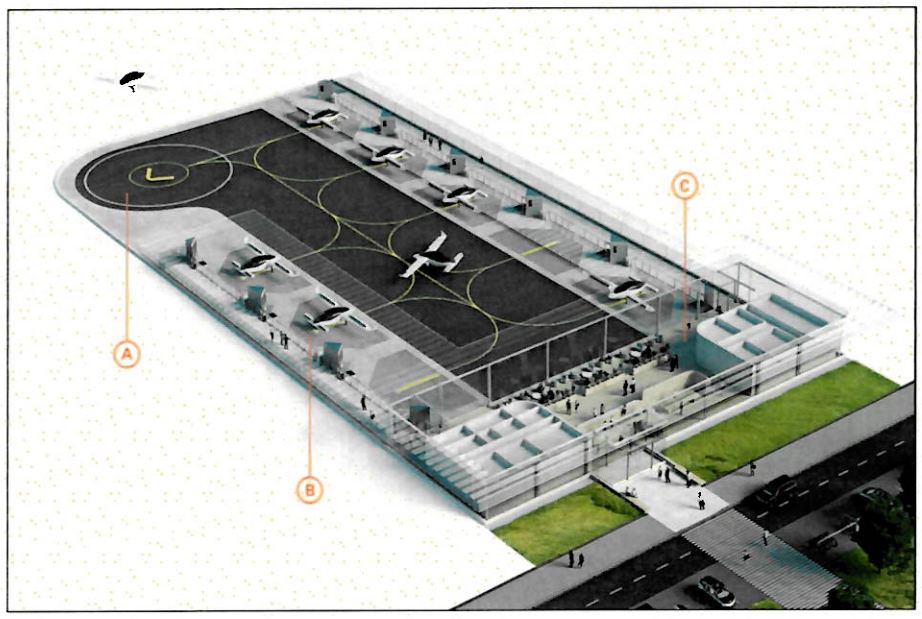
Optimal planning for an Urban Air Mobility transport system – Placement of vertiports in Munich

Master's Thesis of Ranjana Huttard

Mentoring:
M. Sc. Katrin Lippoldt
M. Sc. Magdalena Peksa



The number of people living in cities will continue to grow in the future. As a result, the rate of congestion in urban transport, in both the private and public sectors will increase, even though the saturation point is probably reached by now. As a result, a new attempt has been made to extend transportation to the third dimension. The aim is to develop an urban air transport networks with flying vehicles and aircraft hovers that take off and land vertically and are therefore dependent on landing spots, vertiports. In order to implement Urban Air Mobility, it is crucial to ensure new spots for vertiports integrated into the existing network.

Even though manufacturers have achieved a huge success on developing the aircraft itself, however when it comes to the necessary infrastructure supporting the transportation of passenger throughout the transport network in urban areas, there is still a necessity for comprehensive groundwork. If UAM should be introduced in the future, a suitable ground infrastructure must be created.

The aim of this thesis is to approach the solution on having an optimal planning for finding locations to place vertiports in Munich. The idea was to construct a proposal to define guidelines for the for the implementation of vertiports while locating the optimal placements for vertiports in Munich. These guidelines could then be used for authorities and cities to develop vertiports.

Since the UAM is not yet operational and cannot be observed in reality, an online survey was conducted to gather experts' opinions on the benefits and the difficulties of implementing a vertiport infrastructure. Furthermore, the survey helped to gain an insight about the influence of a UAM network on Munich's existing infrastructure. A quantitative data analysis was carried out, using an anonymous online questionnaire. Therefore, the investigation concentrated on the Munich region. With the findings based on the literature review and the results of the survey the guidelines were defined.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
The low-density UAM* network is realistic for the region of Munich					
The low-density UAM* network will relieve the public transportation mode in Munich					
The low-density UAM* network will relieve the traffic congestion in Munich					
The low-density UAM* network will merely serve as an extra transportation mode					

Alternate Hypothesis		Median η	Condition for Wilcoxon Test	p-value	Retain	Reject
H 1	A medium-density network of vertiports is realistic for Munich	3	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,915		x
H 2	A UAM transport mode will be used as an extension to the public transport network	1 - 1.5	-	-		x
Regulations for vertiports:						
H 3.1	There is a necessity to develop new regulations for vertiports	5	-	-	x	
H 3.2	Regulations for vertiports should be based on heliport regulations	4	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,007	x	
H 3.3	There is a necessity to develop regulations for vertiports nationwide	4.5	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,001	x	
H 3.4	There is a necessity to develop regulations for vertiports statewide	2	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,986		x
H 3.5	There is a necessity to develop regulations for vertiports in each city	4	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,714		x
Munich Building Division:						
H 4.1	UAM should not be assigned to the "Tiefbau" Department of the Munich Building Division	3	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η < 3	0,054		x
H 4.2	UAM should not be assigned to the "Ingenieurbau" Department of the Munich Building Division	3	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η < 3	0,417		x
H 4.3	UAM should not be assigned to the "Hochbau" Department of the Munich Building Division	3	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η < 3	0,663		x
H 4.4	There is a necessity to open a new main department for UAM at the Munich Building Division.	3	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,384		x
Weather Conditions:						
H 5.1	Strong winds have an negative influence on VTOL operations	4	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,714		x
H 5.2	Rain has an negative influence on VTOL operations	3	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,597		x
H 5.3	Snow has an negative influence on VTOL operations	3.5	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,265		x
H 5.4	Icing has an negative influence on VTOL operations	4	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,103		x
Fueling:						
H 6.1	Having a fuel storage near to a housing is considered a safety risk	3	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,675		x
H 6.2	Having a battery storage near to a housing is considered a safety risk	2	Null Hypothesis H_0: η = 3 Alternate Hypothesis H_1: η > 3	0,675		x

In summary, problems such as noise, cyber threats, establishing new regulations, and allocating UAM to a responsible division must be addressed seriously and overcome in order to successfully implement a vertiport network. On the other hand, opportunities arise as a result of having to worry less about weather conditions, fueling storage facilities, visual pollution, and some safety precautions that may be adapted from airports or traditional helicopter operations.

The study, which was carried out within the scope of this work, serves as a preliminary study. As there will be some test cities in the next few years, such as the city of Ingolstadt, the study could be carried out with realistic values and a larger collective sample. The study discussed here is based on theoretical knowledge that has not yet been put into practice and can therefore not be compared with any other studies. The results of this study only serve to provide an overview of the guidelines.