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Characterization of Search and Rescue Aircraft

Mohd Harridon Mohamed Suffian, Mohd Khir Harun, Muhd Siv Azhar Merican Abdullah, Muhd Faiz Maula Kamaruddin

Abstract: ***Several different aircraft have been used in aviation search and rescue mission. The use of the aircraft in such mission has been mostly for common purpose of scouring the sea or land to identify and locate the victims. In addition, they are also utilized for rescue mission with some specialized equipment onboard. This study aims to identify the myriad of aircraft that have been used in the aviation search and rescue mission, and perform the simplistic analysis on their common and uncommon denominators. Based on the results, it has been established that these aircraft often have a small capacity and perimeter coverage, with low flight pace and rate of climb performance capabilities.***

Keywords: Search and rescue, performance characterization, simplistic analysis, aircraft design.

I. INTRODUCTION

There are many types of aircraft, either from commercial or military sector, that have been used in the search and rescue missions. In order to perform such specialized missions, these aircraft have to be in compliance with the regulations set forth by the relevant authorities, or in another word, authorized. For instance, the Spanish Aviation Safety Agency rules that any of the aircraft within their jurisdiction that are involved in search and rescue mission to be regulated in accordance to its safety regulations [1]. Moreover, the authority in Australia has also regulated all aircraft that are involved in the search and rescue missions, where periodic audits are conducted upon operators of the aircraft to ensure their compliance and also continuous improvement [1]. There have been some precedents and current scenarios in the use of several aircraft types in search and rescue missions. The Aerospatiale SA342 Gazelle is a rotary wing aircraft that is manufactured by the Aerospatiale of France and Westland Aircraft of United Kingdom. Its primary usage is for military purposes (i.e. fitted with missiles such that it could be used as an anti-tank gunship) [2]. Nevertheless, due to its lightweight features, it is suitable to be used for scout and reconnaissance operation, which is vital in search and rescue missions [3].

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***** Correspondence Author
Mohd Harridon Mohamed Suffian*, Universiti Kuala Lumpur Malaysian Institute of Aviation Technology, Dengkil, Selangor, Malaysia. Email: mdharridon@unikl.edu.my
Mohd Khir Harun, Universiti Kuala Lumpur Malaysian Institute of Aviation Technology, Dengkil, Selangor, Malaysia.
Muhd Siv Azhar Merican Abdullah, St John Ambulance Wilayah Persekutuan, Malaysia.
Muhd Faiz Maula Kamaruddin, St John Ambulance Putrajaya, Malaysia.

In the meantime, the MD 900 / 902 Explorer is mainly used for emergency medical services and search and rescue operation, where one of its missions is for the London's Air Ambulance [4]. The MD 900 / 902 stands apart due to its maneuverability in various wind conditions, which is a big advantage for use in the search and rescue mission especially in severe conditions. Furthermore, Airbus has developed EADS C-295 aircraft that is able to perform maritime patrol and reconnaissance, which are also part of search and rescue mission. The C-295 aircraft is fitted with two turboprop engines and it is designed with the ability to perform mission in all weather conditions, making it the versatile, robust and also reliable aircraft [5]. In addition, the Diamond Aircraft Industries in Austria has built the DA42 aircraft, which has proven to be a successful design for cross country operations. This is highly suitable for the operation in Austria that is clad with mountains and is a landlocked nation. The DA42 is regarded as an aircraft that is easy to handle and has optimum stability and control, which is important for any long duration aerial observation [6]. Additionally, China has also been a prominent member of the search and rescue efforts worldwide with its inception of Avicopter AC313, which is a rotary wing aircraft with a huge fuselage that can offer bigger onboard space advantage for holding more medical or other search and rescue equipment [7]. The aircraft can fit up to 27 passengers at one time or accommodate simultaneous transfer of 15 injured people for medical evacuation, and this provides suitable capability for a comprehensive or big scale extraction of injured personnel.

Apart from rotary wing, there are also hybrid between fixed wing aircraft and helicopter in the market that are being used for the search and rescue missions. One of the aircraft is V-22 Osprey that is manufactured by the Boeing Company. For the vertical take-off, its tilt rotors are positioned vertically while during flight, the rotors are positioned horizontally and hence enables it to fly like a fixed wing aircraft. The Osprey aircraft is operated by the United States military in combat search and rescue missions due to its agility to take off and land at remote confined spaces [8]. Furthermore, the Osprey aircraft has the capacity to hold up to 24 troops onboard, which makes it very suitable for a big scale extraction of injured personnel during combat. Meanwhile, the HC-144 aircraft is being deployed by the United States Coast Guard in performing surveillance and reconnaissance operations of the ocean. The HC-144 aircraft that they use is well-equipped with few specialized equipment including sensors for search and rescue missions. Since it can fly for up to maximum of 10 hours,

the HC-144 aircraft is very suitable for search and rescue missions that typically require long duration of airborne time [9].

With many types of aircraft and their differences in terms of design and flying performance, it is good to analyze and also identify their commonalities. Such knowledge will definitely serve as reference guideline in the design of future aircraft or in selection of suitable available aircraft in the market for use in the search and rescue missions. Based on this notion, simplistic analysis is conducted using the historical data of aircraft that have been used in such missions to characterize the common critical parameters to be considered.

II. METHODOLOGY

In order to identify and categorize common denominators of the aircraft operated in the search and rescue missions, Fig. 1 shows the methodological framework that is followed in this study. Based on the findings in the literatures, it is imperative for an aircraft that is used in search and rescue missions to be capable to carry payloads that can be excessive in nature such as medical and reconnaissance equipment, injured personnel, and others. Furthermore, the aircraft should also be able to fly with optimum distances and altitudes, especially to avoid any unwanted firings from the ground in war zone areas during the missions. Moreover, the aircraft must also be able to be swift and agile in accommodating several different types of terrains during the operation like mountainous and others. With these information, five main aircraft parameters have been derived in this study to properly reflect these requirements: maximum takeoff gross weight, range, ceiling, maximum speed and also rate of climb.

To conduct a simplistic analysis based upon the established five parameters, the data of 40 different aircraft that have been used in search and rescue missions are collected and studied. Based on [10], with five heuristics in the analysis, data of 40 aircraft is appropriate to derive a fairly accurate conclusion. The tabulation method is applied in the comparison process of the identified 40 aircraft with respect to the five parameters. In general, tabulation is a systematic process of arranging data that offers advantage of ease of analysis and comparison [11]. Once the analysis is completed, the common and uncommon denominators are presented in graphical forms.

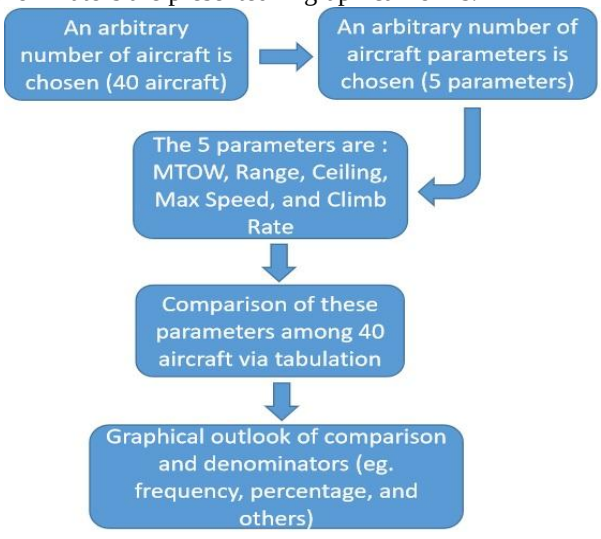

Fig. 1. Methodology framework of conducted study

III. RESULTS AND DISCUSSION

Fig. 2 presents the plot of maximum takeoff gross weight of the typical aircraft used for search and rescue missions. It can be noted that the majority of the aircraft has maximum takeoff weight in the lower region of the plot. The highest value has been recorded as 86,000 kg while the lowest value is 930 kg, with the mean value of 16,144.65 kg as indicated by the mean line in the plot. In line with the previous observation that most of the data points are located within the plot's lower region, 72.5% of the 40 aircraft has a maximum takeoff gross weight that is below the average value and only 27.5% is above that. From this finding, a simplistic deduction is made that most of the operators are more keen to employ a lighter aircraft. This can also entail that in most of the conducted search and rescue missions, the number of people intended to be rescued is often small and/or the aircraft is expected to hold only a little or few amount of equipment onboard.

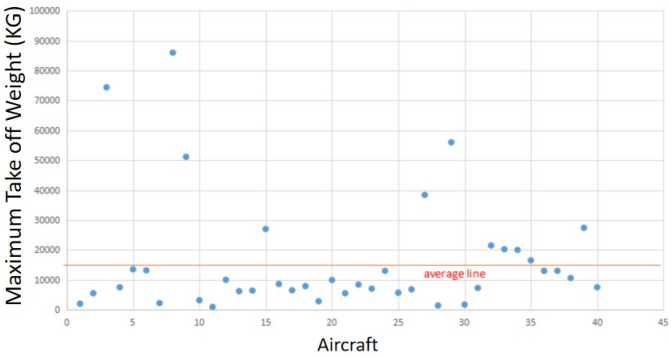

Fig. 2. Maximum takeoff gross weight of the search and rescue aircraft

Meanwhile, Fig. 3 depicts the data spread for the range of the considered aircraft that have been used in the search and rescue missions. It can be observed that the longest range that can be achieved by one of the aircraft is 6,435 km whereas the shortest range distance is only 350 km. On average, the range of the aircraft as being indicated by the average line in the plot is 1,712 km. Of the 40 aircraft considered in the analysis, 70% of them actually have a range capability that is lower than the average. This implies that only 30% of them can reach a flying range farther than the average. Based on this observation, it is simplistically deduced that the search and rescue missions are mostly conducted by the operators with aircraft that can only transverse a short distance or cover a small mission perimeter. This situation can also be contributed to the available capacity of the aircraft's fuel tank that ultimately limits their search and rescue operation. The data spread for the ceiling of the aircraft often operated for the search and rescue missions are depicted in Fig. 4. From the plot, the highest service flight ceiling that can be achieved by the aircraft is roughly 12.8 km (or 41,995 ft) and the lowest is about 0.5 km (or 1.532 ft). The mean value of flight ceiling for the 40 analyzed aircraft is 6.5 km (or 21,251.9 ft) and this is indicated by the average line in the plot. There appears to be almost the same numbers of aircraft that have a flight ceiling performance above and below the average value.

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Specifically, 55% of the aircraft have a flight ceiling that is below the average line while that of the other 45% is above the average line. This finding leads to a simplistic deduction that a mixture of aircraft has been operated for the search and rescue missions as the operations may involve both high and low altitude search. As indicated in [12], the mixture of high and low altitudes' operation could facilitate in optimizing the search and rescue missions.

Furthermore, Fig. 5 illustrates the maximum speed that can be achieved by the commonly used aircraft for the search and rescue missions. As indicated by the plotted data, the fastest aircraft among the 40 considered aircraft in this study has the maximum speed of 860 km per hour. On contrary, the slowest of the aircraft has the maximum speed of 175 km per hour. As indicated by the average line in the plot, the mean maximum speed among the 40 aircraft is around 372 km per hour and the majority of them (i.e. 70% of them) have the maximum speed below this value. Only 30% of the 40 aircraft have maximum speed that is higher than the average. Based on this, it can be simplistically deduced that most aircraft that are operated in a search and rescue mission do not need to have a high speed. In fact, a slow pace aircraft is more preferred and considered as a better option because by moving too fast, some vital details of the search and rescue operation may be overlooked and also missed. As stated in [13], a slow pace operation will help to ensure that observations during search are done thoroughly.

Last but not least. Fig. 6 presents the rate of climb data for the 40 aircraft that have been commonly utilized in the search and rescue missions. Of them all, the highest rate of climb that can be achieved is about 2,073 m/min (or 6800 ft/min) and the lowest rate of climb has been found to be about 229 m/min (or 750 ft/min). The majority of these aircraft, or about 72.5% of them, has rate of climb performance that is below the average as illustrated by being below the average line in the plot. The average rate of climb for the 40 aircraft is roughly about 635 m/min (or 2,083.98 ft/min). With only 27.5% of the aircraft are capable of climbing with a higher than the average rate of climb, a simplistic deduction can be made that it is imperative for the aircraft used in search and rescue missions to be able to climb as fast as possible. This is perfectly in line with the fact that such missions are often conducted in a slow pace in order to optimize the search for survivors or wrecks. A closer look on the aircraft that have a high rate of climb, they are mainly military type of aircraft such as LTV XC-142, Beriev Be-42 Albatros and Kazan Ansat, which are used in battlefield. For such search and rescue missions within the combat areas, it is desirable for the aircraft to be capable of climbing fast after a rescue sortie in order to avoid enemy fire on the ground.

All in all, the findings from comparative analysis between the 40 considered aircraft are tabulated in Table I.

Table-I: Comparison findings for search and rescue aircraft

Parameters	Minimum	Maximum	Average
Maximum Takeoff Gross Weight (kg)	930.00	86,000.00	16,144.65
Range (km)	350.00	6,435.00	1,712.00
Ceiling (km)	0.50	12.80	6.50
Maximum Speed (km/hr)	175.00	860.00	372.00
Rate of Climb (m/min)	229.00	2,073.00	635.00

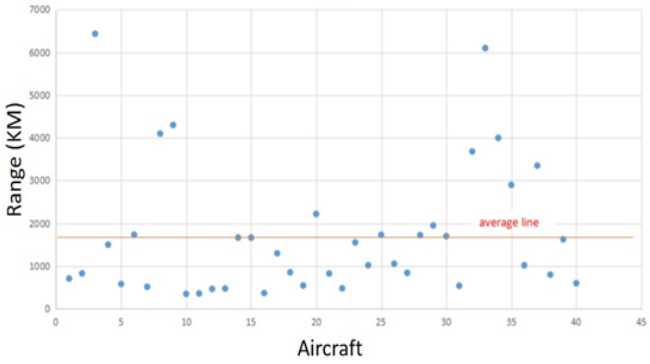

Fig. 3. Range of the search and rescue aircraft

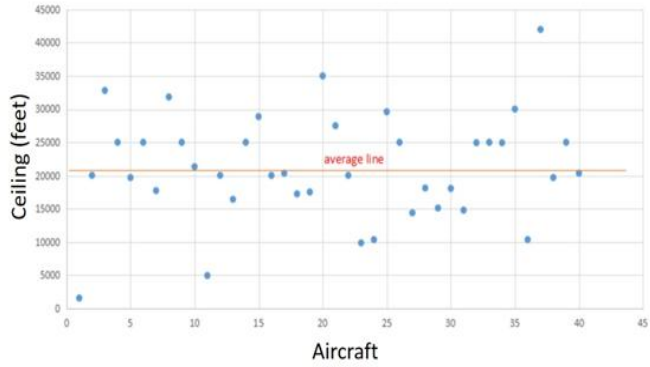

Fig. 4. Flight ceiling of the search and rescue aircraft

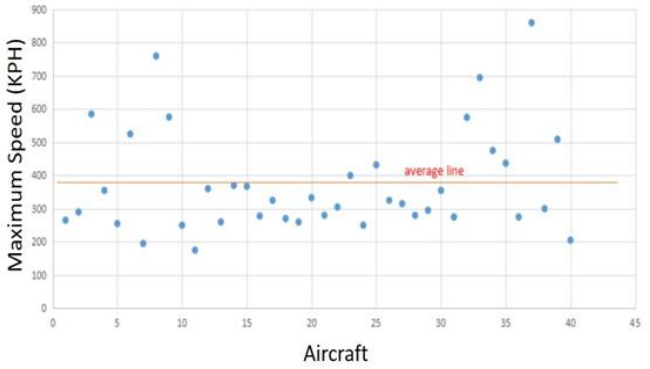

Fig. 5. Maximum speed of the search and rescue aircraft

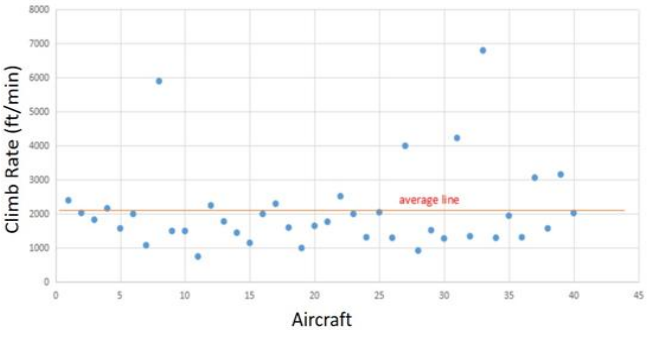

Fig. 6. Rate of climb of the search and rescue aircraft

IV. CONCLUSION

Overall, 40 aircraft that have been operated for search and rescue missions are identified and also analyzed in simplistic manner. From the analysis findings, several characteristics of the common search and rescue aircraft have been established based on the five critical parameters: maximum takeoff gross weight, range, flight ceiling, maximum speed and climb rate. It can be concluded that majority of search and rescue aircraft have a small capacity in terms of payloads to carry equipment weight or injured personnel. Furthermore, the aircraft in such missions are only expected to cover a small perimeter during the search and rescue operation, which is reflected by the low range capability. Since the efficiency of the search and rescue operations can be improved by having the search at both high and low altitudes, there are balanced flight ceiling capability among the aircraft used. Finally, based on the effectiveness of the operation to be conducted at an adequate slower pace, the typical maximum speed and rate of climb of the aircraft have been found to be mostly on the lower end. All in all, with these findings, they provide some insights into the design and also mission requirements for an aircraft that is suitable to be used in search and rescue missions. More detailed analysis should be done to gain further understanding of these aircraft.

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AUTHORS PROFILE

Mohd Harridon Mohamed Suffian is involved in a number of search and rescue missions and holds several certifications in Search and Rescue, and Physical Fitness. He is affiliated with several organizations including the National Association for Search and Rescue of USA, Flight Test Society of Australia, Universiti Kuala Lumpur MIAT, European Paratroopers, and others. He is also the President of St John Ambulance Putrajaya.

Mohd Khir Harun is a Professor at Universiti Kuala Lumpur MIAT and has involved in aviation industry for more than 25 years in various countries. He is currently involved in planning and development of Smart Aviation Hangar at UniKL MIAT and was a former Dean of UniKL MIAT. Furthermore, he is a Licensed Aircraft Engineer with several type ratings and has written several academic papers pertaining to aviation.

Muhd Siv Azhar Merican Abdullah is a medical doctor and is currently the Deputy Director at Putrajaya Hospital. He got his education in the United Kingdom and Malaysia, and is also the Regional Commander for St John Ambulance Federal Territories of Malaysia. He has vast experiences in Emergency Medicine and Hospital Management, and has written several academic papers in relation to community outreach, hospital care, and others.

Muhd Faiz Maula Kamaruddin is a certified paramedic with vast experiences in emergency situations. He is a Superintendent at St John Ambulance Putrajaya and also the Chairman of Community Relief Society of Malaysia. He is passionate in serving the community and has recently aided the community in Kuala Selangor that was engulfed in flood waters. Apart from that, he offers medical health screening for those in need.