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Strategic Assessment of eVTOLs for Sustainable Urban Air Mobility Using the CRITIC-Based EDAS Method

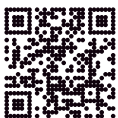
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Abstract

The selection of electric vertical takeoff and landing (eVTOL) aircraft is a strategic decision that directly shape the economic sustainability of urban air mobility (UAM) systems due to high investment costs and its impact on operational efficiency. In, this study aims to provide an objective framework for evaluating and selecting suitable eVTOL aircraft, which is an important step in establishing sustainable urban air mobility. In the study, the CRITIC-based EDAS method was used in an integrated manner to determine the importance of the evaluation criteria of eVTOL aircraft and to rank the models. The criteria of pax number, range, speed, alt meter, empty weight, payload, and maximum take-off weight identified from the literature have provided a unique perspective for evaluating eVTOLs regarding sustainability and efficiency. The results revealed that there were significant differences in the performances of the eVTOL aircraft in the context of the determined criteria. This demonstrates the critical importance of strategic decision-making frameworks in sustainable urban air mobility planning. It is expected that this research will provide strategic guidance for manufacturers and urban planners by developing a systematic approach to eVTOL evaluation.

Keywords

Urban Air Mobility • Strategic Decisions • eVTOL • CRITIC • EDAS



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Strategic Assessment of eVTOLs for Sustainable Urban Air Mobility Using the CRITIC-Based EDAS Method

The global population is becoming increasingly concentrated in urban areas. Currently, approximately 57% of the world's population lives in urban areas, and this proportion is increasing daily (World Bank, 2025). It is anticipated that this trend will rise to 66% by 2050 (United Nations, 2014). However, there will be a substantial increase in the number of individual journeys. At present, approximately 64% of all journeys are made in urban areas. It is projected that urban travel will triple by 2050 (Swadesir & Bil, 2019). As urban populations grow, existing transport systems face traffic problems such as traffic congestion, pollution, accidents and infrastructure failure (Audenhove et al., 2014). These problems cause mobility disruptions, especially in developing economies. The goal of any city is to have a flexible transport system without frequent and severe disruptions (Mageto et al., 2024). Specifically, mounting challenges related to escalating traffic congestion, environmental concerns, and the imperative for efficient transportation systems have exerted substantial pressure on contemporary urban transport infrastructures.

Traditional roads and public transportation systems are no longer sufficient for urban mobility. Cities have been trying to overcome this problem for many years. Today, urban air mobility is seen as a practical and effective solution to combat urban traffic problems (Zhang et al., 2024). The first aircraft used in urban air mobility was the helicopter. However, these efforts have not reached the desired levels due to problems such as fatal accidents with helicopters, noise restrictions and financial difficulties (Vascik et al., 2018). Unlike conventional fixed-wing aircraft and helicopters, eVTOL aircraft have the ability to take off and land vertically with exceptional efficiency in confined spaces (Brown & Harris, 2020; Zhang et al., 2024). To solve the traffic problems of megacities, eVTOL aircraft are considered more suitable than helicopters in the UAM system.

eVTOL aircraft are suitable for operation in densely populated areas because they can take off and land in confined spaces like helicopters. Unlike airports, passengers can reach take-off and landing points faster thanks to vertiport positioned in various parts of cities (Ackerman et al., 2022; Bridgelall, 2023). These innovative aircraft outperform helicopters in areas such as operating costs, noise pollution, sustainability, and energy efficiency (Garrow et al., 2025; Swadesir & Bil, 2019; Vascik et al., 2018). With the ability to hover and maneuver in confined spaces and the potential for autonomous flight, these aircraft could serve as air taxis, emergency response units, and logistics platforms while reducing noise pollution and carbon emissions (Exactitude Consultancy, 2024).

The global eVTOL aircraft market reached USD 13.16 billion in 2023, and the market continues to develop rapidly. This rate is estimated to increase to approximately \$38 billion by 2032, with a CAGR of roughly 12% (Zion Market Research, 2024). According to a different study, this market will reach approximately \$24 billion by 2030 (Exactitude Consultancy, 2024). It will continue to develop in parallel with the countries' demands for sustainable transportation solutions. eVTOL aircraft generally run on electricity and promise a sustainable future by reducing dependence on land transportation (Grand View Research, 2024).

The eVTOL industry includes various designs and manufacturers such as Joby Aviation, Lilium, and Archer Aviation. These companies are bringing a new dimension to urban transport with eVTOLs (Ugwueze et al., 2023). With their low carbon emissions, quiet operation, and flexible use, these aircraft are expected to be one of the building blocks of future urban air mobility (Kiesewetter et al., 2023; Liu et al., 2024). However, selecting a sustainable eVTOL for urban air mobility is a complex decision problem. This situation arises from the diversity in the design, operational capabilities, and urban requirements of the eVTOL aircraft.

Since this study is based on a decision problem, the use of MCDM methods has been considered appropriate. MCDM methods, which are among the contemporary decision-making approaches, allow optimal choices among different alternatives according to a large number of criteria and are also used in evaluating and ranking these alternatives. The study used the CRITIC (Criteria Importance Through Intercriteria Correlation) method to evaluate the criteria and the EDAS method to determine the most suitable eVTOL aircraft. First, the weights of the criteria were determined by the CRITIC method. Then, the obtained weightings were used as the input of the EDAS method and the ranking of 10 eVTOL aircraft for UAM was made. In practice, the CRITIC method is preferred because the criterion weights can be found directly from the quantitative data without consulting any decision maker. EDAS is preferred because it uses two distance measures such as Positive Distance from Average (PDA) and Negative Distance from Average (NDA). Thus, by considering the average solution when selecting the best alternative, the eVTOL aircraft with the highest and lowest suitability levels in terms of UAM can be ranked by comparing them to the eVTOL with the average suitability level.

Many criteria impact the successful integration of eVTOL aircraft into urban air mobility systems. The study identified seven criteria for evaluating eVTOLs: Number of passengers, range, speed, altitude, empty weight, payload and MTOW. These criteria will facilitate a deeper understanding and more effective evaluation of the role of eVTOL aircraft in the UAM ecosystem. To determine the most suitable aircraft for UAM, eVTOL aircraft from the top ten original eVTOL aircraft manufacturers were identified.

The findings of this study provide valuable insights to various stakeholders such as policy makers seeking solutions to urban air mobility problems, manufacturers who are rapidly developing eVTOL prototypes, and urban planners. In addition, the absence of studies identifying eVTOL selection criteria in the literature highlights the originality of this research and its contribution.

This study contributes to the literature on air transport management and urban planning by offering an objective framework for evaluating and selecting suitable eVTOL aircraft, a crucial step in establishing a sustainable urban air mobility system. As eVTOL technology continues to evolve rapidly, the proposed framework provides both theoretical and methodological guidance for future research, supporting the development of sustainable mobility solutions. By addressing the key challenges in eVTOL adoption, this study aims to inspire further academic inquiry and practical advancements in the field.

The remaining sections of the article proceed as follows: A literature review on eVTOL selection is presented in Section 2. In the third section, the introduced methodology of the study is explained, while in the fourth section, it is applied and the results are discussed. The last section contains the results of the study.

Literature Background

A review of studies on eVTOL aircraft reveals that topics such as environmental impacts (Velaz-Acera et al., 2025), charging efficiency (Phung et al., 2024; Qasem et al., 2024), design studies (Kim et al., 2025; Zhou et al., 2025), potential cities for implementing (Spühler et al., 2025), determination of vertiport location (Jiang et al., 2025), evaluation of use in cargo transportation (Farazi & Zou, 2024), market segmentation (Garrow et al., 2025), enhancing human comfort (Bhalla et al., 2025), certification requirements (Cardoso et al., 2022), navigation systems (Wei et al., 2024) and air taxi (Boddupalli et al., 2024) are addressed. Given that eVTOL technology is a relatively new and rapidly developing field, it is observed that the majority of research focuses on fundamental design and engineering challenges. No studies on eVTOL aircraft selection have been found. It can be seen that most studies in the literature focus on conventional aircraft selection. When these studies are analyzed, it is clear that the methods and criteria used for conventional aircraft

selection can also be used effectively in the evaluation of eVTOL aircraft. Due to the nature of these studies, a methodological analysis shows that they are predominantly based on multi-criteria decision-making methods.

Methods used for aircraft selection in air transport include EDAS (Bağcı & Kartal, 2024), CRITIC (Kaur et al., 2023), Analytic Hierarchy Process (AHP) (Dožić & Kalić, 2014; Kiracı & Akan, 2020), Fuzzy AHP (Akyurt & Kabadayı, 2020; Dožić et al., 2018), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Kocakaya et al., 2021), Fuzzy TOPSIS (Güntut & Gökdalay, 2023), Even Swaps (Dožić & Kalić, 2015a), Hypothetical Equivalents and Inequivalents model (See et al., 2004), Fuzzy Set Theory (Yeh & Chang, 2009), ELECTRE (Sun et al., 2011), Fuzzy logic (Dožić & Kalić, 2015a), Linear Physical Programming (Ilgın, 2019), Interval Type-2 fuzzy sets (Kiracı & Akan, 2020), VIKOR (Ardil, 2020; Tanrıverdi et al., 2022), SWARA (Bağcı & Kartal, 2024) and COPRAS (Bağcı & Kartal, 2024).

As demonstrated in the extant literature, different selection criteria are used in the studies conducted on aircraft selection. Considering the traditional aircraft selection criteria, these can also be used to evaluate eVTOL aircraft. The prominent criteria include speed (Kiracı & Akan, 2020), range (Ardil, 2023; Dožić et al., 2018), seat capacity (Bağcı & Kartal, 2024; Ilgın, 2019), luggage capacity (Ardil, 2023; Dožić & Kalić, 2014, 2015b; Ilgın, 2019), cargo capacity (Bağcı & Kartal, 2024), maximum takeoff weight (Bağcı & Kartal, 2024; Dožić & Kalić, 2014) untechnical performance (Bruno et al., 2015). In this context, evaluating eVTOL aircraft using traditional selection criteria allows us to develop a comprehensive understanding of the next generation of air transportation and produce appropriate solutions for sustainable urban air mobility.

Methodology

CRITIC

In multi-criteria decision-making methods, there are many subjective and objective weighting methods for determining the importance of criteria (Alkan, 2024). As the weighting of criteria in subjective weighting methods is influenced by the subjective judgments of the analysts, there is some debate in the literature about the reliability of these studies (Sahoo & Goswami, 2023). There are objective evaluation methods as well as subjective approaches in determining the criterion weights. In this study, the CRITIC method, which is an objective evaluation method, was used to determine the importance level of the criteria. The CRITIC method is an objective weighting method that considers the interrelationship, direction, and intensity of input and output factors without making personal judgments (Çaloğlu Büyükselçuk & Tozan, 2022). The steps of the method are as follows;

Stage 1: Organizing the decision matrix;

At the beginning of the weighting stage, the decision makers form a decision matrix by combining 'n' criteria and 'm' alternatives. y_{ij} is the performance value of alternative i under criterion j.

$$Y = [y_{ij}] = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{bmatrix} \quad (1)$$

Stage 2: Normalization of the decision matrix;

In the second stage of the application, the criteria values to be included in the analysis are converted into a common unit by performing the normalization process using the formulas below.

$$r_{ij} = \frac{y_{ij} - y_j^{\min}}{y_j^{\max} - y_j^{\min}} \quad (2)$$

$y_j^{\min}$ = Minimum value of criterion j

$y_j^{\max}$ = Maximum value of criterion j

Stage 3: Organizing the correlation coefficient matrix;

To determine the direction and strength of the relationship between the criteria, the correlation coefficient of the relevant criteria is calculated using the following equation.

$$\rho_{jk} = \frac{\sum_{i=1}^m (r_{ij} - \bar{r}_j)(r_{ik} - \bar{r}_k)}{\sqrt{\sum_{i=1}^m (r_{ij} - \bar{r}_j)^2 \sum_{i=1}^m (r_{ik} - \bar{r}_k)^2}} \quad (3)$$

Stage 4: Calculation of the total amount of information;

At this stage, the value of (C_j), which represents the total amount of information contained in each criterion, is calculated using the formula below. The normalized decision matrix's standard deviation is used in the calculation process.

$$C_j = \sigma_j \sum_{k=1}^n (1 - \rho_{jk}) \quad (4)$$

In the above equation, it is assumed that the criteria with a low correlation coefficient and a high standard deviation value contain the most information, and therefore their importance level is quite high.

Stage 5: Calculation of criterion weights;

In the final stage of the analysis, the following equation calculates the weighting of the criteria included in the analysis according to their importance levels.

$$w_j = C_j / \sum_{k=1}^n C_k \quad (5)$$

EDAS

The EDAS (Evaluation Based on Distance from Average Solution) method was developed by Keshavarz Ghorabae and colleagues in 2015. The authors compared the EDAS method with other multi-criteria decision making (MCDM) methods such as VIKOR, TOPSIS, SAW and COPRAS and tested the validity of the method (Keshavarz Ghorabae et al., 2015). When the content of the method is examined, it is seen that the preference of the alternatives depends on two different indicators. These are positive distance to the average solution and negative distance to the average solution (Fan et al., 2019). In the evaluation phase, it is preferred that the positive distance is maximum and the negative distance is minimum for the optimal solution. The method is guiding in determining the best alternative (Yalçın & Karakaş, 2019).

The steps of the EDAS method are listed as follows (Keshavarz Ghorabae et al., 2015, 2017; Keshavarz Ghorabae et al., 2018; Kiracı & Bakır, 2019)

Stage 1: Building the decision matrix;

In the first step, the decision matrix (X) showing the criteria and alternatives of the decision problem is formed. In the decision matrix shown in equation (6), y_i represents the performance of alternative i according to criterion j .

$$Y = [Y_{ij}]_{n \times m} = \begin{bmatrix} Y_{11} & Y_{12} & \dots & Y_{1m} \\ Y_{21} & Y_{22} & \dots & Y_{2m} \\ \dots & \dots & \dots & \dots \\ Y_{n1} & Y_{n2} & \dots & Y_{nm} \end{bmatrix} \quad (6)$$

Stage 2: Organization of the mean matrix;

The second stage of the method calculates the mean solution for all criteria using Equation (7).

$$AV_j = \frac{\sum_{i=1}^n Y_{ij}}{n} \quad (7)$$

Stage 3: Calculation of negative and positive distances from the mean

The positive distance from the Average (PDA) and Negative Distance from the Average (NDA) matrices are generated for each criterion. In calculating these values, the benefit and cost analyses of the relevant evaluation criteria are considered. If the requirements are maximization (benefit) oriented, equations (10) and (11) are used; if they are minimization (cost) oriented, equations (12) and (13) are used.

$$= [NDA_{ij}]_{n \times m} \quad (8)$$

$$PDA = [PDA_{ij}]_{n \times m} \quad (9)$$

$$NDA_{ij} = \frac{\max(0, (AV_j - Y_{ij}))}{AV_j}, j \in \text{benefit criterion} \quad (10)$$

$$PDA_{ij} = \frac{\max(0, (Y_{ij} - AV_j))}{AV_j}, j \in \text{benefit criterion} \quad (11)$$

$$NDA_{ij} = \frac{\max(0, (Y_{ij} - AV_j))}{AV_j}, j \in \text{cost criterion} \quad (12)$$

$$PDA_{ij} = \frac{\max(0, (AV_j - Y_{ij}))}{AV_j}, j \in \text{cost criterion} \quad (13)$$

In the above equations, the cost criterion represents the minimum desired criterion, while the benefit criterion represents the maximum desired criterion.

Stage 4: Calculation of the weighted totals for each criterion;

At this analysis stage, the weighted total negative distances (S_{Ni}) and the weighted total positive distances (S_{Pi}) are calculated using the following equations. In the calculation stage, the weight coefficients (W_j) expressing the importance levels of the relevant criteria are multiplied by the distance matrix (NDA).

$$SN_i = \sum_{j=1}^m W_j \times NDA_{ij} \quad (14)$$

$$SP_i = \sum_{j=1}^m W_j \times PDA_{ij} \quad (15)$$

The increase in the (S_{Pi}) value while the (S_{Ni}) value decreases shows that the alternatives have reached the desired level. In other words, the optimality of the options varies according to the increases and decreases in the (S_{Ni}) and (S_{Pi}) values.

Stage 5: Normalization of total weighted values for each criterion;

At this stage, the normalization process is applied to the weighted total negative distances (S_{Ni}) and the weighted total positive distances (S_{Pi}) through the equations below.

$$NSN_i = 1 - \frac{SN_i}{\max_i(SN_i)} \quad (16)$$

$$NSP_i = \frac{SP_i}{\max_i(SP_i)} \quad (17)$$

Stage 6: Calculation of the evaluation score for each alternative;

In the final stage of the analysis, the evaluation score (AS) for each alternative was calculated using the following equation, and the alternative with the highest score was determined as optimal.

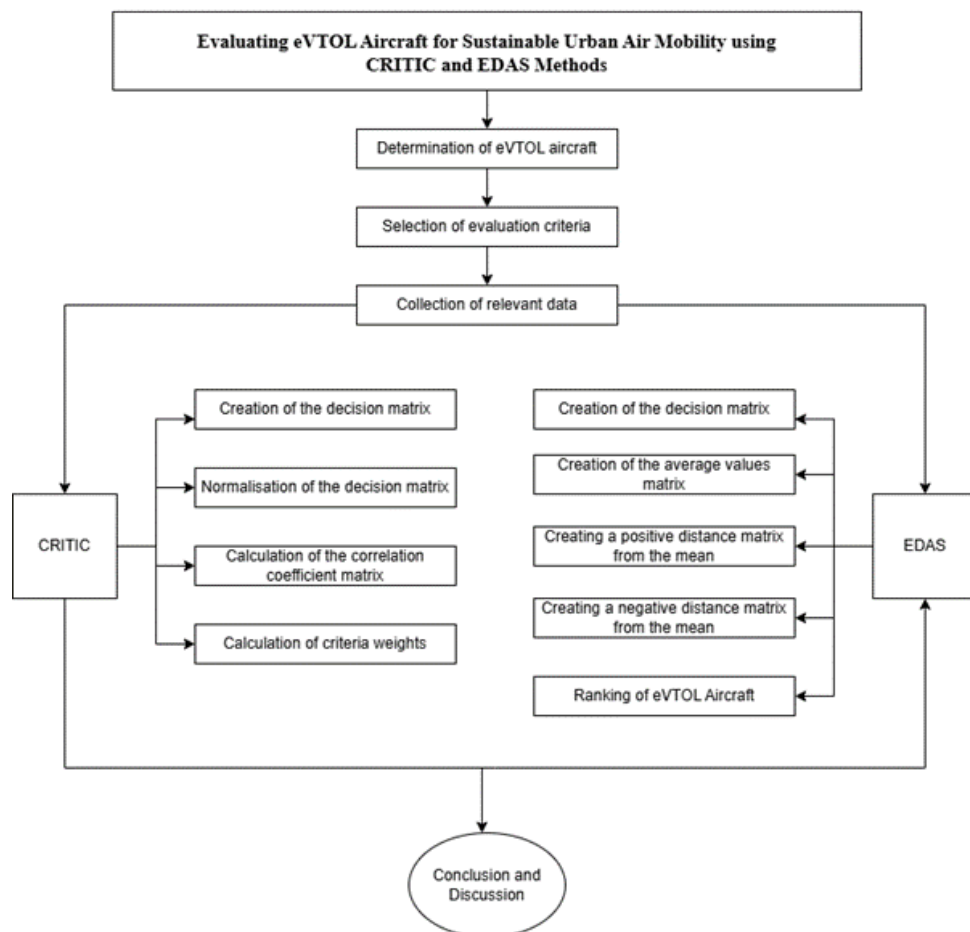
$$AS_i = \frac{1}{2}(NSP_i + NSN_i) \quad (18)$$

Application and Findings

In this study, eVTOL vehicles were ranked according to a defined set of criteria for sustainable urban air mobility. The Criterion Importance Through Intercriteria Correlation (CRITIC) method was used to determine the weights of the criteria used in the ranking. Using these weights, the EDAS method was applied, and 10 different eVTOLs were ranked for sustainable urban air mobility.

There is no study in the literature that uses the CRITIC-based EDAS method to compare eVTOLs in urban air mobility; therefore, this study is the first to contribute to the literature based on the relevant characteristics.

Figure 1
Research workflow



In this study, where the use of integrated MCDM methods is considered appropriate, the UAM applications offered by the top ten original eVTOL aircraft manufacturers were sampled as an alternative. Table 1 shows that eVTOL aircraft developed by the top ten eVTOL manufacturers are widely considered to have advanced powertrain technologies combined with contemporary design concepts. These include various eVTOLs designed with different philosophies such as bladeless multi-copters, hybrids, lift + cruise, tilt rotor, tilt rotor + wing configurations and thrust vectoring concepts (Imanov, 2024). Most of the proposed characteristics can

be considered when selecting UAM aircraft appropriate to the geographical characteristics of the country concerned.

Table 1

eVTOL models evaluated in the study.

	Manufacturer	eVTOL
1	Airbus	City Airbus
2	Archer	Midnight
3	Beta Tech	ALIA-250
4	EHang Intel. Tech	EHang216
5	Jaunt Air Mobility	Jaunt journey
6	Joby Aviation	S4
7	Lilium	Lilium jet
8	Vertical Airspace	VA-X4
9	Volocopter	VoloCity
10	Wisk aero	Cora Gen 5

In this study, 7 different criteria were identified to evaluate eVTOLs. These criteria were selected based on the relevance of eVTOLs to UAM, the effectiveness of these vehicles and those that are frequently used as selection parameters in the academic literature. This will facilitate a deeper understanding and more effective evaluation of the role of VTOLs within the UAM ecosystem.

Table 2

eVTOL aircraft evaluation criteria

Kod	Criteria	Reference	Objective
C1	Pax Number	(Rakas et al., 2021)	Max
C2	Range (km)	(M. Liu et al., 2024)	Max
C3	Speed (km/h)	(Hascaryo & Merret, 2020)	Max
C4	Alt Meter	(Mou et al., 2021; Wang, 2024)	Max
C5	Empty Weight (kg)	(Anderson et al., 2024)	Max
C6	Payload (kg)	(Xu et al., 2024)	Max
C7	MTOW (kg)	(Alves et al., 2022)	Max

In the study, the CRITIC method was primarily used to calculate the weights of the eVTOL evaluation criteria. The criteria and technical information regarding the eVTOL aircraft are given in the table below. Relevant data are compiled from open sources.

Table 3*Technical data for the eVTOL aircraft*

	Pax Number	Range (km)	Speed (km/h)	Alt Meter	Empty Weight (kg)	Payload (kg)	MTOW (kg)
City Airbus	4,00	80,00	120,00	3.100,00	1.950,00	250,00	2.200,00
Midnight	5,00	80,00	240,00	610,00	1.050,00	450,00	1.500,00
ALIA-250	4,00	463,00	270,00	2.438,00	2.540,00	635,00	3.175,00
EHang216	2,00	35,00	130,00	3.000,00	360,00	260,00	620,00
Jaunt Journey	5,00	129,00	282,00	1.829,00	1.633,00	453,00	2.722,00
S4	5,00	290,00	322,00	3.350,00	1.950,00	453,00	2.404,00
Lilium jet	7,00	300,00	300,00	3.048,00	1.800,00	700,00	2.500,00
VA-X4	4,00	161,00	241,00	3.000,00	2.750,00	450,00	3.200,00
VoloCity	2,00	65,00	110,00	1.981,00	700,00	200,00	900,00
Cora	2,00	100,00	180,00	900,00	1.088,00	180,00	1.268,00

Kaynak: (Imanov, 2024; Vertical Flight Society, 2024)

Application of the CRITIC method

In the initial phase of the study, the CRITIC method, an objective weighting technique, was used to determine the weights of the criteria. In multi-criteria decision making (MCDM), there are several studies where the weights of the criteria are determined based on expert opinion (Chen, 2016a, 2016b; Tanrıverdi et al., 2022; Tsaur et al., 2002). However, such studies have found that the opinions, perspectives and biases of experts, as well as their practical or theoretical experience, are influential in decision-making processes. Moreover, subjective evaluation and weighting methods inherently reflect the value judgements of experts and the uncertainties associated with those judgements (Trinkūnienė et al., 2017). For this reason, the CRITIC method, which determines the criteria weights through objective measures, is deemed the most fitting approach for this study. In this part of the study, the weighting process required to solve the problem was carried out using the CRITIC method. This approach minimized the uncertainties and challenges associated with the subjective weighting methods.

The first stage of the CRITIC method begins with the construction of the decision matrix. As shown in Table 4, the decision matrix, constructed using Equation (1), consists of 10 eVTOL vehicles (alternatives) and 7 criteria (indicators). On the other hand, the analysis of the criteria shows that all of them focus on benefits, meaning they aim to reach their maximum levels.

Table 4*Decision matrix*

	Max.	Max.	Max.	Max.	Max.	Max.	Max.
	C1	C2	C3	C4	C5	C6	C7
City Airbus	4,00	80,00	120,00	3.100,00	1.950,00	250,00	2.200,00
Midnight	5,00	80,00	240,00	610,00	1.050,00	450,00	1.500,00
ALIA-250	4,00	463,00	270,00	2.438,00	2.540,00	635,00	3.175,00
EHang216	2,00	35,00	130,00	3.000,00	360,00	260,00	620,00
Jaunt Journey	5,00	129,00	282,00	1.829,00	1.633,00	453,00	2.722,00
S4	5,00	290,00	322,00	3.350,00	1.950,00	453,00	2.404,00
Lilium jet	7,00	300,00	300,00	3.048,00	1.800,00	700,00	2.500,00
VA-X4	4,00	161,00	241,00	3.000,00	2.750,00	450,00	3.200,00

	Max.	Max.	Max.	Max.	Max.	Max.	Max.
	C1	C2	C3	C4	C5	C6	C7
VoloCity	2,00	65,00	110,00	1.981,00	700,00	200,00	900,00
Cora	2,00	100,00	180,00	900,00	1.088,00	180,00	1.268,00

In the second stage of the CRITIC method, the decision matrix undergoes a normalization process. This process is performed using Equation (2), where the maximum values for each criterion are identified, followed by applying the equation using alternative values. The resulting normalized decision matrix is presented in Table 5.

Table 5

Normalized decision matrix

	C1	C2	C3	C4	C5	C6	C7
City Airbus	0,40	0,11	0,05	0,91	0,67	0,13	0,61
Midnight	0,60	0,11	0,61	0,00	0,29	0,52	0,34
ALIA-250	0,40	1,00	0,75	0,67	0,91	0,88	0,99
EHang216	0,00	0,00	0,09	0,87	0,00	0,15	0,00
Jaunt Journey	0,60	0,22	0,81	0,44	0,53	0,53	0,81
S4	0,60	0,60	1,00	1,00	0,67	0,53	0,69
Lilium jet	1,00	0,62	0,90	0,89	0,60	1,00	0,73
VA-X4	0,40	0,29	0,62	0,87	1,00	0,52	1,00
VoloCity	0,00	0,07	0,00	0,50	0,14	0,04	0,11
Cora	0,00	0,15	0,33	0,11	0,30	0,00	0,25
σ_j	0,33	0,32	0,37	0,35	0,32	0,34	0,36

As shown in Table 5, not only was the normalization process performed, but the standard deviation values (σ_j) used in the calculation of the (c_j) values were also determined. Following the normalization process on the criteria, a correlation analysis was conducted to reveal the relationship and strength between the criteria. The results of the correlation analysis are shown in Table 6.

Table 6

Correlation Coefficients Between Criteria

	C1	C2	C3	C4	C5	C6	C7
C1	1,00	0,50	0,78	0,22	0,50	0,83	0,63
C2	0,50	1,00	0,70	0,33	0,68	0,80	0,70
C3	0,78	0,70	1,00	0,11	0,56	0,83	0,69
C4	0,22	0,33	0,11	1,00	0,41	0,25	0,36
C5	0,50	0,68	0,56	0,41	1,00	0,60	0,96
C6	0,83	0,80	0,83	0,25	0,60	1,00	0,72
C7	0,63	0,70	0,69	0,36	0,96	0,72	1,00

Following the calculation of the correlation coefficients between the criteria, the subsequent step was to calculate the information content and determine the weights of the criteria. In this process, the information content (c_j) of each criterion was calculated using Equation (4), with the standard deviation values from Table 5 being used to determine it. Finally, the value of each criterion (c_j) was divided by the sum of all criterion values (c_j) to calculate the criterion weights, as shown in Equation (5). The information content (c_j) and the criterion weights (w_j) for each criterion are presented in Table 7.

Table 7*Criterion Weights for the eVTOL Evaluation*

	C1	C2	C3	C4	C5	C6	C7
c_j	0,83	0,74	0,86	1,53	0,74	0,68	0,69
w_j	0,136625	0,121378	0,142065	0,251755	0,122015	0,111544	0,114618

Application of the EDAS Method

This study constitutes an evaluation of the most suitable eVTOL for use in urban air mobility transportation. The CRITIC method was used to determine the criterion weights, followed by the EDAS method to rank the alternatives (eVTOLs). The initial step in the EDAS method involves the construction of the decision matrix using Equation (6). This matrix is derived by averaging the values in each column of the decision matrix, as illustrated in Table 8.

Table 8*Decision matrix*

	Mak.	Min.	Mak.	Mak.	Mak.	Mak.	Mak.
	C1	C2	C3	C4	C5	C6	C7
City Airbus	4	80	120	3100	1950	250	2200
Midnight	5	80	240	610	1050	450	1500
ALIA-250	4	463	270	2438	2540	635	3175
EHang216	2	35	130	3000	360	260	620
Jaunt Journey	5	129	282	1829	1633	453	2722
S4	5	290	322	3350	1950	453	2404
Lilium jet	7	300	300	3.048	1.800	700	2.500
VA-X4	4	161	241	3.000	2.750	450	3.200
VoloCity	2	65	110	1.981	700	200	900
Cora	2	100	180	900	1.088	180	1. 268
AV_j	4	170	220	2326	1582	403	2049

As an example of the calculation of (AV_j) values presented in Table 8, the C1 criterion value for 10 eVTOL vehicles is calculated as follows:

$$AV_{C1} = \frac{4 + 5 + 4 + 2 + 5 + 5 + 7 + 4 + 2 + 2}{10} = 4$$

After the construction of the decision matrix, the positive and negative distances from the mean matrices are created. These matrices are generated using Equations (8) and (9), which consider the benefit and cost characteristics of the criteria. As is well known, in decision problems involving benefit-based criteria, the matrices are constructed based on the benefit characteristic using Equations (10-13). The positive and negative distance-from-average matrices are presented in Tables 9 and 10, respectively.

Table 9*Positive Distance from the Average Matrix*

	C1	C2	C3	C4	C5	C6	C7
City Airbus	0,0000	0,0000	0,0000	0,3330	0,2325	0,0000	0,0737
Midnight	0,2500	0,0000	0,0934	0,0000	0,0000	0,1163	0,0000
ALIA-250	0,0000	1,7187	0,2301	0,0483	0,6055	0,5753	0,5496
EHang216	0,0000	0,0000	0,0000	0,2900	0,0000	0,0000	0,0000

	C1	C2	C3	C4	C5	C6	C7
Jaunt Journey	0,2500	0,0000	0,2847	0,0000	0,0322	0,1238	0,3285
S4	0,2500	0,7029	0,4670	0,4405	0,2325	0,1238	0,1733
Lilium jet	0,7500	0,7616	0,3667	0,3106	0,1377	0,7365	0,2202
VA-X4	0,0000	0,0000	0,0979	0,2900	0,7382	0,1163	0,5618
VoloCity	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Cora	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000

As demonstrated in Table 9, the creation of the (PDA_{ij}) matrix is achieved through the implementation of Equation (11), which is predicated on the benefit characteristics of the criteria. To illustrate this, consider the City Airbus scenario:

$$PDA_{CityAirbusC1} = \frac{\max(0, (X_{ij} - AV_j))}{AV_j} = \frac{\max(0, (4 - 4))}{4} = \frac{\max(0, -4)}{4} = 0,0000$$

Table 10
Negative Distance from the Average Matrix

Dönem	C1	C2	C3	C4	C5	C6	C7
City Airbus	0,000	0,530	0,453	0,000	0,000	0,380	0,000
Midnight	0,000	0,530	0,000	0,738	0,336	0,000	0,268
ALIA-250	0,000	0,000	0,000	0,000	0,000	0,000	0,000
EHang216	0,500	0,794	0,408	0,000	0,772	0,355	0,697
Jaunt Journey	0,000	0,243	0,000	0,214	0,000	0,000	0,000
S4	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Lilium jet	0,000	0,000	0,000	0,000	0,000	0,000	0,000
VA-X4	0,000	0,055	0,000	0,000	0,000	0,000	0,000
VoloCity	0,500	0,618	0,499	0,148	0,558	0,504	0,561
Cora	0,500	0,413	0,180	0,613	0,312	0,553	0,381

As demonstrated in Table 10, the generation of the (NDA_{ij}) matrix for the benefit criteria employs Equation (10). The negative distance from the average matrix is constructed following steps similar to those applied in the positive distance from the average matrix.

After creating the positive and negative distance-from-average matrices, the weighted total negative (SN_i) and positive (SP_i) distance values were calculated using Equations (14) and (15). Given the implementation of the CRITIC-EDAS integrated method in this study, the criterion weights obtained through the CRITIC method were utilized in the weighting process conducted via Equations (14-15). After the calculation of the total weighted distances, the normalization step was performed. The normalization was applied to the (SN_i) and (SP_i) values using Equations (16-17), resulting in the (NSN_i) and (NSP_i) values.

In the final stage of the EDAS method, the evaluation scores reflecting the performance of the alternatives are calculated using Equation (18). In this process, half of the sum of the (NSN_i) and (NSP_i) values is determined as the evaluation score (AS_i) for the relevant alternative. The alternative with the highest (AS_i) value is designated as optimal, according to the criterion. The calculation results of the stages of the EDAS method performed using Equations (14-18) and the rankings of the relevant alternatives are presented in Table 11.

Table 11
eVTOL ranking

	SP_i	SN_i	NSP_i	NSN_i	AS_i	Sıralama
City Airbus	0,12066	0,17112	0,26547	0,61270	0,439084	6
Midnight	0,06040	0,32182	0,13290	0,27162	0,202260	7
ALIA-250	0,45451	0,00000	1,00000	1,00000	1,000000	1
EHang216	0,07301	0,43645	0,16063	0,01218	0,086402	8
Jaunt Journey	0,13000	0,08319	0,28601	0,81171	0,548860	5
S4	0,35875	0,00000	0,78932	1,00000	0,894658	3
Lilium jet	0,44941	0,00000	0,98878	1,00000	0,994391	2
VA-X4	0,25436	0,00663	0,55965	0,98500	0,772322	4
VoloCity	0,00000	0,44004	0,00000	0,00406	0,002032	9
Cora	0,00000	0,44184	0,00000	0,00000	0,000000	10

Table 11 presents a quantitative comparison of 10 eVTOL aircraft for sustainable UAM. The most compatible eVTOL aircraft were determined to be ALLIA-250 and Lilium Jet. These two models achieved superior scores in all normalized parameters. The strong performance of these aircraft in critical criteria such as range, payload and maximum take-off weight demonstrates their adaptability to urban environments. These aircraft will be followed by the S4 and VA-X4 eVTOL models. The results obtained suggest that these models are also suitable for urban air mobility.

Conclusion

This study presents the evaluation of eVTOL models through the superior performance criteria of eVTOL aircraft over conventional aircraft for sustainable urban air mobility. In this context, the study provides valuable strategic insights into the evaluation of eVTOL aircraft. The research shows that there are performance differences between the eVTOL aircraft models. This confirms that the strategic decision-making processes play a critical role in a sustainable UAM system.

This study employed a combined CRITIC-EDAS methodology to objectively assess and rank eVTOL aircraft models. By leveraging the CRITIC method, we established the relative importance of evaluation criteria, minimizing subjective bias often inherent in decision-making processes. Subsequently, the EDAS technique facilitated the ranking of eVTOL models based on these weighted criteria. To ensure a robust and transparent evaluation, we focused on readily available, open-access data related to key performance indicators. These indicators, derived from existing literature, specifically included passenger capacity, range, speed, altitude capability, empty weight, payload, and maximum take-off weight. This selection aimed to provide a comprehensive assessment of eVTOLs, particularly concerning their sustainability and operational efficiency.

According to the results of the CRITIC method analysis, the three most important criteria are the alt meter, speed, and pax number. Other criteria received similar values. Studies have shown that the alt meter criterion is an important factor in terms of safety, operational performance and regulatory compliance for eVTOL aircraft (MOU et al., 2021; Wang, 2024). Altitude measurement systems enable the successful integration of eVTOLs into the airspace ecosystem (Sánchez et al., 2021). The speed criterion directly impacts the safety level, performance, energy efficiency, and compliance with the regulatory standards of eVTOL aircraft. In this respect, eVTOL aircraft that can balance speed and other factors will be a more suitable option for urban air mobility (Al-Rubaye et al., 2023; Xiang et al., 2024). Another criterion in which eVTOL aircraft differ is the pax number criterion. eVTOL aircraft with different passenger capacities are designed to meet different UAM needs. While smaller models are suitable for short-haul flights with low demand, larger models can be

effective on longer routes with high demand (Hader et al., 2020). According to the results of the analyses, the importance of the range, empty weight, payload and maximum take-off weight criteria evaluated in the research were close to each other.

The criterion importance weights determined by the CRITIC method were used as input to the EDAS method to compare and rank eVTOL aircraft. There are over 400 eVTOL aircraft in production for urban air mobility. This study tested the compatibility of selected aircraft from the top ten eVTOL manufacturers. These aircraft were analyzed using the EDAS method to measure their compatibility with sustainability. The findings show significant differences in the performance of the eVTOL models. According to the evaluations, the eVTOL aircraft named ALIA-250 is the most suitable aircraft and showed the highest performance according to all criteria. The closest model to this model is the Lilium Jet. It has demonstrated superior performance, particularly in terms of range, speed and number of passengers. In this context, both the ALLIA-250 and the Lilium Jet model can be considered as the most technically and operationally suitable eVTOL aircraft for urban air mobility. On the other hand, it is understood that other eVTOL models that received lower values according to the analysis results need to be improved in terms of design and operation. This situation indicates the need for continuous innovation and strategic differentiation of eVTOL aircraft for a sustainable UAM system.

The findings of this study provide valuable insights to various stakeholders such as policy makers seeking solutions to urban air mobility problems, manufacturers who are rapidly developing eVTOL prototypes, and urban planners. In addition, the fact that there is no study in the literature that identifies eVTOL selection criteria is extremely important in terms of bringing the originality of this study and selection criteria into the literature.

This study also has some limitations. In this study, the evaluation of eVTOL aircraft was only carried out according to specific criteria. eVTOL manufacturers are continuously making improvements to increase the efficiency of these aircraft. Depending on these developments, new criteria may be defined. Different criteria and methods may be preferred in future studies. This study presents an original methodology by applying the CRITIC-based EDAS method for eVTOL evaluation for the first time in the literature. The findings in this study can be compared using different MCDM methods. This study evaluated selected aircraft from the top ten eVTOL manufacturers. In different research, other aircraft can be evaluated using the model presented in this study.

As a result, it is expected that eVTOL aircraft will be widely used for a sustainable future. The key issue will produce and selecting suitable eVTOL aircraft for establishing a sustainable urban air mobility system. In this respect, the study contributes to the literature by providing an objective framework that can be used in the evaluation of these aircraft in today's rapidly developing eVTOL technology. It is expected to provide theoretical and methodological inspiration for future studies.

Finally, this study makes a valuable contribution to the literature on air transport management and urban planning by providing an objective framework for the selection of these aircraft during the rapid development of eVTOL technology. This framework will provide a theoretical and methodological basis for future studies.



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