

Concept Of Airship Technology Mass Transportation In Semarang City, Indonesia

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Abstract— Population growth in Central Java for the last three years has increased. The Central Java Statistics Agency states that the population 2022 will reach 28,990,900 people. Semarang, as the provincial capital, has a population of 16,889,810 people. In line with this population increase, it resulted in increased population mobility in Central Java. The high level of mobilization is a future challenge in determining the concept of mass transportation that can be used as a facility for residents to mobilize. The concept of mass transportation with a high level of effectiveness and on time is needed as an effort to minimize the impact of high mobility. Using the method of literature study and SWOT analysis, this paper proposes the concept of mass transportation that operates on air platforms, with technological systems and a fairly high level of effectiveness in facilitating the mobilization of the people of Central Java. The method results showed that the airship concept could solve existing problems by paying attention to policies, effective routes, and costs incurred.

Keywords— Population Increase, Semarang City, Airships

I. INTRODUCTION

Central Java Province is a province with a population of 37.3 million in 2022 [1], The total population is ranked third after East Java Province. Semarang as the provincial center of Central Java has a population of 16.9 million [2]. The increase in population over the last three years has resulted in an increase in the pattern of population mobilization that occurs in Central Java, especially Semarang City. This increase will affect the existing transportation system, namely the use of private vehicles as a mode of transportation in fulfilling daily activities. The number of motorized vehicles in Central Java in 2022 reached

17,633,513 vehicles [3], and in Semarang City reached 1,520,222 vehicles [4]. The high use of private vehicles in the Central Java region will result in congestion. This is especially true in major cities in Central Java, especially in Semarang.

The increasing population movement in the city of Semarang requires the provision of mass transportation integration that is expected to accommodate the high intensity of population movement. The development of Semarang City as the Provincial Capital that spreads to the outer regions requires a transportation network that is able to connect between regions and the center of the Provincial Capital. The congestion that occurs in the city of Semarang reaches 37 hours a year with the length of time the vehicle takes when stuck reaching 17%. This is largely due to the high use of private vehicles [5]. Based on this problem, the province of Central Java seeks to provide a type of mass transportation that is able to attract people to switch to using public transportation modes. From these efforts the Central Java government provides Trans Jateng operational transportation, which operates in several areas such as Semarang, Purwokerto, Purbalingga, Kendal, Magelang, Purworejo, Sragen, and Grobogan. The transportation is operated at the farthest distance of 40 Km, with a headway time of 10-15 minutes, which connects Semarang with Bawen [6]. However, existing mass transportation operates on land, so it may potentially also increase the number of existing congestion. For this reason, a mass transportation proposal with an air operation area is needed, because it can be the main alternative in achieving effective travel time to reach the destination [7].

Mass transportation by air operations can be one of the options in implementing transportation systems in urban areas. Airships initially embrace the concept of lighter-than-air (LTA) vehicles, which represent a unique and promising platform for many applications involving prolonged airborne presence. Achieving lift through buoyancy, these vehicles require much less power than traditional aircraft. This opens the door to renewable energy sources, which will allow controlled flight to be maintained indefinitely. Potential applications include hovering surveillance and communication utilities for military and commercial use, plus a range of remote sensing instruments for the scientific community. In particular, the Missile Defense Agency (MDA) plans to utilize high-altitude unmanned aircraft to provide a long-term missile defense presence around the coastline of the United States [8]. In its development, the main challenge faced in the development of airships today is one of control and propulsion systems, with how to fully control the airship to be able to maintain buoyance while in the air. The definition of aircraft in Indonesia according to Law No. 83 of 1958 is any device that can obtain lift from the air, then in Law No. 2 of 1962, aircraft is defined as all means of conveyance that can move from land or water to air or space or vice versa.

This research through a literature study proposes a future mass transportation mode based on air vehicles other than airplanes, which can connect regions by minimizing the number of congestion that occurs in Central Java or in Semarang City, as the provincial capital. The air vehicle is an airship, which is a vehicle with propulsion technology in the form of hydrogen gas or helium.

II. RESEARCH METHODS

The method used in this research is qualitative with a literature review approach in the form of desk research from various literatures related to the development and use of airships. This research is carried out with procedures that produce descriptive data from the analysis carried out [9] [10]. A descriptive qualitative approach is carried out with the aim of presenting a complete picture of a phenomenon or to clarify a phenomenon that occurs [11]. The data obtained in qualitative research refers to empirical data in the form of tangible words and not a series of numbers. It also cannot be organized into categories or classification structures [12]. To obtain data, this research uses literature studies from books, articles, journals, proceedings, online news, and others, which are then compiled to draw conclusions [13]. SWOT analysis is used to organize key strengths, weaknesses, opportunities and threats into an organized list. Strengths and Weaknesses are variables of internal origin. Meanwhile, Opportunities and Threats are external variables

III. RESULTS AND DISCUSSION

Semarang as the provincial capital is the center of strategic activities, such as economic, political, educational, and social, this is the reason many people go back and forth to Semarang. Transportation can be defined as a means available to transport people and or goods from one place to another, and is an important element in human progress because it helps create good economic and social opportunities for society. Transportation system planning in a sustainable area must be carried out continuously in line with technological developments. In addition, the need for innovations in the concept of mass transportation is needed as a solution to overcome existing congestion. Airships are air transportation that is no longer a foreign and familiar thing in the field of air transportation. Its use is more as an advertising medium, often used abroad and in the military world. But

in addition, airships have functioned as a means of transportation in the civilian field which has become commercial transportation since the early 1930s, with the first flight across the Atlantic, with the Zeppelin type of aircraft. This lighter-than-air airship flew for eighteen minutes over the hanger at Manzell on July 2, 1900 [14].

Airships are included in one of the infrastructures in High Altitude Platform (HAP) technology [15]. Its use is generally developed as a tourism media, advertising media, and as a monitoring media. One of them is in research [16] which discusses the use of mobile zappleline as a medium for weather modification technology (TMC) and Air Pollutant Depletion. The flying characteristics of airships are different from other air transportation vehicles, with their reliability can be utilized in military or civilian needs.

Ship development is currently a branch of research in the field of aeronautics. Supported by technological developments. The development of modernization of airships is used as an efficient transportation platform with large payloads, low energy consumption, and long cruising missions [17]. Lighter-than-air vehicles (LTAs) are airships and floating vehicles with new advances in materials and technology [18]. The development of airships was first introduced by an Italian mathematician in the 1970s and modified in 1844 [19]. First operated for luxury transatlantic travel with a lighter structure. The fuel used is hydrogen gas or helium which weighs less than air. The airship could fly for eighteen minutes on a hanger at Manzell in 1900 [14].

The famous airships at the beginning of their development consisted of several types, one of which was the Hinderburg type. The Hinderburg airship was the first airship to provide travel between Europe and North America. This airship was designed as a conventional airship and was based on proven technology. The development of the airship until 1999 was carried out with a commercial version of the hybrid airship [20]. Aircraft carriers have many applications in the military, including the U.S.S. Akron (ZRS-4) and U.S.S. Macon (ZRS-5). Designed as long-range scouts to support fleet operations, or often called flying carriers [21].

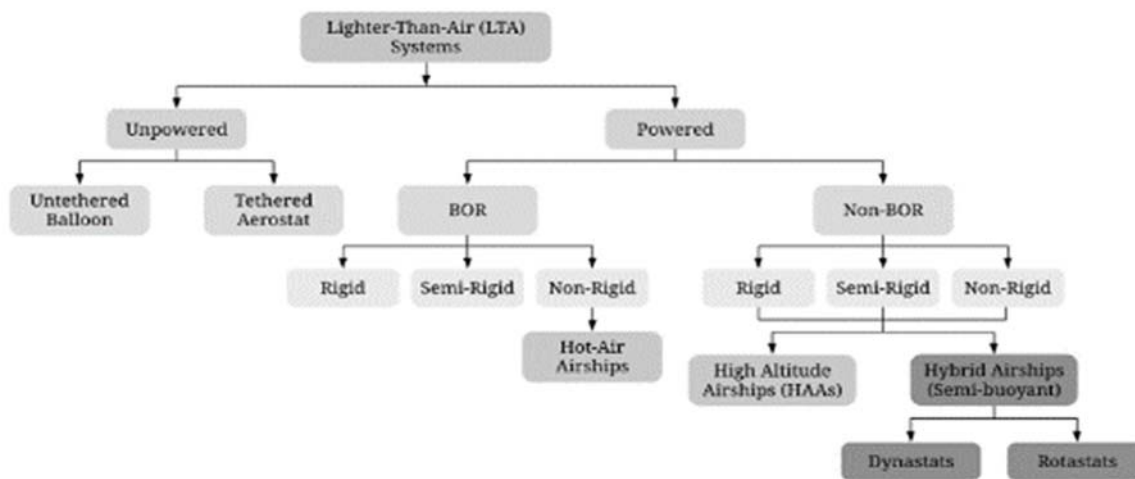


Fig. 1 Category of airships as powered vessels [17]

Airships belong to the Lighter-Than-Air (LTA) System, which can be classified into two, namely powered and unpowered. Powered airships are categorized as conventional as shown in Figure 1 [22]. Based on structural configuration, airships can be classified into three types, namely rigid airships, semi-rigid airships, and non-rigid airships.

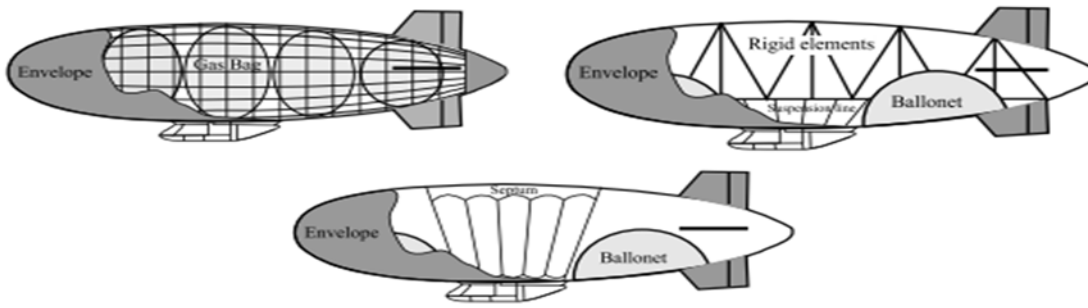


Fig. 2 Types of airships, 1 rigid airship, 2 semi-rigid airships, and 3 non-rigid airships

Several countries in the world from the history of the development of airships have used several classifications of airship types. One of them is an airship created by America with the first semi-rigid type. The airship is Goodyear. The historical development of airship types can be shown in the figure 2 [23]. Rigid airships have a shape that is maintained regardless of the pressure of the shell, which is metal-skeletonized. The lightweight structure can serve to resist external loads carried by the structural outer shell. Lift due to altitude or temperature changes can be achieved by expansion and contraction of individual gas cells. Rigid airships are constructed with load-bearing frames, which allow for the accommodation of all sizes and types of cargo airships. The length of rigid airships is large enough for a rigid structural frame, with a volume in excess of two million cubic feet. Rigid airships have the advantage that the rigid airship hull is efficient as there is no size limitation due to the strength of the fabric envelope. In addition, rigid airships can overcome the possibility of airship nose collapse at high flight speeds [18].

The semi-rigid airship type has several characteristics that exist in rigid airships and non-rigid airships. Semi-rigid airships have several structural forms consisting of keel and frame structures. The shape of the external casing is maintained by the internal pressure in the lifting gas. Semi-rigid airships use balloons with air to maintain a balance of pressure between the inner lifting gas and the outer air during up and down manoeuvres [18]. A non-rigid airship is defined as an airship consisting of the difference between the pressure in the lifting gas in the hull of the airship and the atmosphere. The envelope used as a gas containment membrane encloses the lifting gas and ballonette by providing protection from the environment. The ballonnet allows the envelope pressure to be controlled which can be linked to the pitch control. The adjusted volume of air in the ballonnet and gas in the envelope can produce buoyancy. The airship envelope fabric is made of laminated composite material and is designed as an environmental and flight load-bearing function. This fabric is lighter so it can be used for ballonnet material, as there is no flight load acting on the ballonnet [18].

Airships as commercial transportation are being studied in different parts of the world, such as Canada, Brazil, Australia, or even India. With the mission of connecting remote areas with those that can only be reached by air. The development of airships as transportation is proven by many researchers conducting research in this field, one of which is research on airships as a transportation system in tourism in Portugal, with a case study of the feasibility of airships as tourism transportation [24]. Study of the potential of airships as public transport in Malaysia, with the result that airships have advantages over other public transport options, for public transportation in urban areas [25]. Based on the research that has been done, the use of airships as mass transportation can be analyzed by paying attention to Strengths, Weaknesses, Opportunities, and Threats.

A. Strengths

Airships have several advantages over fixed-wing aircraft, with the ability to operate without the need for runway facilities as a medium for take-off and landing [25] Airship operations help minimize fuel consumption and reduce air pollution, [26]. Modern airships have advanced avionics and electronics systems that ensure a good level of operation safety and maneuverability of all flight phases, such as FBW (Fly by Wire) control. Using the Onboard Managing Data Exchange System (ODEMS) in the management of data exchange systems on flight data processing and flight control systems. Today's airships meet the safety rules imposed by the FFA (Federal Aviation Administration). In addition, modern airships have utilized onboard systems such as Ground Position System (GPS), infrared vision systems, and meteorological sensors to enable night operations [24]. With the development of new technologies leading to operating systems, airships are much safer than in the past, and are expected to be of interest to the public. The operating system of airships as transportation can be compared with rail vehicles and land vehicles such as buses and private cars, which can be shown in table

Table 1 Comparison of operating characteristics of airships with rail and road vehicle modes of transportation [27]

Operating system characteristics	Airship vs Train	Airship vs Land Vehicle
Speed	Faster	Faster
Capacity	More capacity	Less Accommodating
Cost expectation	More expensive	Much more expensive
Adaptability	Less flexible	More flexible

Until now, there are many types of mass transportation available in supporting community activities, transportation options that serve the city area include taxis, online motorcycle taxis, buses, and trains. Taxis, buses, and online motorcycle taxis will be vulnerable to traffic jams on the road, on the other hand train transportation, will depend on the existence of a station as a place to get on and off. Although it may be possible to avoid congestion, the main limitation is the need for rail lines to operate which are expensive to build and maintain, and must be built around existing buildings which can reduce transportation efficiency.

In contrast to this, airships in the process of operation only require docking facilities as a place for departure and disembarkation of passengers, and can fly directly from one point to the next without maneuvering between buildings. Airships are easier to maintain, as they do not require land facilities such as railways or roads to operate, but provide greater operational flexibility and potentially greater point-to-point coverage, as they can depart and disembark passengers on top of existing buildings that are already equipped with docking. Airships can land on top of buildings, e.g. on top of railway station buildings, bus terminals, or tall buildings with docking facilities for airships [25]. This fits well with Semarang City's condition as a metropolitan city that is able to background the rapid development of the city, with a high level of physical development activities..

B. Weaknesses

Lighter-than-air aircraft require a lot of fuel to lift the ship. So far, airships have used helium as a source of lift gas. Compared to hydrogen, helium is an inert gas that is not flammable. However, in its use, helium is costly and limited in availability, compared to hydrogen which is inexpensive and can be easily produced. In addition, helium is less buoyant, with about 7% less lift capability. [28]. The large dimensions of airships require large storage facilities, requiring a large amount of land

C. Opportunities

Nowadays airships are a technology of increasing interest and are being developed and studied, one of which is the hybrid airship. These airships do not rely on the gas contained in the envelope to provide the lift required for flight, but instead use a combination of buoyant forces provided by the gas, aerodynamic lift from airflow across the surface, and in some cases direct vertical lift provided by the propulsion system [28]. Based on the description above, it can be an opportunity to develop airships as a mode of mass transportation in urban areas. The mastery of technology and the development of human resources can allow opportunities in the application of the concept of airships as urban mass transportation. The use of airships as mass transportation can attract tourists so that they can study the pace of the regional economy.

D. ²

The use of airships as a mode of mass transportation has several threats, one of which is the control of buoyancy which has always been a major problem and is related to safety when operating. In addition, the large size of airships is a threat to the needs and challenges of airships. [29]. Airships have a limited ability to reach high altitudes with maximum payload, which poses a threat when passing through mountainous terrain.

Based on the results of the SWOT analysis, the use of airships as mass transportation has great potential, especially in minimizing congestion, and the fuel used does not cause air pollution, but in the application process requires careful study by paying attention to policies implemented in Indonesia, effective routes, and cost calculations.

IV. CONCLUSION

The application of airship technology is the utilization of airspace in transportation and the innovation of future vehicles. Airships are one of the preferred options in developing airspace innovation and can be one way out in breaking congestion in urban areas, especially in Semarang. Airships are a new technology that is being studied and developed in several countries with its application as mass and cargo transportation, from the results of the analysis of strengths, weaknesses, opportunities, and threats, the concept of airships has the potential to be applied as an effort to solve existing congestion problems and as a solution to reduce air pollution that occurs. However, in the process it must pay attention to several aspects, such as policies, effective routes, and cost calculations, so that a mature concept is obtained and can attract tourists and accelerate the pace of the regional economy.

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