Study on the Use of Heliport as Landing and Take-off Sites for Urban Air Mobility

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Abstract. UAM (Urban Air Mobility) is a new mode of transportation to move passengers or goods from one place to another that is previously less or not yet served by current aviation in urban areas. To facilitate UAM operations, infrastrucutre for landing and take-off is essensial. Since UAM vehicles have the same VTOL (Vertical Takeoff and Landing) capabilities as helicopters, heliport serve as the most comparable infrastructure. This study examines the potential use of heliport for UAM operations, referencing guidelines and regulations from ICAO, EASA, and FAA. As a case study, a comparison is made between the landing and take-off requirements of the Bell 505 helicopter and the UAM vehicle Joby S4, based on their unique specifications. Additionally, an analysis of heliport characteristics in Indonesia was conducted. Out of the 38 heliports analyzed, 24 met the landing and take-off criteria for the UAM Joby S4. This suggests that UAM could operate in Indonesia using the existing heliport infrastructure, with necessary improvements such as charging facilities.

Keywords: *UAM, Heliport, Vertiport, ICAO, FAA, EASA*

1 Introduction

According to the Federal Aviation Administration (FAA), the United States government agency responsible for establishing aviation safety standards and regulations, Advanced Air Mobility (AAM) refers to air transportation for moving people and goods between various locations—local, regional, interregional, and urban—that are currently underserved or not served by traditional aviation. AAM employs new aircraft, technologies, infrastructure, and operations. Urban Air Mobility (UAM) is a subset of AAM, focusing specifically on the movement of people and goods within metropolitan and urban areas [1]. UAM vehicles have Vertical Takeoff and Landing (VTOL) capabilities similar to helicopters. In recent years, interest in UAM has grown significantly, with many countries and companies seeking to enable UAM operations. At the Vertical Flight Society’s 2021 technical meeting, Jay Merkle, Executive Director of the FAA's Unmanned Aircraft System (UAS) office, discussed the possibility of type certification (TC) for certain UAM aircraft. At that time, the FAA was collaborating with 30 companies for certification purposes. TransportUP has

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compiled a comprehensive list of 68 air vehicles from 18 leading manufacturers competing in the Urban Air Mobility (UAM) market [2]. Several UAM aircraft are predicted to begin operations within the next two years. Among them are the Volocopter, Joby, Lilium Jet, Archer, Archer Midnight, Autoflight Prosperity 1, Ehang EH216, and Vertical Aerospace VX4 [3]. In Indonesia, UAM is planned to operate in the new capital city (IKN) in East Kalimantan.

To support UAM operations, a study is required on UAM landing and takeoff sites, known as vertiports. A vertiport is an area on land, water, or a building used for the landing and takeoff of aircraft with VTOL capabilities [4]. Since UAMs have VTOL capabilities similar to helicopters, the closest existing infrastructure is the heliport, making it necessary to compare current heliport infrastructure with the requirements of vertiports. While many have developed vertiport concepts, there are still no clear or standardized regulations. EASA and the FAA are working to publish vertiport specifications to provide global guidelines for designing vertiports. Companies like Skyport and Ferrovial have already started designing vertiports in various countries. This paper aims to determine whether current infrastructure, such as heliports, can be used for UAM operations in alignment with vertiport guidelines and regulations.

2 Literature Review

2.1 Urban Air Mobility

Urban Air Mobility (UAM) is a subset of Advanced Air Mobility (AAM), focusing on the transportation of passengers and cargo within urban areas [1]. UAM features VTOL capabilities, similar to current helicopters. VTOL refers to the ability of an aircraft to take off and land vertically. UAM is currently being developed as electric-powered aircraft, commonly referred to as electric Vertical Take-Off and Landing (eVTOL) vehicles. While UAM may not significantly reduce ground traffic volume, it will provide a fast alternative mode of transport that can bypass traffic congestion during peak hours. UAM operations are expected to evolve over time, as illustrated by the FAA in Figure 1.

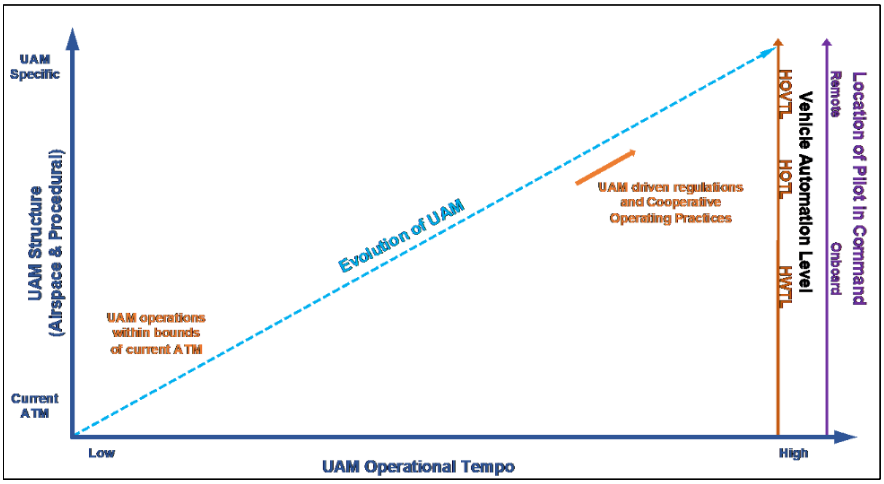

Figure 1 Evolution of UAM Operations [1]

Figure 1 shows that the initial UAM traffic will be managed by the existing Air Traffic Management (ATM) system, as operations will be limited and pilots will still be present on the vehicles. As UAM operations increase in frequency and automation levels rise, the airspace structure and procedures will evolve. UAMs, initially piloted, will eventually transition to autonomous operations over time. UAM will have its own dedicated airspace for operation. This is illustrated by National Aeronautics and Space Administration (NASA) in Figure 2.

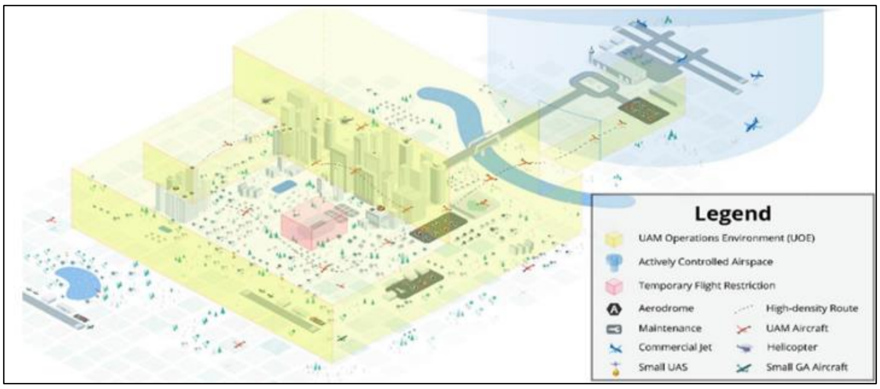

Figure 2 NASA UAM Operations Environment (UOE) [5]

NASA states that UAM operations will take place within the UAM Operations Environment (UOE) at higher levels, as shown in Figure 2. UAM aircraft can operate both inside and outside of the UOE. The UOE will be managed by the Provider of Service to UAM (PSU). Whereas outside the UOE, UAM aircraft must follow the airspace regulations and coordinate with Air Traffic Control (ATC). The UOE can extend into controlled airspcace by ATC, such as the airport environment depicted in Figure 2. UOE within controlled airspace will be fully managed by the PSU.

2.2 Vertistop, Vertiport, and Vertihub

According to EASA, a vertiport is an area on land, water, or a building used for the landing and takeoff of aircraft with Vertical Take-Off and Landing (VTOL) capabilities [4]. Vertiport is a general term for UAM infrastructure. As UAM operations increase, there will be several categories of vertiports offering different facilities. These are generally classified into vertistops, vertiports, and vertihubs. NASA uses the term "Vertiplace" to refer to these three types. To illustrate the differences between vertistop, vertiport, and vertihub, a comparison is made using several documents, including FAA : *UAM Concept of Operation V2.0*[1], Boeing, Wisk : *Concept of Operation for Uncrewed Urban Air Mobility V2.0*[6], NUAIR,NASA : *Advanced Air Mobility (AAM) Vertiport Automation Trade Study*[7], Bluenest : *Vertiport Whitepaper V1.0*[8], Munich Airport International (MAI) : *Advance Air Mobility at Airports*[9] dan MCKinsey&Company[10]. The differences between vertistop, vertiport, and vertihub are shown in Table 1.

Table 1 Comparison of Vertistop, Vertiport, and Vertihub

	Vertistop					**Vertiport**					**Vertihub**				
Document	**FAA**	**Boeing**	**NASA**	**Bluenest**	**MAI**	**FAA**	**Boeing**	**NASA**	**Bluenest**	**MAI**	**FAA**	**Boeing**	**NASA**	**Bluenest**	**MAI**
Minimum size	100 ft x 60 ft					250 ft x 100 ft					400 ft x 200 ft				
TLOF	1	1	1	1	1	≥1	≥2	≥1	≥1	≤3		≥2	≥1	≥1	≥2
Parking stand		-	√	√	≤3	√	√	√	√	4-10		√	√	√	≥10
Charging station	-	√		Optional	√	√	√	√	√	√		√	√	√	√
Terminal	-	-	-	-		√	√	√	√	√		√	√	√	√
Hangar		-	-			√	√	√	√	√		√	√		√
MRO facilities	-	-	-	-			-	-	-	√		√	√	√	√

From the comparison of several documents in Table 1, a proposal for categorizing vertiports is obtained. The proposal is shown in Table 2.

Table 2 Proposal for Vertiport Categories

Category	**Vertistop**	**Vertiport**	**Vertihub**
Size and electricity needs	Small	Medium	Large
Number of landing sites	1	At least 1 TLOF, as per EASA documents	

Category	Vertistop	Vertiport	Vertihub
Parking stand	Optional, usually none	Available	Available, usually many
Charging station	Optional	Available	Available
Passenger terminal	None, only passenger check-in area	Available	Available, similar to airports (flight connection area, hotels, shopping areas, etc.)
Hangar	None	None	Available
MRO facilities	None	None, usually only basic maintenance by ground staff	Available

Vertistop is the smallest type in the vertiport network, so it has limited size. The facilities at a vertistop are also minimal, with only 1 Touchdown and Lift-Off Area (TLOF). Vertistops are usually used solely for landing and takeoff. Parking stands and charging infrastructure are optional and if available are in limited numbers. There is no passenger terminal, but there must be an area for passenger and cargo checks. Hangars and maintenance facilities are not available at vertistops.

Vertiport is the main infrastructure for UAM operations in urban areas. A vertiport has more facilities than a vertistop but fewer than a vertihub. Both vertihubs and vertiports must have at least 1 TLOF, as described in EASA documents. A vertiport also has several parking stands and charging infrastructure. The passenger terminal at a vertiport is similar to a current heliport terminal, which includes passenger and cargo screening areas. Maintenance at a vertiport is usually limited to basic maintenance by ground staff.

Vertihub is the largest type in the vertiport network. Vertihubs usually have many parking stands. A vertihub also has hangars to store UAM vehicle and includes Maintenance, Repair, and Overhaul (MRO) facilities. The passenger terminal facilities are similar to modern airports, featuring shopping areas, hotel facilities, and more.

2.3 Vertiport and Heliport Dimension

According to ICAO, heliport is an airport or a designated area on a building used entirely or partially for the arrival, departure, and surface movement of helicopters [11]. A vertiport serves the same function as a heliport, which is as a landing and takeoff site for VTOL aircraft. Both vertiports and heliports can be located on top of buildings, open areas, or airports.

Vertiport has a landing and takeoff area similar to a helicopter. The vertiport's landing area also consists of FATO (Final Approach and Take-Off Area), TLOF

(Touchdown and Lift-Off Area), and SA (Safety Area). FATO is defined as the area designated to complete the final phase of the landing maneuver or hovering to begin takeoff. TLOF is the area where helicopters or UAMs land and lift off. SA is the area surrounding FATO, free from obstacles, intended to reduce the risk of damage to helicopters or UAMs that accidentally deviate from the FATO. An illustration of TLOF, FATO, and SA is shown in Figure 3..

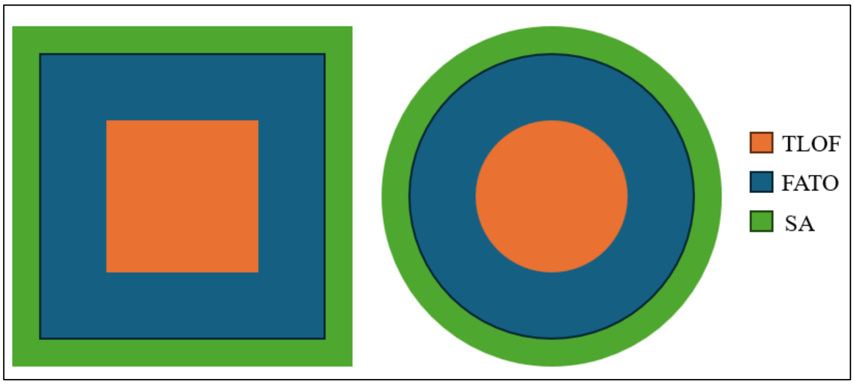

Figure 3 Ilustration of TLOF, FATO, and SA

The design of a vertiport and heliport depends on the dimension of condition (D). D for a vertiport is the smallest circle diameter that encompasses the entire VTOL aircraft on the horizontal plane, including the rotating rotors [12]. The design comparison between heliports and vertiports is conducted through 2 documents for heliports : ICAO - Annex 14 Aerodromes Volume II : *Heliport* [11] and FAA - Advisory Circular : *Heliport Design* [13] as well as 2 documents for vertiports : EASA - *Vertiports Prototype Technical Specifications for the Design of VFR Vertiports for Operation with Manned VTOL-Capable Aircraft Certified in the Enhanced Category* (PTS-VPT-DSN) [12] and FAA – Engineering Brief No. 105 : *Vertiport Design* [14] . The design comparison from these 4 documents is shown in Table 3.

Table 3 Comparison of vertiport and heliport dimensions

	Heliport		Vertiport	
Dokumen	**Annex 14 Vol 2 (ICAO)**	**AC 150/5390-2D (FAA)**	**PTS-VPT-DSN (EASA)**	**EB No. 105 (FAA)**
TLOF	0.83 D	0.83 D, ≥ 50 ft	0.83 D	1 D
FATO	Performance Class 1 : 1 D Performance Class 2 & 3 : 1 D jika MTOW > 3175 kg 0.83 D jika MTOW≤ 3175 kg	1.66 D, ≥ 100 ft	1.5 D	2 D
SA (from FATO)	3 m or 0.25 D	0.28 D, ≥ 20 ft	3 m or 0.25 D	0.5 D

From Table 3, it can be observed that UAM requires a larger landing or takeoff area compared to helicopters with the same D dimension. The following discussion will address whether UAM can land and take off at existing heliports.

2.4 Obstacle Free Volume

The Obstacle Free Volume (OFV) is intended to provide protection above the vertiport in densely populated areas surrounded by buildings. According to its concept, a vertiport can be located near urban communities. Therefore, EASA has introduced the Obstacle Free Volume concept to ensure that UAM aircraft can safely enter or exit the vertiport. This is a new concept introduced by EASA, which was not previously included in heliport regulations. An illustration of the Obstacle Free Volume is shown in Figures 4 and 5.

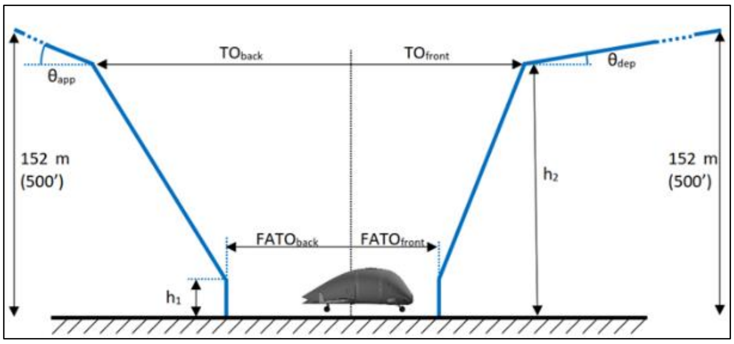

Figure 4 Illustration of Obstacle Free Volume Parameters [12]

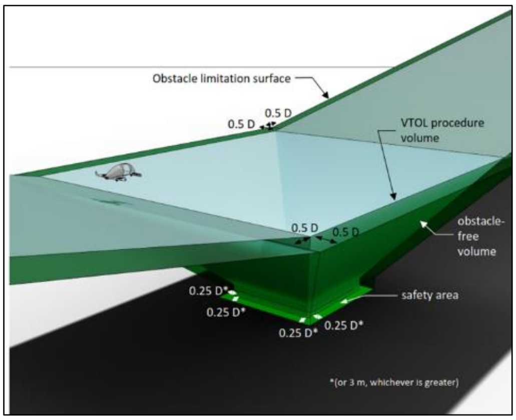

Figure 5 Illustration of Obstacle Free Volume [12]

To achieve a more specific design, EASA has established Reference Volume Type 1 as a standard reference. Details regarding the parameters and dimensions according to Reference Volume Type 1 are shown in Table 4.

Table 4 Explanation and dimensions of obstacle free volume

Parameter	Short Description	Max/Min	Ref volume Type 1
h_1	*Low hover height*	-	3 m
h_2	*High hover height*	$\geq h_1$	30.5 m
TO_{width}	*Width at* h_2	$\leq$ 5 D	3 D
TO_{front}	*Front distance at* h_2	$\leq$ 5 D	2 D
TO_{back}	*Back distance at* h_2	$\leq$ 5 D	2 D
$FATO_{width}$	*Width of the FATO*	$\geq$ 1.5 D	2 D
$FATO_{front}$	*Front distance on FATO*	$\geq$ 0.75 D	1 D
$FATO_{back}$	*Back distance on FATO*	$\geq$ 0.75 D	1 D
θ_{app}	*Slope of approach surface*	$\geq$ 4.5 %	12.5%
θ_{dep}	*Slope of departure surface*	$\geq$ 4.5 %	12.5%

3 Analysis

3.1 Implementation of Heliport and Vertiport Dimensions for Bell 505 and Joby S4

Based on the comparison table obtained from Table 3, heliport dimensions will be applied to the Bell 505 helicopter, and vertiport dimensions to the Joby S4. The Bell 505 and Joby S4 have the same passenger capacity of 4+1[15][16]. The Bell 505 helicopter was chosen because it is widely used in Indonesia, while the Joby S4 was selected due to its potential as a UAM and its achievement of Stage 3 certification from the FAA. Images and data for the Joby S4 and Bell 505 are shown in Figure 6 and Table 5.

Figure 6 Joby S4 (left) and Bell 505 (right)

Table 5 Comparison of Specifications for Bell 505 and Joby S4

Element	Bell 505	Joby S4
MTOW	1669 kg	2177 kg
Length	10.53 m	6.4 m
Overall length	12.95 m	
Wingspan		11,8 m
Rotor	11.28 m	2.89 m
Max. Altitude	6096 m	4572 m
Cruising Speed	232 km/h	322 km/h
Range	566 m	241 m
Max. Pax	4+1	4+1

An illustration of the D dimension for the Joby S4 UAM and Bell 505 helicopter is shown in Figure 7.

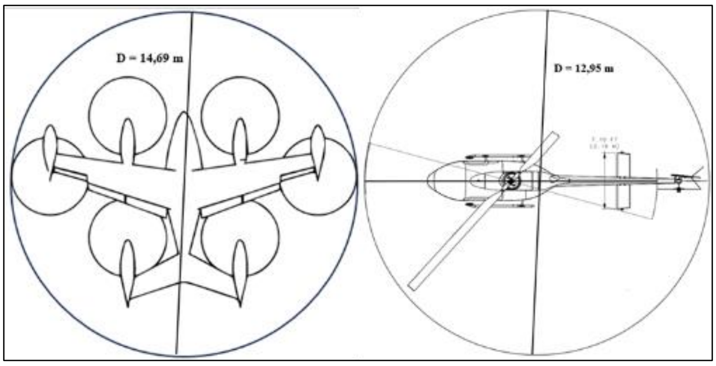

Figure 7 'D' Dimension on the Joby S4 UAM (left), 'D' Dimension on the Bell 505 Helicopter (right)

Next, the implementation of heliport and vertiport dimensions on the Bell 505 helicopter and Joby S4 UAM will be carried out according to their respective guidelines and regulations. This aims to provide a more realistic comparison between the two. The dimensional comparison is shown in Table 6.

Table 6 Comparison of Pad Dimensions for Bell 505 and Joby S4

Dokument	Heliport		Vertiport	
	Bell 505		Joby S4	
	Annex 14 Vol 2 (ICAO)	AC 150/5390-2D (FAA)	PTS-VPT-DSN (EASA)	EB No. 105 (FAA)
D	12,95 m		14,69 m	
TLOF	10.75 m	10.75 m	12.19 m	14.69 m
FATO	19.43 m	21.50 m	22.04 m	29.38 m
SA (from FATO)	3 m or 3.24 m	3.63 m	3 m or 3.67 m	7.35 m
Total	25.90 m	28.75 m	29.38 m	44.07 m

From Table 6, it can be seen that vertiports require larger dimensions compared to heliports. The Joby S4 has a "D" dimension of 14.69 meters, which is larger than the Bell 505's 12.95 meters. The significant size of the Joby S4 necessitates a larger design for the vertiport as well.

The TLOF required for the Bell 505 is 10.75 meters, while the Joby S4 requires a TLOF of 12.19 meters based on EASA vertiport standards and 14.69 meters based on FAA vertiport standards. The FATO needed for the Bell 505 is 19.43 meters according to ICAO heliport standards and 21.5 meters according to FAA heliport standards. The Joby S4 requires a larger FATO of 22.04 meters based on EASA vertiport standards and 29.38 meters based on FAA vertiport standards. The safety area required for the Bell 505 is 3.24 meters according to ICAO heliport standards and 28.75 meters according to FAA heliport standards. Meanwhile, the Joby S4 requires a safety area of 3.67 meters based on EASA vertiport standards and 7.35 meters based on FAA vertiport standards.

The total landing pad dimension required for the Bell 505 for both landing and takeoff is 25.9 meters based on ICAO heliport standards and 28.75 meters based on FAA heliport standards. In contrast, the Joby S4 requires a total dimension of 29.38 meters based on EASA vertiport standards and 44.07 meters based on FAA vertiport standards. The vertiport designed for the Joby S4 according to EASA standards requires 3.48 meters, which is 0.63 meters larger than the Bell 505, designed according to ICAO and FAA heliport standards. On the other hand, the vertiport designed for the Joby S4 based on FAA vertiport standards requires 18.17 meters, which is 15.32 meters larger than the Bell 505 designed based on ICAO and FAA heliport standards. Vertiports designed according to FAA vertiport standards will have larger dimensions compared to other regulations.

From this comparison, it can be concluded that UAM requires larger dimensions compared to helicopters. The dimensions mentioned above are the minimum requirements and can be expanded. The Joby S4 cannot land on a heliport designed for the Bell 505 using its minimum dimensions.

3.2 Implementation of Obstacle Free Volume for the Bell 505 and Joby S4

Next, a comparison of the Obstacle Free Volume will be analyzed using the reference volume type 1 dimensions for the Bell 505 helicopter and Joby S4 to assess their respective requirements. The comparison is shown in Table 7.

Table 7 Comparison of Obstacle Free Volume between Bell 505 and Joby S4

Parameter	Bell 505	Joby S4
h_1	3 m	3 m
h_2	30.5 m	30.5 m
TO_{width}	38.85 m	44.07 m
TO_{front}	25.90 m	29.38 m
TO_{back}	25.90 m	29.38 m
$FATO_{width}$	25.90 m	29.38 m
$FATO_{front}$	12.95 m	14.69 m
$FATO_{back}$	12.95 m	14.69 m
θ_{app}	12.5 %	12.5 %
θ_{dep}	12.5 %	12.5 %

From Table 7, it can be seen that the requirements for the Joby S4 are larger than those for the Bell 505. This is due to the larger condition (D) dimension of the Joby S4 and its higher FATO requirements. The TO_{width} dimension required for the Joby S4 is 5.22 meters larger than the Bell 505. The TO_{front}, TO_{back} and $FATO_{width}$ dimensions needed for the Joby S4 are 3.48 meters larger compared to the Bell 505. Additionally, the $FATO_{front}$ and $FATO_{back}$ dimensions required for the Joby S4 are 1.74 meters larger than those of the Bell 505. Therefore, based on these dimensions, it can be concluded that if the Obstacle Free Volume is designed for the Joby S4, the Bell 505 can operate within that design.

3.3 Analysis of the Capability of UAM Joby S4 to Land and Take Off at Several Heliports in Indonesia

Several heliports were reviewed to assess whether the existing helicopter infrastructure can be used as a landing and takeoff site for the UAM Joby S4. The regulations used to determine the required size for UAM are the EASA vertiport standards, as the FAA vertiport standards differ significantly from the heliport regulations. Heliport data was sourced from the AIM Indonesia (Aeronautical Information Management Indonesia) website [17]. There are 65 heliports listed on the AIM Indonesia website, but only 63 heliports are accessible. Of these 63 heliports, only 38 have complete data regarding FATO, TLOF, SA, and weight. These 38 heliports will be analyzed in this section. The 38 heliports and the Joby S4's capability to land are shown in Table 8.

Table 8 Analysis of Joby S4's Capability at 38 Heliports

Heliport Name	Location	FATO (m)	TLOF (m)	SA (m)	Load (ton)	Meets/ Doesn't Meet				
						FATO	TLOF	SA	Load	OFV
SGI	Bali	13	13	3	6	X	√	√	√	√
Viceroy Bali	Bali	19.5	12	3	2.5	X	X	√	√	√
Bali Helitour	Bali	22.5	12.2	6.9	3	√	√	√	√	√
JAG Nusadua	Bali	14	14	7	5	X	√	√	√	√
Fly Bali	Bali	22.5	15	3.73	5	√	√	√	√	√
Alfa Tower Heliport	Banten	18	18	4.5	5.5	X	√	√	√	√

Heliport Name	Location	FATO (m)	TLOF (m)	SA (m)	Load (ton)	Meets/ Doesn't Meet				
						FATO	TLOF	SA	Load	OFV
Cengkareng Heliport	Banten	30	20	3	18	√	√	√	√	√
Gudang Garam Jakarta	DKI Jakarta	25	25	65	5	√	√	√	√	√
PM Tower	DKI Jakarta	27	27	6.75	9.4	√	√	√	√	√
Tempo Pavilion	DKI Jakarta	16	16	4	10	X	√	√	√	√
Bangko	Jambi	24	16	8	9	√	√	√	√	√
Altius Resinda	Jawa Barat	29	19	7	11.2	√	√	√	√	√
Cibeureum Family Resort	Jawa Barat	22.5	15	3	3	√	√	√	√	√
Karawang	Jawa Barat	21	21	4.5	10	X	√	√	√	√
GG Temanggung	Jawa Tengah	28	28	32	10	√	√	√	√	√
Alas Tua	Jawa Timur	18	18	3	14	X	√	√	√	√
Gudang Garam	Jawa Timur	18.24	18	24.76	6	X	√	√	√	√
SA Kediri	Jawa Timur	28	28	20	25	√	√	√	√	√
Japfa SDA	Jawa Timur	27	18	3	5	√	√	√	√	√
GG Unit 1	Jawa Timur	18	18	9	6	X	√	√	√	√
PCS	Jawa Timur	30	20	25	8.6	√	√	√	√	√
GG Waru	Jawa Timur	22	22	7	10	X	√	√	√	√
Sepanjang 600	Jawa Timur	20	20	5	6	X	√	√	√	√
Kariangau	Kalimantan Timur	27	18	17	20	√	√	√	√	√
Senipah	Kalimantan Timur	32	18	13	8	√	√	√	√	√
Handil	Kalimantan Timur	26	17	8	15	√	√	√	√	√
Tanjung Santan	Kalimantan Timur	30	24	60	15	√	√	√	√	√
NPU	Kalimantan Timur	24	16	21	8	√	√	√	√	√
Lagoi Bravo	Kepulauan Riau	20	15	3	3	X	√	√	√	√
Minas	Riau	24	16	8	9	√	√	√	√	√
Rumbai	Riau	30	20	60	9	√	√	√	√	√
DSF Cogen	Riau	27	18	9	9	√	√	√	√	√
Duri	Riau	24	16	21	6	√	√	√	√	√
Matthew	Riau	20	20	3.25	4	X	√	√	√	√
Libo	Riau	24	16	21	6	√	√	√	√	√
Petapahan	Riau	24	16	8	6	√	√	√	√	√
Grissik	Sumatera Selatan	15	15	13.5	20	X	√	√	√	√
Martubung	Sumatera Utara	29	14	4.5	4	√	√	√	√	√

From the 38 heliports analyzed, 24 heliports (63.2%) meet all the criteria for the landing and takeoff of the UAM Joby S4. 14 heliports (36.8%) do not meet the minimum FATO dimensions, and 1 heliport (2.6%) does not meet the minimum TLOF dimensions for the UAM Joby S4. All heliports meet the minimum safety area dimensions and can support the weight of the UAM Joby S4. None of the heliports are located between buildings, so Obstacle Free Volume is not an issue in this case.

For the regions of Jakarta, Banten, West Java, East Java, and Central Java, there are 17 heliports listed in the AIM Indonesia data. Of these 17 heliports, all characteristics except for FATO have been met. There are still 8 heliports (47.1%) that do not meet the minimum FATO dimensions for the UAM Joby S4. Therefore, if the UAM Joby S4 is to be operated at these heliports, it is recommended to expand the FATO dimensions.

The 24 heliports that meet all the criteria can be considered vertistops but are not yet capable of becoming vertiports, as they lack charging facilities and passenger terminals. If these heliports are to be developed into vertiports, charging facilities and terminals must be provided. Additionally, heliports that do not have parking areas must provide parking space for UAM vehicles if they are to become vertiports. This aligns with the proposal in Table 2.

Overall, the existing heliports can be used as landing and takeoff sites for the UAM Joby S4. It can be concluded that UAM can utilize the existing heliport infrastructure at the beginning of its operations as landing and takeoff sites, particularly for the Joby S4. However, improvements are needed, such as expanding the FATO area and providing parking spaces, as well as upgrading facilities such as charging stations and passenger terminals.

3.4 Discussion and future recommendation

In this study, we compared UAM vertiports and heliports across various aspects, including dimensions, categories, and locations. However, there are several limitations to this research. Since UAM has not yet been fully operationalized, studies on the required infrastructure remain limited. Furthermore, standardized regulations for UAM and vertiports have yet to be established, restricting the scope of available literature. Due to these limitations, this study explores whether existing helicopter infrastructure can be adapted for use when UAM becomes operational. The heliport data used in this study is limited and may not fully reflect global needs or regional variations. Additionally, this study does not comprehensively address economic feasibility or environmental sustainability, which are critical elements for the practical implementation of vertiports. To enhance the relevance and impact of this research, several recommendations and suggestions for future studies are proposed:

1. Integration with Urban Infrastructure : Further research is needed to identify how vertiports can be efficiently integrated with existing urban transportation systems, such as rail hubs, bus stations, or highways.
2. Environmental Impact Assessment : Evaluating the environmental impacts of UAM operations, including noise, emissions, and energy consumption, is crucial to ensuring long-term sustainability.
3. Economic Feasibility : A more detailed analysis of the costs associated with vertiport development and operations, as well as business models that facilitate public-private partnerships, is essential.
4. Regulatory Challenges and Standards : Research on developing operational standards, certification processes, and international regulations is necessary to ensure the safety and efficiency of vertiport operations.

By adopting a more integrated approach, this research is expected to contribute to the practical development of vertiports, not only for Indonesia but also as a global reference for advancing UAM infrastructure.

4 Conclusion

The dimensions required for a vertiport are larger than those of a heliport, even with the same vehicle condition (D) dimensions. The dimensions are 2% to 13% larger when using the Vertiport EASA design and 53% to 70% larger when using the Vertiport FAA design. In the analysis of the Bell 505 and Joby S4, it was found that the Joby S4 has a larger condition (D) dimension compared to the Bell 505, which results in larger dimensions required for the vertiport and Obstacle Free Volume. The total landing pad dimensions required for the UAM Joby S4 for both landing and takeoff are larger than those for the Bell 505 helicopter..

From the 38 heliports analyzed, 24 heliports (63.2%) meet all the criteria for the landing and takeoff of the UAM Joby S4. All heliports meet the minimum safety area dimensions and can support the weight of the UAM Joby S4. None of the heliports are located between buildings, so Obstacle Free Volume (OFV) is not an issue in this case. The 24 heliports that meet all the criteria can be used as vertistops, but they cannot yet be considered vertiports because they lack charging facilities and passenger terminals. Additionally, heliports that do not have parking spaces must provide parking for UAM vehicles if they are to become vertiports.

Overall, the existing heliports can be used as landing and takeoff sites for the UAM Joby S4. It can be concluded that UAM can utilize the existing heliport infrastructure at the start of operations as landing and takeoff sites, particularly for the Joby S4. However, improvements are necessary, such as expanding the FATO area and providing parking spaces, as well as upgrading facilities such as charging stations and passenger terminals.

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