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URBAN COMMUTERS' EXPECTATION LEVELS ON THE e-VTOL VERTICAL AIRPORT DESIGN IN KUALA LUMPUR, MALAYSIA

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ABSTRACT

The world's urban dwellers are rapidly growing by 60.3% over six decades (1960-2019) (The World Bank Group, 2020), and two third of the world's population is projected to reside in the urban setting by 2050. The same issue occurred in Malaysia, where the shifting from 73% rural to 73% urban population is real (Mohd Hussain, N. H.; Byrd, H.; & Ahmad, N. A., 2017), and this phenomena contributed to the increasing number of population in big cities such as Kuala Lumpur. Therefore, it is expected that the existing challenging traffic congestion will worsen if a better traffic dissemination planning strategy is not developed. Hence, the development of an e-VTOL (electrical vertical take-off landing) vehicle is a possible strategy to ease the urban traffic congestion problem. Serious collaboration among the departments such as planning, engineering, architecture, aviation developers, policy makers, and the sponsors, is important to establish sustainable future urban mobility and connectivity. This study aims to obtain information on the needs and expectations of urban commuters on the development of a vertiport in the city of Kuala Lumpur. A series of surveys involving 157 commuters using public transportation within the city centre, and a case study analysis, were conducted to gain an understanding of the viability of building a vertiport in Kuala Lumpur. Initially, findings show that nearly 50% of the respondents totally agree with the proposed

development idea, while approximately 13% are really against this future urban air mobility strategy.

Keywords*: Urban commuters, e-VTOL, vertical airport, urban air mobility, urban connectivity*

INTRODUCTION

Frequent and increasing traffic congestions have always been part of the traffic management issues that are affecting many urban areas globally, and the condition is expected to worsen with more people today chosing to live within the urban establishment mostly due to work-related reasons. The Department of Economic and Social Affairs of The United Nations estimated that two-third of the world's population is estimated to be living in the urban establishments by the year 2050 (Meredith, S., 2017). In 2019, The World Bank reported an increment by 60.3% from only 33.61% of the world population living in urban settings in the 1960's, however, in the year 2018 a total of 55.71% from the total world population are living in the urban areas around the world (World Bank Group, 2020).

Hence, based on the increasing trend of today's world urban dwellings, it is already a challenging task for the urban and city authorities, and policymakers, to ensure the smooth mobility of this huge number of people commuting daily within the city areas. A well-planned mobility strategy could help in relieving congestion in the normal street network (Momtaz, R. I., & Shaban, R. M., 2018), therefore assisting to increase urban connectivity. Thus, when a great and efficient mobility increased the urban connectivity, a city would probably start to experience positive economic and social growths, increased creativity, as well as elevating personal achievement and total well-being.

Consequently, a sensitive and well-planned urban public mobility is desirable as it will provide urban dwellers with more opportunities-personally, and as a community. Besides the normal well-known ground traffic strategies such as the use of buses, taxis, e-hailing, motorcycle, cycles,

MRT, ERL, and other means of transportation, a city should explore the possibility of introducing urban air mobility to increase the efficiency of the overall urban connectivity within their cities.

Urban Air Mobility

The advancement in today's modern flying technology and the recent global business trends and models that emphasized on fast delivering economy are supposed to be one of the pushing factors to explore the feasibility of integrating urban air mobility in cities - to move people and goods faster, quicker, and easier using either the manned or unmanned e-VTOL flying vehicles. Not only will it support the economic part of businesses, this advance version of an e-VTOL can be assigned to conduct rescue, emergency medical evacuations, humanitarian missions, ground traffic monitoring, news coverage, weather monitoring, and also provide choice of transportation for the public (Thipphavong, D. P., Apaza, R. D., Barmore, B. E., Battiste, V., Belcastro, C. M., Burian, B. K., … Verma, S. A., 2018). For that reason, integrating e-VTOL as part of the mode of public transportation will significantly reduce traveling time, and could also alter the travelling patterns of the urban dwellers.

However, to verify whether urban dwellers are ready to add the e-VTOL as part of their option for mode of transportation, it is important to understand fully the preferences and expectations of urban dwellers regarding the autonomous transportation services (Fu, Rothfeld, & Antoniou, 2019) such as the newly proposed e-VTOL in their cities. So, a provision of a vertical airport to support the use of e-VTOLs in helping the urban connectivity should be encouraged to support the demand for better urban connectivity through better urban commuting experiences. Urban air mobility could also fulfil the five important demands for today's urban dwellers fast-moving lifestyle such as; (i) faster traveling option, (ii) reasonable riding fares, (iii) safe and enjoyable flight experience, (iv) integrated mobility solution, and (v) passenger-winning service (Baur, S., Schickram, S., Homulenko, A., Martinez, N., & Dyskin, A., 2018).

Vertiport Design Consideration

A vertical airport or 'vertiport' is purposely designed and constructed

for tiltrotors flying vehicles or aircraft such as helicopters, drones, and other vertically taking off and landing flying vehicles. A vertiport also called vertical stop or vertistop by the Uber Elevate (a company interested to implement the service of e-VTOL into the public market with a brand name UberAir). The vertiport proposed by Uber Elevate is to be equipped with multiple take-off and landing pads, and the vertiport will also be installed complete with charging facilities for the e-VTOLs (Holden, J. & Goel, N., 2016).

From the architectural design perspective, it is extremely important to develop a design with effective overall building layout design, complete with a precise, supporting facilities for the entire vertiport complex to function at optimum. In consequence, careful space planning design and sensitivity towards the needs and concern of the urban dwellers must be seriously taken into consideration for a vertiport to be included in as a new typology of building in the architectural field (Cohen, M. M., 1996). So, a vertiport should be able to serve the urban dwellers far beyond just a launching pad for the e-VTOLs, but efficient urban connectors.

Multiple design options for a vertiport and its supporting facilities can be developed to cater for different taking off and landing capacity from one, two, three or even six e-VTOLs at one time, with the provision of supporting facilities such as the charging stations, the check-in counter, waiting areas, boarding gates, and other safety and security screening areas that are essential for safer operation. A vertiport may also consider providing storage and e-VTOL maintenance spaces like a mini hangar or a garage.

Besides the design of the vertiport building design, architects and designers must also ensure that the design of a vertiport comply with the local zoning guidelines, and regulatory requirements (Duvall, T., Green, A., Langstaff, M., & Miele, K., 2019). Though a vertiport physical design is impressive, however, a vertiport cannot be allowed to operate without the clearance from the aviation authority who will determine e-VTOLs flying zone or aerodrome. Apart from all the technical needs, a vertiport could be a solution to provide an opportunity for a city to rejuvenate some ‘dead’ or ‘depressed’ areas and spaces as part of the urban renewal strategies as per what Cheyno, E. (1973) stated that the vertiports need to be a virtuous neighbour.

From the earlier discussion on the needs for a vertiport to support the future urban mobility, it is concluded that there should be (at least) five main design criteria to be considered in a vertiport building design programme, and this include (i) the access and connectivity – to, and from the vertiport to surrounding areas, (ii) amenities & facilities that must be provided to ensure ease of use, (iii) availability of information to assist the movement of passengers, (iv) the cleanliness and comfort to ensure comfortable long-term use, and (v) the safety and security of the terminal building, occupants, and commuters.

PROBLEM STATEMENT

The advance technology in the development of an e-VTOL flying vehicles could be a new mode of urban public transportation using the free air space. Perhaps, the e-VTOL can help solve the current global traffic congestion problem, and possibly could contribute to better urban connectivity. So, to have e-VTOL serving the urban connectivity, the provision of vertiports to cater as the departure and arrival platforms for the e-VTOL must first be materialised.

However, to start the initial design of a vertiport could be quite a challenge, because at present there is no other identical building (for the e-VTOL) that has ever been built for the general public. It is crucial to develop the correct and precise building layout and space design programme that is efficient for the vertiport (Cohen, M. M., 1996). Appropriate vertiport locations can in fact facilitate the air mobility services and reduce the dependency for the ground transportation. If enough vertiports are available, it will have a significant effect on total commuting time (Lim, E., & Hwang, H., 2019).

RESEARCH QUESTION

This research assumed that both current policy of the central government of Malaysia and an e-VTOL flying guidelines by the Civil Aviation Authority of Malaysia (CAAM established on 19th February 2018) are already approved to enable an e-VTOL services for general Malaysian urban

commuters – starting with Kuala Lumpur. Accordingly, a question arose regarding the proper vertiport building design programme to be developed in Kuala Lumpur that will suit the urban commuters best, so, "…what are considered (by the Kuala Lumpur urban commuters) as the most critical and important architectural design features to be considered and incorporated into a vertiport building design programme?"

PURPOSE OF THE STUDY

Before initiating a public-interest related project especially for a project with no precedent to be taken as an example such as this vertiport, the technical design team (that should comprise the planners, architects, designers, engineers, surveyors, and also authorities) must fully understand the most critical and seek to fulfill the needs of the end-users. This is important to ensure that the service to be provided fulfil their exact requirements. Moreover, a positive feedback gained through experiences of the building end-users could reflect the usability of the physical design environment that is supposed to fulfil the end-users' expectations (Haron, S. N. et al., 2016). So, this research was conducted to obtain as much information to understand and acknowledge the expectations of the Kuala Lumpur urban dwellers on the possibility of developing a vertiport in the capital city of Malaysia. The research also aimed to identify the needs of the urban commuters from the proposed additional new public transportation within the Klang Valley. Therefore, the information obtained can be useful to assist in the establishment of the basic crucial design needs recommended for an e-VTOL vertiport in the effort to increase the urban mobility and connectivity.

RESEARCH METHOD

This research involved the distribution of questionnaires to the urban commuters within the Kuala Lumpur city area. The questionnaires were distributed on-site and were completed by 157 respondents at several public transportation hubs within the Kuala Lumpur City. Respondents were randomly selected from among groups of urban commuters who were using public transportations within the Klang Valley. The ratio of female to male respondents was 1:1.21 with 45.2% female, and 54.8% male; and

the majority of them are from the working age adult groups where 87.9% aged 18-30, with 8.9% are from the age group of 31 to 55 years old. At the same time, one e-VTOL prototype exhibited in Singapore in 2019 has been made a case study building to study the basic needs of this newly introduced building typology. Also, it was through this research four transportation experts were interviewed to expand the understanding of the technical requirements needed in a vertiport, and of the possibility of developing the first e-VTOL vertiport in Kuala Lumpur.

Questionnaire

This research questionnaire was designed based on the content analysis developed through literature review, before it was then distributed to the general public who were identified as urban commuters who regularly use the public transportation in the KL area. The questionnaire consists of four sections, i.e. (i) demographical data of respondents (ii) respondents' satisfaction level toward current public transportation provided, (iii) respondents' level of acceptance towards an e-VTOL service, and (iv) the respondents' expectation of the overall design (including the services and facilities to be provided in a vertiport). However, this working paper is only focusing on reporting the last two inquiries i.e. the respondents' level of acceptance towards an e-VTOL service, and the respondents' expectation of the overall design. For data analysis purposes, a Likert scale of 1 to 5 was used.

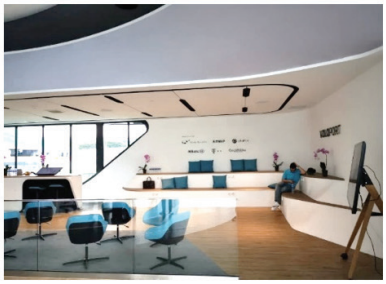
Case Study: The VoloPort by Volocopter, Singapore

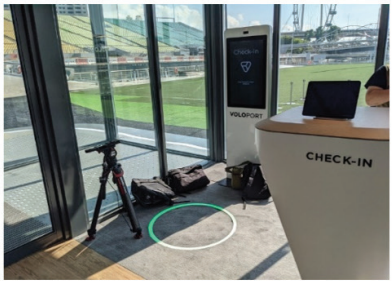
Due to the fact that a fully operational vertiport (for e-VTOL service) has never been built, the case study analysis was conducted on the first one-to-one scale vertiport prototype belonging to an air taxi firm – The Volocopter. The prototype was named VoloPort and was on display during the Intelligent Transport Systems (ITS) World Congress, Singapore on the 24th - 25th of October 2019 for the public to visit and experience it at the Float, Marina Bay, Singapore (Figures 1 & 2).

Figures 1. (left) & 2 (right): Exterior View Towards the Entrance of the Terminal, and the View of the Take-off and Landing Platform Equipped at the VoloPort

(Source: Author, 2021)

The VoloPort was equipped with the basic crucial facilities such as the e-VTOL's battery charging terminals, and the operation office. A huge flight information display was located at the lounge area showing the Volocopter service coverage routes. The information board provided details including the boarding time, estimated time of departure (ETD), estimated time of arrival (ETA), speed of the e-VTOL, weather conditions, wind speeds, temperature, and other flying related information. The VoloPort is also equipped with the information counter, waiting lounge, meeting area, and a pantry that provides refreshment for the users. Since flying must comply with the strict aviation authority safety and security guidelines, it is taken seriously hence the provision of a biometric security screening at the entrance and the boarding gates (Figure 3 & 4).





Figures 3. (left) & 4 (right): The interior views of The VoloPort showing the Information Counter, and the Waiting and Meeting Lounge (left), and the Self-checking-in Station Provided (right).

(Source: Author, 2021)

RESULTS & DISCUSSIONS

Results obtained from this research are divided into two segments, i.e. firstly, the urban commuters' acceptance of the proposed vertiport idea, and secondly the urban commuters' expectations on the design of a vertiport. Urban commuters' acceptance for an e-VTOL service to be operated is crucial to ensure the viability of the e-VTOL service for a longer term. While, the level of the urban commuters' expectation on the overall design of a vertiport will assist planners and designers in providing the best design solutions to ensure optimum building operation. The data collected was analysed based on the implementation of the Likert Scale 1 to 5 (1 = totally disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = totally agree).

The Acceptance of Urban Commuters towards the Proposed e-VTOL Service

Based on the results shown in Figure 5 below, it shows that some 8.9% and 3.8% of respondents from the total 157 respondents are either in disagreement or in total disagreement respectively with the idea of an e-VTOL as another option besides other existing public transportations available. There are however, 12.1% who are in total agreement with the idea, with an additional 35.0% of respondents that are in agreement with the proposed idea to use an e-VTOL as a mode of public transportation. However, 40.1% of the respondents chose to be neutral with this proposition.

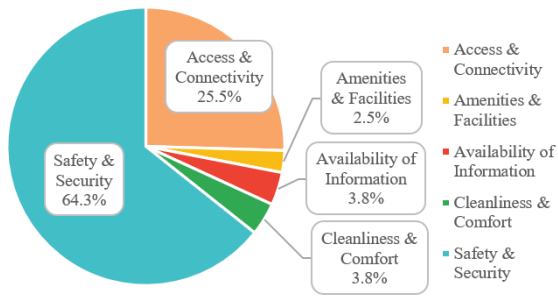


Figure 6. Levels of the Urban Commuters' Preferences on the Important Building Design Criteria for a Vertiport Building

(Source: Author, 2021)

Notwithstanding from the five main building design criteria preferences has been identified, the research however further made an analysis on 11 specific design elements to further understand the real needs of the KL urban commuters regarding the overall vertiport building design.

Referring to Table 1 below, there are seven building design elements that were ranked as 'very important' with average responses index (RI) ranging from 4.21 to 5.00 and this include; information effectively delivered (RI = 4.46), connection to other transportation system (4.45), availability of information (4.43), adequate security personnel (4.39), building easily accessible (4.38), adequate security checkpoint (4.34), and a well maintained amenities and facilities (4.33). Besides that, the other four building design elements that were ranked as 'important' were indexed at 3.41 to 4.20 that are; enough provision of amenities and facilities (RI = 4.14), cleanliness and well maintained (4.14), cosy and comfortable environment (4.03), and adequate illumination and lighting (4.01).

Table 1. Ranking of the Vertiport Preferred Building Design Elements by the KL Urban Commuters

Ranking	Building design elements	Response Index, RI (average)	Scale of Responses
1	Information effectively delivered	4.46	Very Important
2	Connection to other transportation system	4.45	Very Important
3	Availability of information	4.43	Very Important
4	Adequate security personnel	4.39	Very Important
5	Building easily accessible	4.38	Very Important
6	Adequate security checkpoint	4.34	Very Important
7	A well-maintained amenities & facilities	4.33	Very Important
8	Enough provision of amenities & facilities	4.14	Important
9	Cleanliness & well maintained	4.14	Important
10	Cosy & comfortable environment	4.03	Important
11	Adequate illumination & lighting	4.01	Important

(Source: Author, 2021)

Surprisingly, although 'safety and security' was identified as the most important building design criteria (as shown in Figure 6 earlier), it is however shown that the needs for information, i.e. 'information effectively delivered' and 'availability of information' ranked higher than the 'safety and security' within the vertiport building design elements list.

Though in general, usually people will see that the 'safety and security' as a very important criteria for an airport, and an e-VTOL operation can be put under the same typology of building as the airport. However, from the examination of the responses it can be concluded that the 'availability of information' (such as the boarding time, estimated time of departure (ETD), estimated time of arrival (ETA), speed of the e-VTOL, weather conditions, wind speeds, temperature, and other flying related information.) is significantly important for today's urban commuters with busy schedules and fast-moving lifestyles.

Topping the ranking table (Table 1) is the need for the 'information effectively delivered', instead of for just the 'availability of information'. This is a very important message to the planners and designers in designing vertiport terminal building. A vertiport should be carefully designed to accommodate the building with effective information delivery as it will ensure the urban commutere are provided service effectively. It is however important to note that the safety and security elements should not be neglected to ensure proper and reliable overall e-VTOL operation.

CONCLUSION

It is absolutely difficult to convince people to accept any new idea that defies convention, especially when there is no convincing evidence or examples to be based on. The same scenario could be comprehended from the Kuala Lumpur urban commuters' responses on the idea of a vertiport to serve the public within the Klang Valley areas. About 12.7% of respondents rejected the idea, while 40.1% could not make any decision either to accept or to decline the idea. However, the results show that 47.1% of respondents agree with it. This survey results could probably indicate that the Kuala Lumpur urban commuters are not yet ready to fully accept the proposal that could possibly reflect their current understanding, knowledge, and exposure to

this latest possible urban public transportation technology.

It is also indeed a challenging task to start designing a building without a precedent, or an example as reference. The idea to have a reference to start designing with is to learn from the previous experiences. Therefore, this research took the opportunity to examine the level of acceptance and also the level of expectation of the Kuala Lumpur urban commuters on a newly proposed e-VTOL vertical airport (vertiport) in an effort to establish early design information and public insights on how a vertiport building should actually be designed. It is from the public (urban commuters) feedback received, that the important understanding on the most important building design criteria, and the building design elements to be implemented are evidenced.

Subsequently, from the survey results it shows that urban commuters are more concerned whether the vertiport building is able to provide adequate information that is related to their travelling itinerary such as the boarding time, ETD, and the ETA, rather than being beautifully designed but failing to deliver its actual function as transportation terminal building. Responses from this group of urban communters in Kuala Lumpur is significantly important because it does reflect today's hectic urban lifestyles where the Surprisingly, although 'safety and security' was identified as the most important building design criteria (as shown in Figure 6 earlier), it is however shown that the needs for information, i.e. 'information effectively delivered' and 'availability of information' ranked higher than the 'safety and security' within the vertiport building design elements list.

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