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Application of the EDAS Technique for Selecting the Electric Motor Vehicles

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Abstract. *The popularity and development of electric motorcycles are exploding. This is merely the beginning of what many predict will be the motorbike industry's fastest-growing sector.The next development in motorcycle technology is the electric motorcycle. High-point electric bikes that are lighter, economical, and enjoyable to ride may be easily offered to clients and partners globally by combining the superlative capabilities of a traditional motorbike with the most cutting-edge technologies now accessible. A future era of electric engines and regulators with "ultra-high efficiency, high power-to-weight, and lightweight" has been specifically created to advance a wide range of models. Due to the abundance of possibilities offered on the global market, conflicting situations can develop while choosing a certain motorcycle. There may not necessarily be a certain number of options available or there may be multiple alternatives to the original pick. The possibility of not having an acceptable option for the criterion exists as well. "Multiple Criteria Decision Making" is a technique designed for the optimization of problems with an "infinite or finite number of choices" and the MCDM technique "EDAS method" is used to optimize the process in this paper. The rank of "Revolt RV400 is fifth, Joy e-Bike Monster is ninth, Tork Kratos R is fourth, Komaki Ranger is third, Cyborg Bob is sixth, Odysse Evoqis is seventh, Oben Rorr is first, PURE EV eTryst 350 is eight, Pure ecoDryft is second". The ranking order is "Oben Rorr> Pure ecoDryft> Komaki Ranger> Tork Kratos R> Revolt RV400> Cyborg Bob> Odysse Evoqis> PURE EV eTryst 350". Depending on EDAS research in this paper, it was discovered that among all sample electric motor vehicles, "Oben Rorr had the best overall performance while PURE EV eTryst 350 had the poorest".*

Keywords: *Motorbikes, Electric Motor bikes, price, top speed, range, battery capacity and MCDM*

1. INTRODUCTION

The next step in the development of motorcycles is the electric motorcycle. Peak-performing electrical bikes that are "lightweight, efficient, and exciting to ride may be easily offered to consumers and partners globally" by fusing the superlative capabilities of a traditional motorbike with the most cutting-edge technologies now accessible. a new wave of electric engines and controllers with extremely "high efficiency, high power-to-weight ratios, and lightweight" that are specifically made to advance a range of vehicles into a younger generation [1,2]. Many city dwellers, particularly those in Southeast Asia, have chosen motorcycles as their main mode of urban transit. In so many towns, a motorbike is a practical option for point-to-point commuting due to relatively large but evenly distributed inhabitants and job concentrations, congested streets, and an evenly dispersed road network. It is also a more economical option thanks to the low cost of Chinese bikes, loans, and cheap fuel. Motorcycles are space-efficient in terms of size and mobility, and their effectiveness is projected to rise as more motorcycles are used in traffic [3,4]. Shorter main roads in motorcycling cities like "Hanoi and Solo" frequently carry more traffic per track than expressways in American cities. The majority of motorists and commuters are accustomed to the bumper-to-bumper halt that occurs on crowded roads when there are a lot of motorcyclists present. Despite the misconception that riding a motorbike is a risky activity, motorbike cities with a high concentration of riders and bikers on the road make riding a motorcycle significantly less hazardous than it is in "the US and Europe" [5,6]. High reliance on motorbikes has drawbacks despite these benefits. Most significantly, cheap motorcycles cause large concentrations of local pollution that shorten lifespans and lead to dangerous respiratory ailments, especially in children and the elderly. Poor air purity, which has been linked to billions of ages of life wasted in Northern China and India, is mostly a result of the transportation industry. Even 4-stroke motors, which emit significantly fewer emissions than 2-stroke ones, worsen the quality of the local air. Ninety-five to ninety-nine per cent of the motorbike squadrons in "Hanoi and Ho Chi Minh City" are powered by four-stroke engines, although both cities have high levels of local pollution [7,8]. By switching from gas-powered to electric bikes, one of the main negative effects of motorcycles would be reduced and regional purity of air would be improved. A switch to electric motorbikes could aid attempts to abandon fossil fuels, even though the impact on "global pollution and fossil fuel consumption" would rely on energy production and vehicle replacement [9,10]. Similar to a motorcycle propelled by gas, an electric motorcycle operates similarly. A conventional motorbike and an electric motorcycle are primarily distinguished by the absence of a gas engine in the electric motorcycle. Better convenience is offered by electric automobiles, which is not the case with gas-powered ones. Since electric motors in electric cars respond rapidly and offer higher performance, motorbikes are more responsive than traditional vehicles, have performance - improvement, and have digital communication. Additionally, they offer choices for charging stations that may be controlled by smartphone applications [11,12]. Due to the abundance of possibilities offered on the global market, conflicting situations can develop while choosing a certain motorcycle. There isn't always a fixed number of possibilities available or there may be multiple alternatives to the original pick. The possibility of not having an acceptable option for the criterion exists as well. " Multiple Criteria (MCDM) Making decisions" is a process created for evaluating issues where there is either an infinite or a finite number of options [13]. "Using the MCDM methodology and the EDAS method", a group of nine distinct electric motorcycles from different companies are evaluated along five distinct criteria, including "price, top speed, range, battery capacity, and time to fully charge".

2. MATERIALS AND METHODS

The EDAS technique's computational process can be characterized as very novel and is also built on tested methodologies utilised in certain well-known MCDM techniques, including "SAW, TOPSIS, and VIKOR" [14]. As a result, it is anticipated that the EDAS technique will eventually be able to have been used to deal with a variety of MCDM issues. However, a lot of real-world judgement issues arise in circumstances when it is impossible to identify with absolute certainty how alternatives should be rated and how important each criterion is. Conventional MCDM techniques that rely on using sharp rating levels in judgement are ineffective in these situations [15]. One could describe the EDAS as a recently proposed system. " Keshavarz Ghorabaee et al." also proposed a fuzzy variation of this approach. " The Positive Distance from Average (PDA) and the Negative Distance from Average (NDA") are the two deviation measures that serve as the foundation of the EDAS technique, and higher numbers of the PDA and lowered with the increase of the NDA are used to evaluate alternatives [16,17]. Select the characteristics that best define the decision possibilities for the given decision problem. It constructed the choice matrix X, which shows how different solutions fare in comparison to particular standards.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ x_{31} & x_{32} & \cdots & x_{3n} \end{bmatrix} \qquad (1)$$

- Weights for the criteria are expressed in equation 2.

$$w_j = [w_1 \quad \cdots \quad w_n], \text{ where } \sum_{j=1}^{n}(w_1 \quad \cdots \quad w_n) = 1 \qquad (2)$$

- The average result concerning all criteria must be computed using the formulas presented below, per the specification of the EDAS method:

$$AV_j = \frac{\sum_{j=1}^{n} k_{ij}}{n} \qquad (3)$$

- The "positive distance from average (PDA)" is expressed in equation 4. Here B is "Beneficial criteria" and C is "non-beneficial criteria".

$$PDA_{ij} = \begin{cases} \frac{\max(0,(x_{ij}-AV_{ij}))}{AV_{ij}} & | \ j \in B \\ \frac{\max(0,(AV_{ij}-x_{ij}))}{AV_{ij}} & | \ j \in C \end{cases} \qquad (4)$$

- The "negative distance from average (NDA)" is expressed in equation 5. Here B is "Beneficial criteria" and C is "non-beneficial criteria".

$$NDA_{ij} = \begin{cases} \frac{\max(0,(AV_{ij}-x_{ij}))}{AV_{ij}} & | \ j \in B \\ \frac{\max(0,(x_{ij}-AV_{ij}))}{AV_{ij}} & | \ j \in C \end{cases} \qquad (5)$$

- Applying equation 2 calculated by multiplying by factors 4 and 5, respectively, "the weighted sum of the positive and negative distances from the average solution for all options" is normalized. The below Equation calculates "weighted sums of the positive and negative distance".

$$SP_i = \sum_{j=1}^{m} w_j \times PDA_{ij} \quad (6)$$

$$SN_i = \sum_{j=1}^{m} w_j \times NDA_{ij} \quad (7)$$

- The "weighted sum of the positive and the negative distance from the average solution for all alternatives" is normalized using equations 8 and 9.

$$NSP_i = \frac{SP_i}{max_i(SP_i)} \quad (8)$$

$$NSN_i = 1 - \left(\frac{SN_i}{max_i(SN_i)}\right) \quad (9)$$

- The "average of the normalized weighted sum of the positive and negative distances from the average solution for all alternatives" is used to determine the "final appraisal score (ASi) for all alternatives".

$$AS_i = \frac{(NSP_i + NSN_i)}{2} \quad (10)$$

where "$0 \leq ASi \leq 1$". The alternative with "the highest appraisal score" is selected as the most preferred choice among the other preferred choice [18,19]. "Using the MCDM methodology and the EDAS method", a group of nine distinct electric motorcycles from different companies are evaluated along five distinct criteria, including "price, top speed, range, battery capacity, and time to fully charge".

3. ANALYSIS AND DISCUSSION

TABLE 1. Data Collected from Various Electric Motorcycles

Electric bikes models	Battery Capacity (kWh)	Range (km)	Top Speed (kmph)	Price (in thousand rupees)	Charging Time (hours)
Revolt RV400	3.2	150	80	129.4	4.5
Joy e-Bike Monster	2.8	75	25	102.249	4.5
Tork Kratos R	4	180	105	192.499	5
Komaki Ranger	3.6	200	80	114.999	6
Cyborg Bob	2.88	110	85	114.999	5
Odysse Evoqis	4.32	140	80	166.25	6
Oben Rorr	4.4	200	100	99.999	2
PURE EV eTryst 350	3.5	140	85	154.999	6
Pure ecoDryft	3	135	75	99.999	3
AVj	**3.5222**	**147.7778**	**79.4444**	**130.5992**	**4.6667**

Table 1 shows the "Decision matrix for Data Collected from Various Electric Motorcycles". The alternatives considered are "Revolt RV400, Joy e-Bike Monster, Tork Kratos R, Komaki Ranger, Cyborg Bob, Odysse Evoqis, Oben Rorr, PURE EV eTryst 350 and Pure ecoDryft". The attributes are considered "Price, Top speed, Range, Battery Capacity and Time to fully charge". "Top speed, Range and Battery Capacity" are beneficial attributes. "Price and Time to fully charge" are non-beneficial attributes. Then, "the corresponding average solution (AV) for all evaluation criteria" is calculated from equation 3 which can be seen in the last row of Table 1.

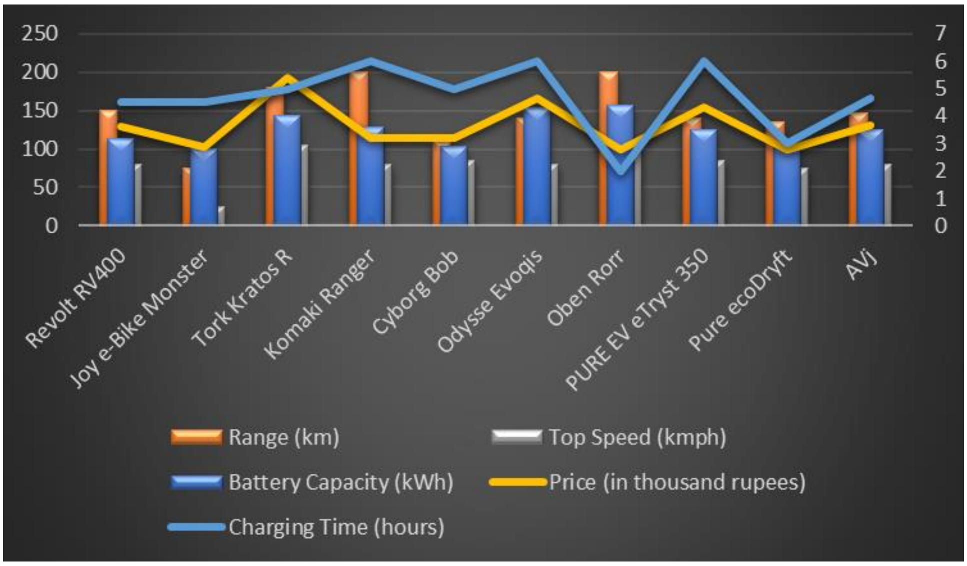

FIGURE 1. The performance of Electric Motor Vehicles

Figure 1 represents the "Decision matrix for Data Collected of Various Electric Motorcycles". The alternatives considered are "Revolt RV400, Joy e-Bike Monster, Tork Kratos R, Komaki Ranger, Cyborg Bob, Odysse Evoqis, Oben Rorr, PURE EV eTryst 350 and Pure ecoDryft". The attributes are considered "Price, Top speed, Range, Battery Capacity and Time to fully charge". "Top speed, Range and Battery Capacity" are beneficial attributes. "Price and Time to fully charge" are non-beneficial attributes.

TABLE 2. PDA

0.0000	0.0150	0.0070	0.0092	0.0357
0.0000	0.0000	0.0000	0.2171	0.0357
0.1356	0.2180	0.3217	0.0000	0.0000
0.0221	0.3534	0.0070	0.1195	0.0000
0.0000	0.0000	0.0699	0.1195	0.0000
0.2265	0.0000	0.0070	0.0000	0.0000
0.2492	0.3534	0.2587	0.2343	0.5714
0.0000	0.0000	0.0699	0.0000	0.0000
0.0000	0.0000	0.0000	0.2343	0.3571

Table 2 displays the PDA corresponding to the evaluation criteria. "The positive distance from average (PDA) value" is calculated using "the average solution" from table 1 concerning "type of criteria (Beneficial criteria and non-Beneficial criteria)" as displayed in equation 4.

TABLE 3. NDA

0.09148	0.00000	0.00000	0.00000	0.00000
0.20505	0.49248	0.68531	0.00000	0.00000
0.00000	0.00000	0.00000	0.47397	0.07143
0.00000	0.00000	0.00000	0.00000	0.28571
0.18233	0.25564	0.00000	0.00000	0.07143
0.00000	0.05263	0.00000	0.27298	0.28571
0.00000	0.00000	0.00000	0.00000	0.00000
0.00631	0.05263	0.00000	0.18683	0.28571
0.14826	0.08647	0.05594	0.00000	0.00000

Table 3 displays the NDA corresponding to the evaluation criteria. "The Negative distance from average (NDA) value" is calculated using "the average solution" from table 1 about "type of criteria (Beneficial criteria and non-Beneficial criteria)" as displayed in equation 5.

TABLE 4. Weight

0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.20

Table 4 shows the weights distributed to the alternatives. Here weights are equally distributed among evaluation parameters "Net profit margin %, Return on long-term fund %, Return on net worth %, Interest expended to total funds %, Operating expenses to total funds % and Interest expended to interest earned %". The weights assigned to the test parameters add up to one.

TABLE 5. Weighted PDA

Weighted PDA					SPi
0.00000	0.00301	0.00140	0.00184	0.00714	0.01339
0.00000	0.00000	0.00000	0.04342	0.00714	0.05056
0.02713	0.04361	0.06434	0.00000	0.00000	0.13507
0.00442	0.07068	0.00140	0.02389	0.00000	0.10038
0.00000	0.00000	0.01399	0.02389	0.00000	0.03788
0.04530	0.00000	0.00140	0.00000	0.00000	0.04670
0.04984	0.07068	0.05175	0.04686	0.11429	0.33341
0.00000	0.00000	0.01399	0.00000	0.00000	0.01399
0.00000	0.00000	0.00000	0.04686	0.07143	0.11829

Table 5 shows the data values of "the Weighted Positive Distance from the Average and the sum of the Weighted Positive Distance from the Average". It is calculated using equation 6. "The weighted matrix of PDA" is calculated using the multiplication of the matrix of PDA from table 2 and the matrix of criteria weight W from table 4. Then "the sum of the weighted PDA values" is calculated corresponding to the alternates.

TABLE 6. Weighted NDA

Weighted NDA					SNi
0.01830	0.00000	0.00000	0.00000	0.00000	0.01830
0.04101	0.09850	0.13706	0.00000	0.00000	0.27657
0.00000	0.00000	0.00000	0.09479	0.01429	0.10908
0.00000	0.00000	0.00000	0.00000	0.05714	0.05714
0.03647	0.05113	0.00000	0.00000	0.01429	0.10188
0.00000	0.01053	0.00000	0.05460	0.05714	0.12226
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00126	0.01053	0.00000	0.03737	0.05714	0.10630
0.02965	0.01729	0.01119	0.00000	0.00000	0.05814

Table 6 shows the data values of "the Weighted Negative Distance from the Average and the sum of the Weighted Negative Distance from the Average". It is calculated using equation 7. "The weighted matrix of PDA" is calculated using the multiplication of the matrix of PDA from table 3 and the matrix of criteria weight W from table 4. Then "the sum of the weighted NDA values" is calculated corresponding to the alternates.

TABLE 7. NSPi and NSNi value

Electric bikes models	NSPi	NSPi
Revolt RV400	0.04015	0.93384
Joy e-Bike Monster	0.15164	0.00000
Tork Kratos R	0.40512	0.60560
Komaki Ranger	0.30107	0.79339
Cyborg Bob	0.11360	0.63163
Odysse Evoqis	0.14006	0.55792
Oben Rorr	1.00000	1.00000
PURE EV eTryst 350	0.04195	0.61566
Pure ecoDryft	0.35478	0.78980

Table 7 shows the normalized values of "the Weighted Positive Distance from the Average and the Weighted negative Distance from the Average". SPi and SNi values are normalized by equations 8 and 9 using values from tables 5 and 6.

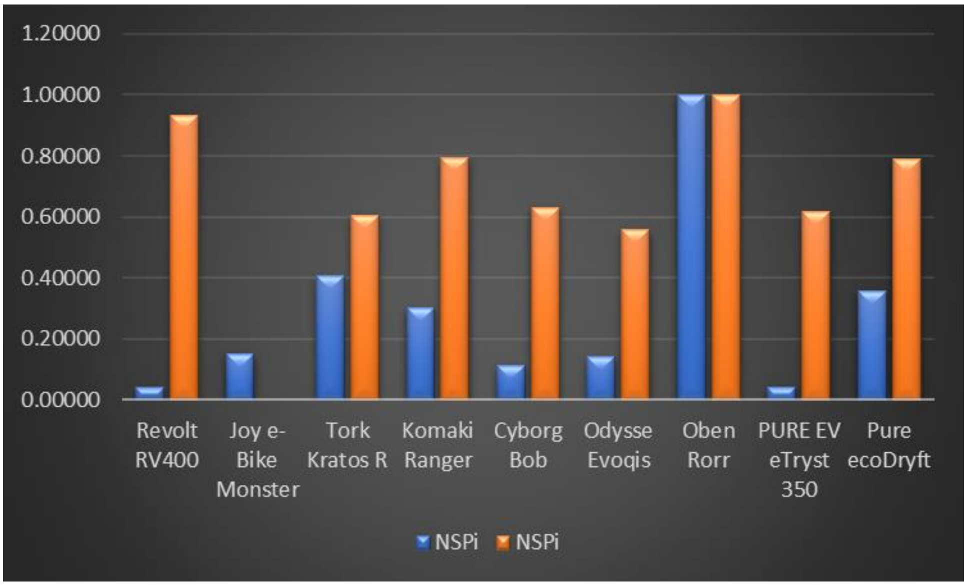

FIGURE 2. NSPi and NSNi value

Figure 2 shows a graphical representation of the normalized values of "the Weighted Positive Distance from the Average and the Weighted negative Distance from the Average". SPi and SNi values are normalized by equations 8 and 9 using values from tables 5 and 6.

TABLE 8. ASi

Electric bikes models	ASi
Revolt RV400	0.48700
Joy e-Bike Monster	0.07582
Tork Kratos R	0.50536
Komaki Ranger	0.54723
Cyborg Bob	0.37261
Odysse Evoqis	0.34899
Oben Rorr	1.00000
PURE EV eTryst 350	0.32880
Pure ecoDryft	0.57229

Table 8 shows the final appraisal score of alternative electric motorcycles calculated by using 10. The final appraisal score values were calculated using the average of NSPi and NSNi. Here the final appraisal score for "Revolt RV400 is 0.48699, Joy e-Bike Monster is 0.07581, Tork Kratos R is 0.50536, Komaki Ranger is 0.54722, Cyborg Bob is 0.37261, Odysse Evoqis is 0.34899, Oben Rorr is 1, PURE EV eTryst 350 is 0.32880 and Pure ecoDryft is 0.57229".

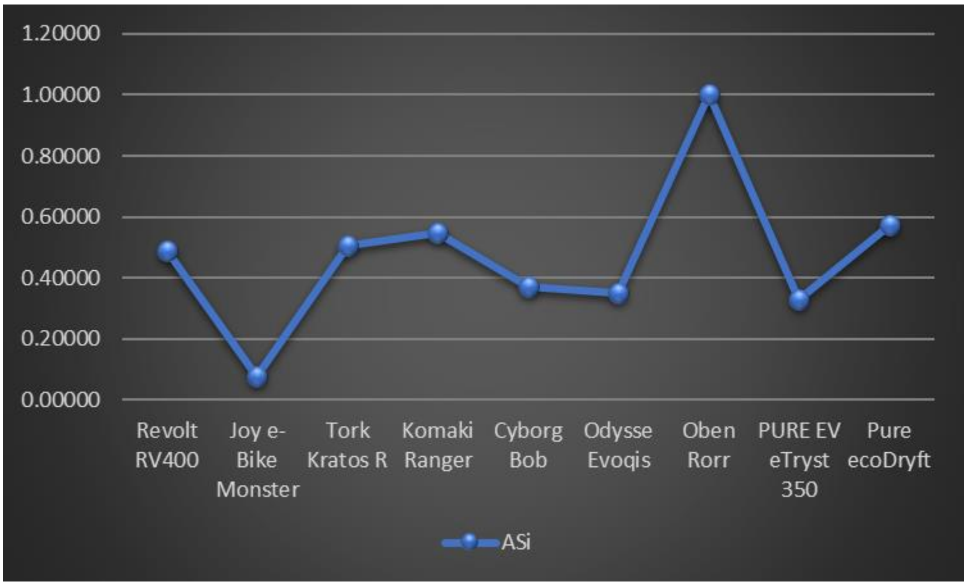

FIGURE 3. Final appraisal score of alternative banks

Figure 3 illustrates the final appraisal score of alternative electric motorcycles calculated by using 10. The final appraisal score values were calculated using the average of NSPi and NSNi. Here the final appraisal score for "Revolt RV400 is 0.48699, Joy e-Bike Monster is 0.07581, Tork Kratos R is 0.50536, Komaki Ranger is 0.54722, Cyborg Bob is 0.37261, Odysse Evoqis is 0.34899, Oben Rorr is 1, PURE EV eTryst 350 is 0.32880 and Pure ecoDryft is 0.57229".

TABLE 9. Rank

Electric bikes models	Rank
Revolt RV400	5
Joy e-Bike Monster	9
Tork Kratos R	4
Komaki Ranger	3
Cyborg Bob	6
Odysse Evoqis	7
Oben Rorr	1
PURE EV eTryst 350	8
Pure ecoDryft	2

Table 9 shows the final rank of alternative electric motorcycles calculated by using 10. In this instance, the options are listed in decreasing order by the "final assessment score (AS)". Here rank of "Revolt RV400 is fifth, Joy e-Bike Monster is ninth, Tork Kratos R is fourth, Komaki Ranger is third, Cyborg Bob is sixth, Odysse Evoqis is seventh, Oben Rorr is first, PURE EV eTryst 350 is eight, Pure ecoDryft is second".

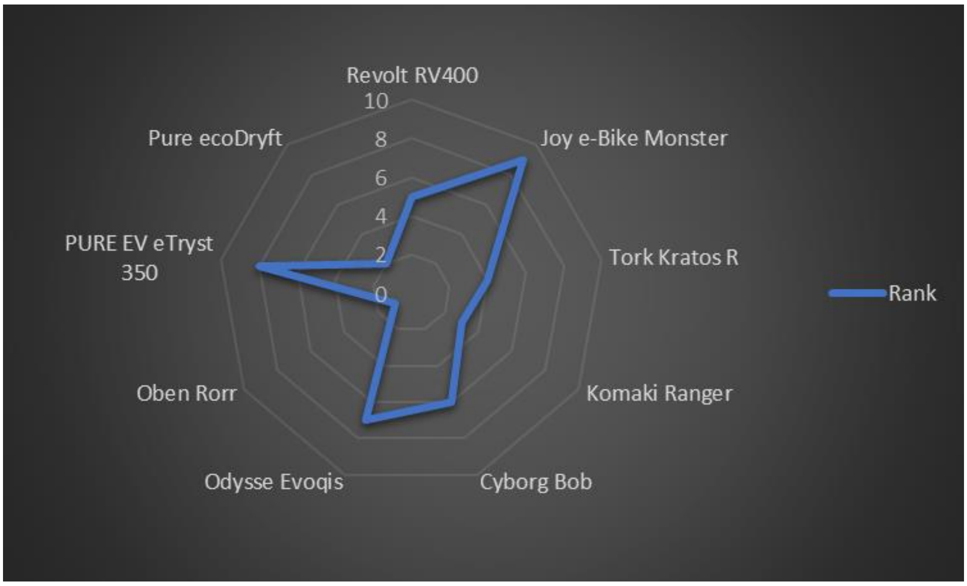

TABLE 4. The rank of electric motorcycles

Figure 4 shows a graphical representation of the final rank of alternative electric motorcycles calculated by using 10. The options are listed here in order of descending of "the final appraisal score (AS)". Here rank of “Revolt RV400 is fifth, Joy e-Bike Monster is ninth, Tork Kratos R is fourth, Komaki Ranger is third, Cyborg Bob is sixth, Odysse Evoqis is seventh, Oben Rorr is first, PURE EV eTryst 350 is eight, Pure ecoDryft is second”. Depending on EDAS research in this paper, it was discovered that among all sample electric motor vehicles, “Oben Rorr had the best overall performance while PURE EV eTryst 350 had the poorest”.

4. CONCLUSION

The unification of electric engine drive technology and controls has sped up the evolution of the electric bike in a world where saving energy and environmental protection are rising issues. Electric motorcycles have a greater chance of replacing more polluting petrol motorbikes as battery technology advances and gas prices climb. Nevertheless, slightly over 50% of participants said they would never buy an electric motorcycle, irrespective of the cost or quality. A significant switch to electric bikes may also put too much strain on the electrical grid due to distribution and manufacturing constraints. Last but not least, motorbikes simply address pollutants while disregarding other detrimental effects of motorbikes and may exacerbate existing environmental concerns. Due to the abundance of possibilities offered on the global market, conflicting situations can develop while choosing a certain motorcycle. There may not always be a certain number of options available or there may be multiple alternatives to the original pick. The possibility of not having an acceptable option for the criterion exists as well. “Multiple Criteria Decision Making” is a technique designed for the optimization of problems with “an infinite or finite number of choices” and the MCDM technique “EDAS method” is used to optimize the process in this paper. The rank of “Revolt RV400 is fifth, Joy e-Bike Monster is ninth, Tork Kratos R is fourth, Komaki Ranger is third, Cyborg Bob is sixth, Odysse Evoqis is seventh, Oben Rorr is first, PURE EV eTryst 350 is eight, Pure ecoDryft is second”. Depending on EDAS research in this paper, it was discovered that among all sample electric motor vehicles, “Oben Rorr had the best overall performance while PURE EV eTryst 350 had the poorest”.

REFERENCES

[1]. LeBel, Felix-A., Louis Pelletier, Pascal Messier, and Joao Pedro Trovao. "Battery pack sizing method-case study of an electric motorcycle." In 2018 IEEE Vehicle Power and Propulsion Conference (VPPC), pp. 1-6. IEEE, 2018.

[2]. Guerra, Erick. "Electric vehicles, air pollution, and the motorcycle city: A stated preference survey of consumers’ willingness to adopt electric motorcycles in Solo, Indonesia." Transportation Research Part D: Transport and Environment 68 (2019): 52-64.

[3]. Ponnada, Venkata Tulasiramu, and SV Naga Srinivasu. "Edge AI system for pneumonia and lung cancer detection." *Int J Innov Technol Exploring Eng* 8, no. 9 (2019).

[4]. Fuladipanah, Mehdi, H. Md Azamathulla, Ozgur Kisi, Mehdi Kouhdaragh, and Vishwandham Mandala. "Quantitative forecasting of bed sediment load in river engineering: an investigation into machine learning methodologies for complex phenomena." *Water Supply* 24, no. 2 (2024): 585-600.

[5]. Sunitha, R., and J. K. Raju. "RISK MANAGEMENT IN BANKING SECTOR--AN DESCRIPTIVE STUDY." (2013).
[6]. Chen, Han-Shen, Chia-Yon Chen, Han-Kuan Chen, and Tsuifang Hsieh. "A study of relationships among green consumption attitude, perceived risk, perceived value toward hydrogen-electric motorcycle purchase intention." Aasri Procedia 2 (2012): 163-168.
[7]. Shanmugasundar, G., M. Vanitha, G. Sai Krishnan, and S. Srinivasan. "Investigation on the mechanical properties of newly modified polymeric fiber for structural applications." *Materials Today: Proceedings* 46 (2021): 3439-3443.
[8]. Cheng, Po-Jen, Chin-Hsing Chen, and Yi-Min Fang. "Design of energy recovery system for electric motorcycles using fuzzy theory." Journal of Information and Optimization Sciences 29, no. 4 (2008): 731-743.
[9]. Mandala, Vishwanadham, and Mahindra Sai Mandala. "ANATOMY OF BIG DATA LAKE HOUSES." *NeuroQuantology* 20, no. 9 (2022): 6413.
[10]. Istiqomah, Silvi, Wahyudi Sutopo, Muhammad Hisjam, and Hendro Wicaksono. "Optimizing Electric Motorcycle-Charging Station Locations for Easy Accessibility and Public Benefit: A Case Study in Surakarta." World Electric Vehicle Journal 13, no. 12 (2022): 232.
[11]. Ponnada, Venkata Tulasiramu, Venkata Tulasikrishna Ponnada, Rama Krishna Raju Sammeta, and Hymavathi Jasti. "Making Healthcare Decisions: An Evolution." In *Intelligent Decision Making Through Bio-Inspired Optimization*, pp. 85-110. IGI Global, 2024.
[12]. Uribe, Alejandro, Mauricio Fernández-Montoya, Jhon Vargas, Gilberto Osorio-Gómez, and Alejandro Montoya. "Discrete event simulation for battery-swapping station sizing for hybrid and electric motorcycles." Journal of Cleaner Production 390 (2023): 136155.
[13]. Herath, Madhawa, Tharaka Jayathilaka, Hazi Mohammad Azamathulla, Vishwanadham Mandala, Namal Rathnayake, and Upaka Rathnayake. "Sensitivity analysis of parameters affecting wetland water levels: A study of flood detention basin, Colombo, Sri Lanka." *Sensors* 23, no. 7 (2023): 3680.
[14]. Chiu, Yi-Chang, and Gwo-Hshiung Tzeng. "The market acceptance of electric motorcycles in Taiwan experience through a stated preference analysis." Transportation Research Part D: Transport and Environment 4, no. 2 (1999): 127-146.
[15]. Reckziegel, Sebastian, Ariel Guerrero, and Mario Arzamendia. "Analysis and design of a functional electric motorcycle prototype." In 2021 IEEE CHILEAN Conference on Electrical, Electronics Engineering, Information and Communication Technologies (CHILECON), pp. 1-6. IEEE, 2021.
[16]. Ponnada, Venkata Tulasiramu, and SV Naga Srinivasu. "End to End System for Pneumonia and Lung Cancer Detection using Deep Learning." *Int. J. Eng. Adv. Technol* 8 (2019).
[17]. Krishnan, G. Sai, G. Shanmugasundar, M. Vanitha, S. Srinivasan, and G. Suresh. "Investigation on the Mechanical and Morphological Properties of Red banana/Ramie Fiber vinyl ester composites." In IOP Conference Series: Materials Science and Engineering, vol. 961, no. 1, p. 012015. IOP Publishing, 2020.
[18]. Mandala, Vishwanadham, R. Rajavarman, C. Jamunadevi, R. Janani, and T. Avudaiappan. "Recognition of E-Commerce through Big Data Classification and Data Mining Techniques Involving Artificial Intelligence." In *2023 8th International Conference on Communication and Electronics Systems (ICCES)*, pp. 720-727. IEEE, 2023.
[19]. Sunitha, R. "A study on competency mapping scale to map the competencies of university teachers (with special reference to karnataka state)." *South Asian Journal of Engineering and Technology* 11, no. 1 (2021): 1-3.
[20]. Mandala, Vishwanadham. "Revolutionizing Asynchronous Shipments: Integrating AI Predictive Analytics in Automotive Supply Chains." *Journal ID* 9339 (2022): 1263.
[21]. Shanmugasundar, G., Ankur Bansod, Vladimira Schindlerova, and Robert Čep. "Influence of Filler Material on the Microstructural and Mechanical Properties of 430 Ferritic Stainless Steel Weld Joints." *Materials* 16, no. 4 (2023): 1590.
[22]. Jeyapandiarajan, Pa, Ga Kalaiarassan, Ja Joel, Rutwesh Shirbhate, Fastin Felix Telare, and Aditya Bhagat. "Design and analysis of chassis for an electric motorcycle." Materials Today: Proceedings 5, no. 5 (2018): 13563-13573.
[23]. Ramadani, Sofia Fitri, Gita Widi Bhawika, and Imam Baihaqi. "Objective and Subjective Integration in Distribution Center Location Selection: A Case Study of Battery-electric Motorcycle Sales." In 2nd International Conference on Business and Management of Technology (ICONBMT 2020), pp. 283-293. Atlantis Press, 2021.
[24]. Landerl, Christian, Christian Hubmann, Bernhard Graf, and Patrick Falk. "Drivability and Acoustics of Electric Motorcycles as the Main Criteria for Satisfied Customers." ATZ worldwide 124, no. 7 (2022): 36-39.
[25]. Blissett, Jonathan, Marco Degano, Miquel Gimeno-Fabra, and Pat Wheeler. "Design of electrical system for racing electric motorcycles." In 2016 International Conference on Electrical Systems for Aircraft, Railway, Ship Propulsion and Road Vehicles & International Transportation Electrification Conference (ESARS-ITEC), pp. 1-5. IEEE, 2016.
[26]. Patel, Arpan, Shubham Jha, Rohan Soni, and Kishan Fuse. "Comparative study of MCDM techniques COPRAS and TOPSIS for selection of electric motorcycles." In Proceedings of the 2020 IEEE 7th International Conference on Industrial Engineering and Applications (ICIEA), Bangkok, Thailand, pp. 16-21. 2020.
[27]. Ponnada, Venkata Tulasiramu, and SV Naga Srinivasu. "Efficient CNN for lung cancer detection." *Int J Recent Technol Eng* 8, no. 2 (2019): 3499-505.
[28]. T. Santhosh; Harshitha. T. N,; Sathiyaraj Chinnasamy; M. Ramachandran, "Adaptive Subgradient Methods for Leadership And Development", Recent trends in Management and Commerce 4(2) 2023, 101-106.
[29]. Govindarajan, Uma, Vigna K. Ramachandaramurthy, and Sudar Oli Selvi T. "Multiple criteria decision making (MCDM) based economic analysis of solar PV system with respect to performance investigation for Indian market." Sustainability 9, no. 5 (2017): 820.
[30]. Shanmugasundar, G., R. Yokesh, S. Yuvaranjith, R. Barath, and S. Balasubramanian. "Design and Fabrication of Intelligent Gas Stove for Indian Women Safety." International Journal of Pharmaceutical Research (09752366) 12, no. 2 (2020).
[31]. Mandala, Vishwanadham, MA Reetha Jeyarani, A. Kousalya, M. Pavithra, and M. Arumugam. "An Innovative Development with Multidisciplinary Perspective in Metaverse Integrating with Blockchain Technology with Cloud Computing Techniques." In *2023 International Conference on Inventive Computation Technologies (ICICT)*, pp. 1182-1187. IEEE, 2023.

[32]. Shanmugasundar, G., R. Muralikumaran, L. Sathishkumar, N. Sethuraman, M. Dharanidharan, R. Kousik Naarayanan, and R. Mahaalakshmi. "Design and finite element analysis of 6 DOF robotic arm for automatic pick and place application in industry 4.0." In *AIP Conference Proceedings*, vol. 2747, no. 1. AIP Publishing, 2023.
[33]. U. Midhundev; Harshith. T. N,; M. Ramachandran; Kurinjimalar Ramu, "An Empirical Investigation of Innovation and Technology in Banking" , Recent trends in Management and Commerce 4(2), 2023: 121-129.
[34]. Ponnada, Venkata Tulasiramu, and SV Naga Srinivasu. "Integrated clinician decision supporting system for pneumonia and lung cancer detection." *International Journal of Innovative Technology and Exploring Engineering (IJITEE)* (2019).
[35]. Kahraman, Cengiz, Mehdi Keshavarz Ghorabaee, Edmundas Kazimieras Zavadskas, Sezi Cevik Onar, Morteza Yazdani, and Basar Oztaysi. "Intuitionistic fuzzy EDAS method: an application to solid waste disposal site selection." Journal of Environmental Engineering and Landscape Management 25, no. 1 (2017): 1-12.
[36]. Alinezhad, Alireza, Javad Khalili, Alireza Alinezhad, and Javad Khalili. "EDAS Method." New Methods and Applications in Multiple Attribute Decision Making (MADM) (2019): 149-155.
[37]. Huang, Yuhan, Rui Lin, and Xudong Chen. "An enhancement EDAS method based on prospect theory." Technological and Economic Development of Economy 27, no. 5 (2021): 1019-1038.
[38]. Akshaya, V., Vishwanadham Mandala, Chunduru Anilkumar, P. VishnuRaja, and R. Aarthi. "Security enhancement and attack detection using optimized hybrid deep learning and improved encryption algorithm over Internet of Things." *Measurement: Sensors* 30 (2023): 100917.
[39]. Spoorthi. S,; Harshith. T. N,; M. Ramachandran; Chandrasekar Raja, " A Review on Child Safety Monitoring System Based on IOT", Recent trends in Management and Commerce 4(2), 2023: 130-135.
[40]. Stanujkic, Dragisa, Edmundas Kazimieras Zavadskas, M. Keshavarz Ghorabaee, and Zenonas Turskis. "An extension of the EDAS method based on the use of interval grey numbers." Studies in Informatics and Control 26, no. 1 (2017): 5-12.
[41]. Ghorabaee, Mehdi Keshavarz, Edmundas Kazimieras Zavadskas, Maghsoud Amiri, and Zenonas Turskis. "Extended EDAS method for fuzzy multi-criteria decision-making: an application to supplier selection." International journal of computers communications & control 11, no. 3 (2016): 358-371.
[42]. Sunitha, R. "Work life balance of women employees of teaching faculties in karnataka state." *Journal of Management and Science* 10, no. 4 (2020): 40-42.
[43]. Shanmugasundar, G., S. Shanmugapriya, M. Vanitha, and M. Dharanidharan. "Brain-computer interface of robot control with home automation for disabled." In *AIP Conference Proceedings*, vol. 2747, no. 1. AIP Publishing, 2023.
[44]. Fuladipanah, Mehdi, H. Md Azamathulla, Kiran Tota-Maharaj, Vishwanadham Mandala, and Aaron Chadee. "Precise forecasting of scour depth downstream of flip bucket spillway through data-driven models." *Results in Engineering* 20 (2023): 101604.