Study on the Potential of Airships as Urban Mass Public Transport in Malaysia

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ABSTRACT

Transportation capability is an essential need in progressing and improving the quality of lifestyle for a society to a better level. In many urban cities, traffic congestion problems have always been a big issue and despite several efforts made to alleviate the situation, the problem still remains. Taking cue from the proposal of a personal flying car to overcome traffic congestion, a concept of "flying bus" using airships is proposed in this study as a new public transport option within urban areas. To highlight the potential of this idea, particularly for Kuala Lumpur city areas in Malaysia, a comparison analysis between the available public transportation options is done along with the new proposed concept using Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. Two case studies have been formulated for the comparison analysis, which is assessed in five different evaluation scenarios to capture the robustness of the results. All in all, it is found that the proposed "flying bus" concept does have some advantages over other public transport options and its implementation can be beneficial to improve the public transportation service for the society within the Kuala Lumpur city areas.

Keywords: *airship, public transport, flying bus, transportation comparison, TOPSIS.*

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Introduction

Transportation can be defined as the available means to carry people and also goods from one place to another. It is a vital element for the human progress as it helps to create better economic and social opportunities for the society. Nowadays, there are many options that have been made available for people to travel, either through ground, air or sea transportation. As time progresses, however, transportation modes available have to be improved accordingly to cater for new challenges that arise. This can be closely related to the problem of traffic congestion that has become a big issue around the world, especially in major cities. In Malaysia, for instance, 84% of 4.8 million people living in the Klang Valley are car owners [1] and this contributes to the worsen traffic congestion problems faced in the surrounding major cities each year. In fact, based on the statistics, number of vehicles on the road in Malaysia has been projected to reach up to 48 million by the year 2020 [2]. This situation does not look favourable in terms of improving efficiency of road transportation in Malaysia.

The negative effects of road traffic congestion have already been well-documented in many studies. Among others, these include wasted travel time and cost for the driver and passengers, increased fuel consumption, increased air and noise pollutions, and elevated rate of accidents [3]. Many efforts have already been made by the Malaysian government to lessen this situation such as improving the infrastructures and facilities but the problem still persists. Of a notable interest in this research study, it is observed that improvements made on the public transportation services within the urban areas have so far shown very negligible effects in reducing the traffic congestion. As indicated in the Kuala Lumpur Structure Plan 2020, available public transports only serve for about 20% of people movement within the Kuala Lumpur city area while the other 80% are using private transportation [4]. Among the common reasons that are given by the public for not using the public transportation include the negligible savings of the travel time and cost, particularly when the public transports are also facing the same traffic congestion problem on the road [5]. Several new ideas have been put forward to improve personal travel such as Personal Air Vehicle (PAVE) concept [6], which aims to make full use of the empty airspace above to bypass the road congestion. Based on this notion, it is believed that having similar approach to public transport (as in the "urban flying bus" concept) can also yield some great benefits to the people. This is due to the fact that a flying public transport will not be facing the road traffic congestion problems since it does not operate on the ground.

Why Airships?

When this "urban flying bus" idea is being further developed, airship seems to be the most suitable means for such transportation concept. Airships are no stranger to the air transportation field. Airships have served as commercial air transportation means since the early 1930s where its first regularly scheduled flights across the Atlantic sea were operated using giant Zeppelins. However, a series of fatal incidents during the airship operation has hindered its design and development progress. Of note is the famous Hindenburg incident, where the transport airship caught fire and was ultimately destroyed while trying to dock, killing a total of 36 people and effectively ending the era of airship in commercial air transportation. Since then, airships' usage has been limited to mainly tourism and advertising purposes.

In comparison to fixed wing aircraft, airships have several advantages in terms of air transport operation. In fact, airships have been lately suggested to make a comeback for commercial air transportation since their operation can help to deal with several ongoing issues with today's operation of fixed wing aircraft. Among others, the issues include fuel dependency, and carbon dioxide and other harmful emissions. Airship's operation, on the other hand, can help minimize fuel consumption and lower the air pollution. Another big advantage of airship against fixed wing aircraft is its ability operate without requiring runway facility for take-off and landing, bypassing the problems of airport congestion. Ref. [7] presents discussions that highlight comparative advantages of airships against the other modes of transportation such as train, ship, fixed wing aircraft, helicopter, car and others in terms of environmental impact, land use, operational efficiency and cost. Figure 1 shows comparison of fuel consumption between airship and the other transportation systems. In addition, Table 1 tabulates the comparison of few operational characteristics of airship against those of other transportation modes, which also supports the potential benefits of the proposed use of airship for public transportation.

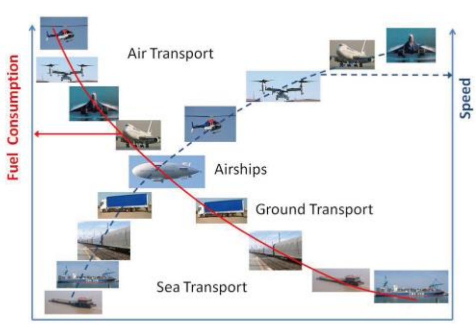

Figure 1: Fuel consumption of several transportation means [8]

Table 1: Operational comparison of airships against other transport modes [9]

Operational Characteristics	Airship vs Maritime	Airship vs Highway	Airship vs Railway	Airship vs Aerial
Speed	Much faster	Faster	Much faster	Much slower
Load Capacity	Less capacity	Much more capacity	Less capacity	Increased capacity
Load Adaptability	Much more flexible	Less flexible	Much more flexible	More flexible
Transportation Cost	Much more expensive	More expensive	Much more expensive	Much more economical

With new technological developments that lead to much safer airship operation compared to in the past, the predicted comeback of airship is also fuelled by market interests and demands [10]. Several of the recent airship researches and development projects have been discussed in Ref. [11]. An exemplary research that studies feasibility and viability of airships as a mass public transportation is the Multibody Advanced Airship for Transportation (MAAT) project that is supported by the European Union. In this project, a novel approach of developing a feeder-cruiser system of airship operation has been researched for transportation of people and goods [12]. All in all, with these developments and interests on use of airships as transportation means, it is not impossible that they can also be operated to alleviate traffic congestion in urban cities as an alternative mass public transportation option. This paper presents a study on the potential of having airships as mass public transport in Malaysia.

Comparison of Public Transportation Modes

The focus in this study for the "flying bus concept" is within Kuala Lumpur and its surrounding urban city areas. To date, there are many available public transportation options that are serving the city area, which include the taxis, buses, Light Rail Transit (LRT), monorail and Mass Rapid Transit (MRT) to name a few. Taxis and buses are susceptible to the road traffic congestions, just like the personal cars. On the other hand, the coverage of the rail vehicles such as LRT, monorail and MRT is highly dependent on the location of their stations. Rail vehicles might be able to avoid the road congestions but their main limitation is that they require rail tracks to operate, which are costly to build and maintain, and have to be built around existing buildings that reduce their transport efficiency instead of going direct point-to-point. Furthermore, the current transportation system in Malaysia is designed to be mostly used interchangeably and this leaves the potential of passengers having to change to taxis and buses to get to their destination after taking the rail services. The envisioned airship usage can potentially bypass all these limitations.

Airship operation just needs docking facility for passenger embarking and disembarking, and it can fly direct point-to-point between the subsequent docking stations without the need to manoeuvre between the buildings. It is anticipated that the current stations used for rail vehicles can be transformed into these docking stations in similar concept with the MAAT. The feeder system will save the overall transportation time as the airship does not have to significantly descend or climb to its cruising altitude at each station. It is also easier to maintain since airships do not require ground facilities like rail track or road to operate, giving more operational flexibility and potentially bigger coverage of point-to-point travel since they can embark and disembark passengers on top of existing buildings that have been equipped with docking and feeder capabilities. An illustration of the envisioned airship use as urban public transportation is shown in Figure 2. It should be noted that Department of Civil Aviation Malaysia has adopted Federal Aviation Authority (FAA) regulations for operation of rigid airships as transport vehicles in Malaysia.

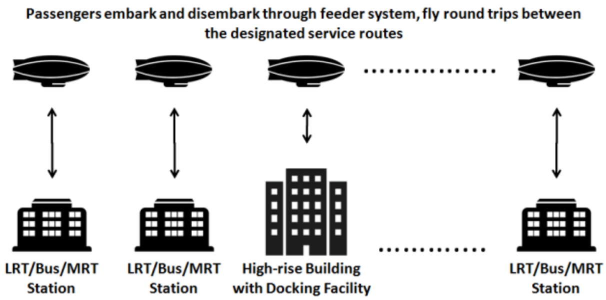

Figure 2: Anticipated mission profile of public transport airships

The comparison of different modes of urban public transports is done here using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. TOPSIS is a widely used method in multi-criteria decision making process. In this method, the best alternative or option is the one that is as close as possible to the positive ideal solution and at same time is as far as possible to the negative ideal solution. The positive ideal solution is the set of best possible value for each of the evaluation criteria. In the meantime, the negative ideal solution is referring to the worst possible condition for each of the evaluation criteria. In this study, the considered evaluation criteria for the comparison analysis are identified from the service expectations of the urban public transport modes. Overall, there are 18 evaluation criteria and they are discussed in Table 2. Furthermore, the rating scale used for the comparative analysis is shown in Table 3.

Table 2: Considered evaluation criteria for TOPSIS

Criteria	Description
Time on transport	Total travel time from the departure point up until the final destination point.
Time of waiting	Time spent waiting for the transport vehicle to arrive at the departure point.
Speed	Maximum speed for the transport vehicle from departure point to destination.
Cost per passenger	Total cost of travel expenses of the transportation such as toll, fuel, etc.
Payload	Maximum number of passengers that can be simultaneously accommodated within the transport vehicle.
Accessibility	Ease of using the transport vehicle, i.e. number of designated departure points and service frequency.
Air pollution	Level of CO_2 and other harmful gases emissions by the transport vehicle.
Noise pollution	Measure of noise emissions by the transport vehicle.
Energy supply	Measure of required fuel usage for the transport vehicle.
Safety	Level of safety protection provided by the transport vehicle design, i.e. minimum injury or death risk.
Flexibility of departure point	Operational flexibility of the transport vehicle's departure point closer to the user.
Comfort	Measure of travel comfort throughout the journey on the transport vehicle.
Privacy	Measure of provided privacy level on the transport vehicle throughout the travel time.
Security	Measure of security level provided to passengers and their belonging while on the transport vehicle.
Reliability	Measure of service capability and quality by the transport vehicle over a period of time.
Cleanliness	Cleanliness level of the transport vehicle.
Aesthetic (Exterior)	External appearance of transport vehicles and facilities.
Aesthetic (Interior)	Internal appearance of transport vehicle and

facilities.

Table 3: Rating scale used in TOPSIS evaluation

Rating	Description
1	Performance level of the evaluation criterion is estimated to be very low compared to the perceived travel preference.
3	Performance level of the evaluation criterion is estimated to be low compared to the perceived travel preference.
4	Performance level of the evaluation criterion is estimated to be moderately low compared to the perceived travel preference.
5	Performance level of the evaluation criterion is estimated to be on average compared to the perceived travel preference.
6	Performance level of the evaluation criterion is estimated to be moderately high compared to the perceived travel preference.
7	Performance level of the evaluation criterion is estimated to be high compared to the perceived travel preference.
9	Performance level of the evaluation criterion is estimated to be very high compared to the perceived travel preference.

SkyCat-20 airship is taken as the representative of transport airship in this comparison analysis. This airship, which is developed by World SkyCat Ltd., can carry up to maximum of 120 passengers and has maximum speed of 140 km/h. Details on SkyCat-20 airship are available on its manufacturer's website and some of them are summarized in Table 4. Apart from the airship, three other modes of public transportation that are currently available within the Kuala Lumpur city areas are included in the comparison study: bus, train and taxi. In this comparison, a normal road traffic condition is assumed and this allows direct evaluation on the strengths and weaknesses of each public transport mean.

Table 4: SkyCat-20 Airship Characteristics

Parameter	Value
Length	81.0 m
Height	42.1 m
Width	41.0 m
Range (with Max. Payload)	2400 nm
Cruise Speed	75 kts
Maximum Passengers	120
Direct Operating Cost (with Max. Passengers)	RM 37.50 per hour per passenger

Two case studies have been chosen for the comparison study. The first is a travel trip from Seri Kembangan to Kuala Lumpur International Airport (KLIA) whereas the second case is the travel from IKEA Damansara to UPM Campus in Serdang. A few scenarios for the evaluation have been established and they are described in Table 5.

Table 5: Evaluation scenarios for TOPSIS

Scenario	Description
Travel time	This scenario emphasizes on the shortest travel time taken for the journey. In this particular scenario, time spent on transport for the travel, time of waiting for the transport to arrive, speed of transport vehicle, accessibility to the transport service, flexibility of departure point for the transport service and reliability of the transport service are the upmost importance. Hence, the weighting for these criteria is assigned as 0.083 each while the other criteria are assigned 0.042 each.
Cost	This scenario emphasizes on the lowest cost for the journey. In this particular scenario, time of waiting for the transport, cost of transport per passenger and flexibility of departure point of the transport vehicle are the upmost importance. Hence, the weighting for these criteria is assigned as 0.167 each while the other criteria are assigned 0.033 each.
Travel Comfort	This scenario emphasizes on the perceived comfort level of the passenger throughout the travel for the journey. In this particular scenario, comfort, safety, privacy, security and cleanliness characteristics of the transport vehicle are the upmost importance. Hence, the weighting for these criteria is assigned as 0.100 each while the other criteria are assigned 0.038 each.
Ease of Use	This scenario emphasizes on the ease of using the transport service for the journey. In this particular scenario, accessibility, flexibility of departure point and reliability characteristics of the transport vehicle are the upmost importance. Hence, the weighting for these criteria is assigned as 0.167 each while the other criteria are assigned 0.033 each.
Balanced	This scenario emphasizes on the balanced performance of all characteristics of the transport vehicle. Hence, the weighting for all criteria are similarly assigned as 0.056.

By having different importance weighting scenarios, the effects of the different travellers' preferences can be analyzed. This is essential to cover the diversity aspects of decision-making process in selecting available travel options and highlight the robustness of the transport means. For instance, if travel time is the most important selection aspect for the traveller in choosing his/her public transportation option, this condition can be reflected with higher assigned weighting for the following evaluation criteria: time spent on transport for the travel, time of waiting for the transport to arrive, speed of the transport vehicle, accessibility to transport service, flexibility of departure point for transport service and reliability of the transport service. All of these criteria of the transport vehicle will contribute to how long the traveller will get to his/her final destination from where he/she start the travel journey.

Results and Discussions

In the first case study, it involves a travel trip from Seri Kembangan to KLIA. For estimating the ticket fare and timetable of available public transportation services, it is taken that this travel trip is done on Monday, 4th July 2016 at 12.30 pm. Based on evaluation criteria listed in Table 2 and using the rating scale as outlined in Table 3, the assessment for this travel trip is done for the different transportation modes for all five different evaluation scenarios (and importance weightings) in Table 5. The ratings are mainly assigned based on information gathered through literature review and also personal assessment. For each scenario, the resultant closeness rating in TOPSIS for the different transportation modes are tabulated in Table 6. Another look at the results can be presented in the form of a web chart in Figure 3.

Table 6: TOPSIS results for case study 1

Scenario	Taxi	Train	Bus	Airship
Travel time	0.51	0.22	0.55	0.71
Cost	0.55	0.38	0.56	0.87
Travel Comfort	0.57	0.34	0.41	0.76
Ease of Use	0.45	0.19	0.67	0.53
Balanced	0.42	0.27	0.50	0.72

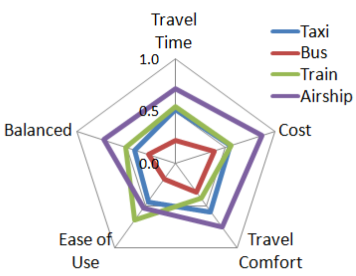

Figure 3: Closeness rating for case study 1

From the results, it can be observed that the anticipated airship use for mass public transport to execute the travel in case study 1 tops almost every considered scenarios with the exception of the "ease of use" scenario. This is aligned with the expected performance of transport airships that can provide cheaper, faster and better travel experiences compared to the other modes of public transport. However, due to its relatively new implementation, it is also anticipated that its accessibility and flexibility of its service may not be fully available, hence its rating is lower in the "ease of use" scenario. Nonetheless, provided that all the performance criteria are of equal importance, airship still emerges as the possibly better public transport means than the others based on the ratings.

To assess the robustness of this assessment result, a second travel case study is done using the same method. The second case study involves a travel trip from IKEA Damansara to UPM Campus in Serdang, Selangor. TOPSIS results for this assessment is presented in Table 7 and also in Figure 4. It can be observed that based on the results, the transport airship's performance once again seems potentially more superior to the other modes of public transport. The results for airship remain essentially similar with the first case study and as expected, airship tops all scenarios except for the "ease of use" scenario. The similarity of results between the first and second case studies highlights the robustness of the transport airship performance and ensures that the result is not biased to any specific travel trip only. This can be taken as a very good indication that airships can help improve the local public mass transportation regardless of the public travel needs and preferences.

Table 7: TOPSIS results for case study 2

Scenario	Taxi	Train	Bus	Airship
Travel time	0.54	0.33	0.45	0.70
Cost	0.52	0.54	0.43	0.85
Travel Comfort	0.57	0.36	0.40	0.75
Ease of Use	0.46	0.21	0.65	0.53
Balanced	0.43	0.31	0.48	0.72

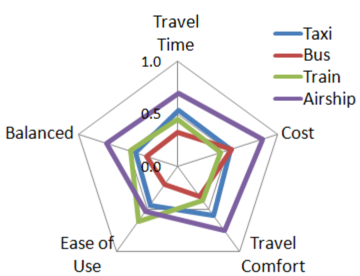

Figure 4: Closeness rating for case study 2

Conclusions

In an effort to facilitate the worsening problems of traffic congestion in urban cities, new public transportation alternative using airships has been proposed. To highlight some of potential advantages of this proposed mode of transport, a comparison analysis is made between its expected performance and that of several existing modes of public transport using the TOPSIS method. In this study, the design characteristics, performance and also operational capability of SkyCat-20 airship are taken as the representative of the proposed transport airship. Based on the TOPSIS results, the potential benefits of having airships as an alternative mode of public transportation within urban areas have been clearly highlighted. This is a good indication to further study the feasibility and viability of this proposed public transportation mode for possible actual implementation.

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