided into several steps. First, a process analysis of hazard prevention according to Becker (2008) was carried out to determine the existing temporal sections of water rescue [9]. The process flow of a water rescue and the integration of a water rescue drone is summarized in Figure 1.

Figure 1: Process flow diagram of a water rescue service in Germany



As part of the process analysis, the incident data from the incident command computer of the responsible Emergency communications centers was comprehensively analyzed and evaluated. The evaluation was broken down into the various predefined keywords for water rescue, which indicate the type of operation. For each operation, the time at which the alarm was raised, the time until the emergency vehicles arrived at the scene and the time until the person in distress was found were also analyzed. In order not to distort the data, the time until a person was found was only evaluated if a person was actually found. This meant that, for example, searches for people were not included in the statistics when a person was not found.

During a water rescue operation, various resources are alerted, including land rescue services, fire department and police resources. Depending on the incident and the location of the scene, other units such as helicopters or permanently stationed rescue, police or fire boats may be called in. Since water rescue-specific equipment and personnel trained in water rescue can be present on fire engines, boats or specific water rescue vehicles, all emergency vehicles that were alerted to the respective operation were listed in the evaluation of arrival times. Since an ambulance, for example, cannot carry out a water rescue on its own, the arrival time of the vehicles cannot provide a conclusive overview of the start of the rescue. For this reason, the time at which the persons were rescued was included in the analysis of the data in order to classify the time it took to rescue the drowning victims. As the time it takes to rescue a person depends largely on the type of operation, the evaluation of the time units was classified according to the type of operation. The analysis of drowning data was used as the basis for the analysis of the potential for optimizing a water rescue mission. To determine the potential of a water rescue drone stationed near bodies of water, the duration of a constructed water rescue drone was tested as part of the Guardian research project. In order to determine the potential, both quantitative parameters, including the take-off time of the drone, the vertical and horizontal speed of the drone, and qualitative parameters, such as the lowering of a flotation device to the person in distress and the recognizability of people in the water using various camera technologies, were determined. Furthermore, drones currently available on the market were included in the determination of the quantitative values. By summarizing the various data, the potential of a drone used for water rescue could be outlined.

4. Results and Discussions

The result of the process analysis is the classification of the potential of drones stationed on the water for people in distress. An analysis of 46 water rescue operations and the involvement of 615 rescue vehicles showed an average duration of around nine minutes and 57 seconds for a reported person in danger of falling from a bridge into the water, 14 minutes and 21 seconds for a reported person in water distress, and 11 minutes and eight seconds for a reported person in water distress in the Rhine, until the rescue resources arrive at the scene. The time it took to rescue the person in distress varied greatly in the deployment scenarios considered. The shortest time until a rescue operation was reported was seven minutes and 17 seconds. The summary of the average times for rescuing a person from the Rhine as part of the case study are listed in Table 1.

Table 1: Average duration for each type of operation in a water rescue, measured in minutes

Type of Operation	Average Travel Time per Operation Type	Number of Operations
Person jumped from bridge	09:57	16
Person in water distress	14:21	5
Person in water distress in the Rhine	11:55	25

As a result of the case study, an average time of around eleven minutes was determined for rescue resources to arrive at the shore of the scene. By calculating the flight time of a water rescue drone, it can be determined that it generally holds a time advantage over conventional rescue resources. Based on the time criticality and the drowning behavior, it can be concluded that finding a drowning person can be improved by using a drone due to the timely provision of the drone and the drone's higher perspective.

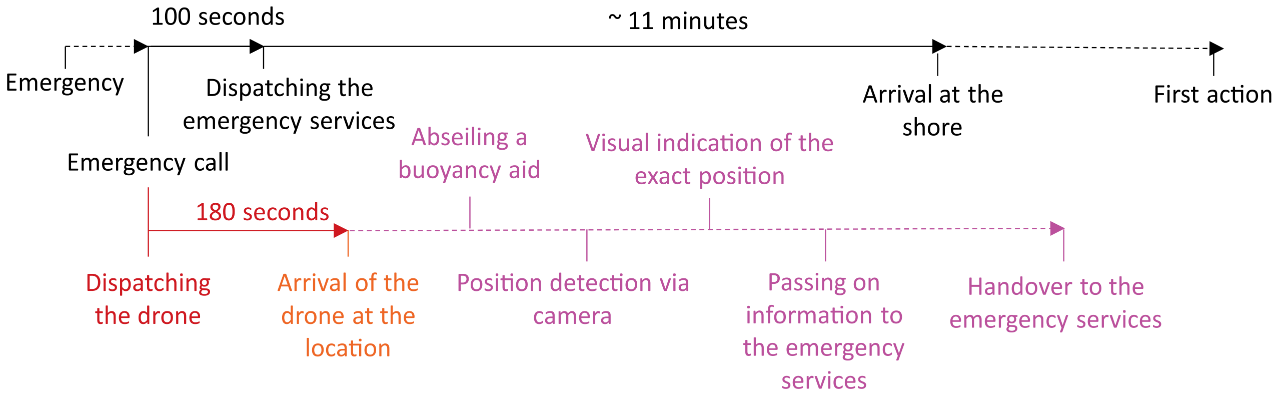
5. Discussion

By evaluating all water rescue operations of an Emergency communications center for one year, it was possible to determine that the arrival times of the emergency services correlate with the requirements resulting from the response time. However, due to the small number of operations compared to other types of operations, the data obtained cannot be generalized to other areas. In particular, the geographical and structural conditions must be taken into account when analyzing the data. By classifying the data according to the operation keywords, it was possible to carry out an evaluation specific to the respective event. The potential of a drone used to support water rescue operations depends not only on the flight speed and set-up time, but also on other factors such as battery life. In the context of the case study conducted in a major German city, the integration of a drone showed the potential for optimizing and supplementing the water rescue service. The potential of the drone is not focused on carrying out the rescue, but on supporting and improving the existing structures.

6. Conclusions

This study highlights the urgent need to reduce rescue times for drowning victims. Drowning is one of the leading causes of death among children and adolescents worldwide, with around 236,000 drowning deaths annually worldwide in 2019 and at least 355 deaths in Germany alone in 2022. The time-critical nature of the drowning process highlights the relevance of rapid rescue. The research emphasizes the problem of the federal system in German disaster control, in which water rescue units are not considered the first suitable means of rescue, which leads to longer response times. The results of the process analysis of water rescue underline that the time taken to rescue drowning victims varies and in some cases is longer than would be desirable in terms of the probability of survival. It also shows that the integration of water rescue drones offers a promising opportunity to significantly reduce rescue times and increase the chances of survival of drowning victims. In view of the continuing high number of drowning deaths worldwide and the time-critical rescue situations, the implementation of this technology is of great relevance for water rescue. Figure 2 illustrates the analyzed time sequences.

Figure 2: Timeline of a water rescue operation involving a drone



Acknowledgement

"Gesamtsystem zur semi-autonomen Rettung Ertrinkender mittels UAV und Vorhalteboxen in Ufernähe" (Guardian, English: Complete system for the semi-autonomous rescue of drowning victims using UAVs and holding boxes near the shore), is a research project funded by the German Federal Ministry for Economic Affairs and Climate Action (Program: Central Innovation Programme for small and medium-sized enterprises, Grant No. KK 5105301DH0).

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