REST Journal on Advances in Mechanical Engineering

Vol: 2(4), December 2023

REST Publisher; ISSN: 2583-4800 (Online)

Website: https://restpublisher.com/journals/jame/

DOI: https://doi.org/10.46632/jame/2/4/2

Feasibility Analysis of Power Generation from Internal Combustion Engine (ICE) Using EDAS Method

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Abstract. *There is a growing demand for research into efficient electric power generation as fuel efficiency for "internal combustion engine (ICE)" cars become a more crucial factor. A transformer is used by an "energy management (EM) system" to regulate the generation of electrical energy. The strategy for EM of the "control mode switch (CMS)" of the alternator for (ICE) automobiles is presented in this research. The remaining kinetic energy of the vehicle is recovered by this EM fuel improvement. When a driver man oeuvres a motorcycle to slow down, residual kinetic energy is created. Other energy is typically wasted as brake heat energy. In such cases, activating a transformer will allow the wasted energy to be transformed into electrical energy. This modification will result in less fuel being used overall. The futures temporal of energy is employed for prolonged energy conversion. The future engine speed is used to calculate the duration. Numerous real-world decision-making issues can be solved using discontinuous stochastic cross decision making (MCTM). A brand-new and effective MCDM technique is estimation depending on location from middle solution (EDAS). The selection of alternatives is established using this method depending on how far away from the average answer they are. The EDAS approach can solve stochastic applications since the sample mean determines the method's overall solution. In order to handle issues when the due to its versatility of the alternative in each condition follow a normal distribution, a coherent EDAS method is proposed in this study. A decision-maker can take into account the uncertainty of the decision-making data and get positive and negative life evaluation scores for analyzing options based on the suggested method. The alternatives are Power output (kW), Jacket water inlet temperature (°C), Jacket water outlet temperature (°C), Jacket water mass flowrate (kg/s), Exhaust gases temperature (°C) and Exhaust gases mass flow rate (kg/s). The evaluation parameter is E200, E250, E310, E375, E500, E1165. Internal Combustion Engine (ICE) using the Analysis for EDAS Method. Exhaust gases temperature (°C) is got first rank and Exhaust gases mass flow rate (kg/s) is got lowest rank.*
Keywords: *electric and hybrid electric propulsion, internal combustion engine (ICE), MCDM.*

1. INTRODUCTION

The fuels and lubricants (F&L) level in the game stability and characteristics, in addition to the ICE feed system's design elements, influence environmental protection. It is well known that the fuel's content and quality have a major role in determining the structure of exhaust gases. Nevertheless, it is also well known that when an ICE is operating, the characteristics of engine oil alter significantly. Different loads, rpm frequencies, and operating pressure are all used by internal combustion engines. The amount of dangerous compounds in exhaust gases varies according to engine wear, operating modes, fuel and lubricant quality, and engine operating conditions. Due to their higher efficiency, energy density, torque, durability, and know exactly to petrols, diesel compression ignition engines (ICE) are indispensable in public transportation, heavy equipment, power production, agricultural, and industrial equipment. Furthermore, the diesel "internal combustion engine (ICE)" generates a sizeable portion of particle and gaseous airborne pollutants. These emissions can lower human immunity and are factors that cause sickness. Additionally, with controlled mixing, the carbon and carboxylic groups (On) of the main alcohol fuel promote the oxidation of soot. Particularly when the workload on an "internal combustion engine (ICE)" is considerable, this decreases smoke. Primary alcohols can be used in spark-ignited "internal combustion engines" since they have a higher octane rating (ICE). Primary alcohol fuels have low cetane values, making it challenging to use them directly in an "internal combustion engine (ICE)" without igniting. As a result, diesel "internal combustion engines (ICE)" with alcohol-DF mixing mode and dual fuel mode are the principal applications for alcohol fuel. Recent years have seen intense study into alternate and clean energy for internal combustion engines due to the quick depletion of fossil fuel supplies plus high levels of pollution (ICE). The EDAS method uses a straightforward computation process to predict risk in number of co and indeterminate contexts. Therefore, in order to create a thorough method of risk management for metro installation, this study investigates the viability of integrating the CN system and the EDAS approach. Expert knowledge serves as the foundation for the CN formation and risk factor evaluation procedures. We adopt the new weighing methodology based on TOPSIS that combines intuitive ranking and family resemblance objective weighting to incorporate expert viewpoints in order to more efficiently gather and analyse expert knowledge. Additionally, multiple formats are used to express the risk factor evaluation values under 4 indicators. In order to manage heterogeneous information, we enhance the traditional EDAS technique. The relevance of the suggested methodology is confirmed by a case study involving the safety risk assessment of the construction of the Dalian Metro in China. Keshavarz Ghorabaee and colleagues created the "Estimation method based on distance from average solution (EDAS)" (2015) The greatest and most often used MCDM techniques are TOPSIS and VIKOR. The best solution is taken into account by these approaches logically based on the optimal distance from either the ideal or optimistic ultimate solution, as opposed to the smallest distance out from ideal or negative ideal solution. However, the distances from the average answer determines the optimum EDAS technique substitute (AV). In this study, we first show the EDAS algorithms for smooth and basic fuzzy data before extending them to their intuitive fuzzy form. "Positive distance average (PDA)" and "negative distance average (NDA)" are the first two metrics in the EDAS method (NDA). These metrics can be used to compare each alternative option toward the mean solution. Therefore, high PDA and low NDA values denote an ideal solution. In fact, high PDA especially low NDA values suggest that the answer (alternative) is superior to the solution for the average life expectancy.

2. INTERNAL COMBUSTION ENGINE (ICE)

A prior publication addressed some research initiatives looking into the usage of maximum dry powder in engines. The inability of these solutions to compete economically with conventional engine fuels has impeded their development and commercialization. A fresh interest in using coal as a renewable alternative to replace coal has emerged in recent years. In order to meet global energy demand increases for electricity while reducing emissions, the global energy portfolio must be expanded to include renewable energy sources or storage technologies. Internal combustion engines (ICEs) can be used as a supplement to intermittent renewable energy sources. The running expenses and carbon emissions associated with ICEs' use of fossil fuels are its principal drawbacks. Standard ICEs powered by second-generation biofuels made from waste materials, energy crops, or agricultural residues have many benefits, but they are more expensive than diesel and natural gas. In their research, Petersen and Wester Holm examined numerous fuel reformers for use in fuel cells and addressed major design issues that some ICE hydrothermal recovery systems can learn from. Kumar et al. focused on the issue of reaction mixture. And much later, Li et al. furled ICE in their research to create a reformer for hydrous ethanol. In order to achieve a fine mist of 20-mm droplets, Kumar et al. recommended delivering water and ethanol to the reformer using an ultrasonic nozzle. Li and co. In order to maximise gas steam and ethanol mixing and guarantee consequent homogenous catalytic reactions in accordance with the anticipated water-to-ethanol ratio, a customised mixing chamber was created for the reformer. Aluminum furnace with a plate with fin heat exchanger was reported by Dams and others. A thin wash coat layer was immediately applied to the furnace material following the oxidation of the aluminium surface. This method produced favourable heat transfer properties, a crucial component of ICE-based TCR systems that make use of waste heat from engine exhaust gas.

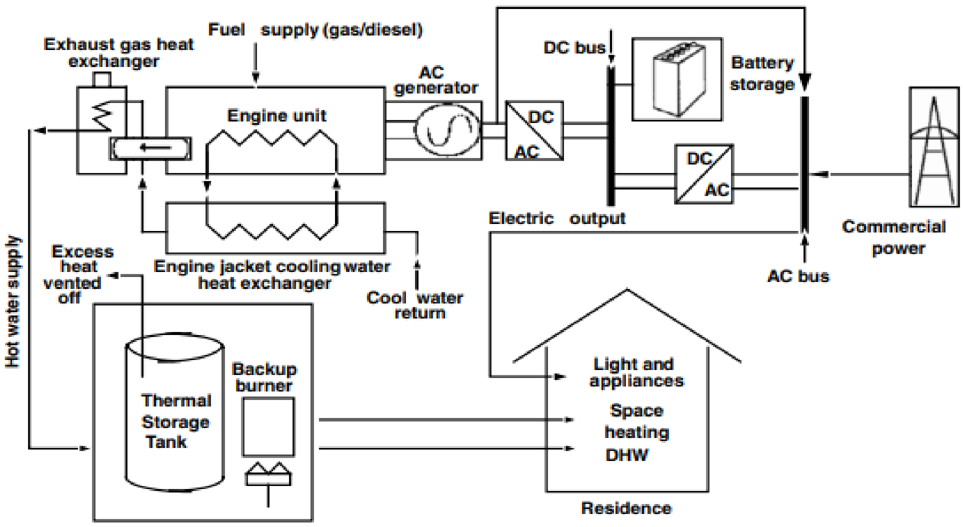

FIGURE 1. Residential Internal Combustion Engine (ICE) with thermal and electrical storage

The ICE co - generation system is presumptively capable of meeting the home's electrical and household hot water heating needs; cool loads are not taken into account. Figure 1 depicts the conceptual design chosen for a home ICE power generator with good electrical storage. For the ICE cogeneration system, two operational scenarios are taken into account. The electromagnetic priority controller works the ICE at its maximum electrical capacity, in contrast to the constant power controller scenario, which works the ICE at the lowest respect to brake power (BSFC) position scenario operates the ICE in response to the building's electrical demand. The thermal energy from of the ICE is used by the electric priority controller to satisfy the thermal energy needs for The grid provides the necessary space, DHW, and fills any gaps in meeting ICE's heating and electricity requirements system as well as the standby burner, respectively. The ICE and battery module work together to provide the fixed output controller, with the battery module serving as a storage space for the ICE's excess power. The ICE must be initiated and run at peak power efficient (lowest BSFC point) till the charge time falls below a lower bound set point in order to achieve this. Until there is an electricity network deficit (the input power of the house surpasses the voltage energy from the ICE), the charge must reach the high-limit set point. The ICE is then turned off at that point, and the battery is used to provide the load if it can do so. If the battery is unable to meet the electrical load, the utility grid is used to refund the bill between the house's electrical load and the battery's contribution.

3. MATERIALS AND METHODS

There are very few studies using the EDAS approach in the complex fuzzy MCDM fields. The range limitations of positively and negatively distances are shown by the EDAS method. Additionally, decision-makers' various risk attitudes might be taken into account in this way. As a result, the research creates a new model for MCDM issues in four-branch fuzzy environments using the EDAS approach. By integrating an analytical hierarchy process (ahp approach with a deviation structural analysis), the periodic model equation of the qualification set is converted into a probabilistic weight matrix in the model. and the determination of an additional weight vector is performed using a number of co adaptive control features and performance. Looking at the EDAS method's evolution in chronological order, Ghorabaee et al. were the ones who originally introduced it. without taking into account the best and nadir answers, seeks out the preferred alternative depends on the difference from the average solution. The EDAS technique also takes into account two characteristics to decision problem according to their attraction. These metrics display the variance between each option and the typical solution. When compared to distance-based methods in the literature, the EDAS method's computational effort is smaller (TOPSIS, VIKOR, CODAS, etc.). Additionally, the EDAS method yields outcomes that are equally reliable as these techniques. Due to this, the EDAS approach has been the subject of numerous applied studies. In order to address the confusion in the context of the MC(G)DM, numerous fuzzy adaptations of the EDAS approach have also been developed. The straightforward fuzzy EDAS approach was put forth by Kahraman et al. and used to solve the problem of choosing a location for solid waste disposal. In order to evaluate suppliers, Ghorabaee et al. examined the EDAS approach taking duration type-2 fuzzy sets into account. A stochastic EDAS approach taking into account normally distributed data was presented by Ghorabaee et al. EDAS was used in conjunction with hesitant fuzzy sets to overcome the hospital selection issue. Carpenter used the fuzzy EDAS approach to evaluate manufacturers along with Stevik et al. Feng et al. investigated the EDAS method adapted with apprehensive fuzzy sets and showed how it might be used to good effect using a numerical example. New interval-valued pythagorean fuzzy EDAS methodology was introduced by Karasan and Karaman, and it was used to prioritise the United States National Goal Of Sustainable development. Ash-based EDAS was used by Kaviani et al. to evaluate suppliers in the oil and gas sector. The interval-valued Pythagorean fuzzy EDAS approach was developed by Yanmas et al. for the MCGDM process and used to solve the automobile selection problem. Keshavars Gorabai and colleagues suggested the "EDAS (estimation based on distance from mean solution)" approach. It begins by dealing with the categorization of inventory as an effective and relatively new MCDM technique. It has gradually been expanded to address additional MCDM issues, such as engineering issues. In contrast to some MCDM layers include VIKOR and TOPSIS, the EDAS technique skips the phase of intricately calculating ideal and nadir solutions. The EDAS method's fundamental tenets can be summed up as follows: The average solution (AS), which may be simply obtained by computing the arithmetic mean, is used for the evaluation/preference of alternatives by assessing their distance from the mean answer. Performance ratings for several options in relation to each criterion. In this situation, two metrics—positive displacement from the means (PDA) and negatives distances from the mean (NDA)—are taken into account for the evaluation and preference of the alternatives. These two measurements geometrically express how each alternative differs from the AS. Depending on whether the criteria are useful or unsuccessful, these distances are measured. High PDA and/or low NDA values for a certain alternative suggest that it is superior to the standard solution.

4. RESULT AND DISCUSSION

TABLE 1. Internal Combustion Engine (ICE) using EDAS Method

ICE parameter	E200	E250	E310	E375	E500	E1165
Power output (kW)	205	255	310	376	502	1170
Jacket water inlet temperature (°C)	80	80	80	80	80	78
Jacket water outlet temperature (°C)	90	90	90	90	90	89
Jacket water mass flowrate (kg/s)	2.9	4.2	3.6	3.8	5	13
Exhaust gases temperature (°C)	453	460	490	482	482	457
Exhaust gases mass flow rate (kg/s)	0.32	0.39	0.5	0.6	0.79	1.69
AVi	**138.5366**	**148.2650**	**162.3500**	**172.0666**	**193.2983**	**301.44833**
	B	**B**	**B**	**NB**	**NB**	**NB**

Table 1 shows the Evaluation of Internal Combustion Engine (ICE) using the Analysis method in EDAS. Power output (kW), Jacket water inlet temperature (°C), Jacket water outlet temperature (°C), Jacket water mass flowrate (kg/s), Exhaust gases temperature (°C) and Exhaust gases mass flow rate (kg/s) is seen all Average in Value.

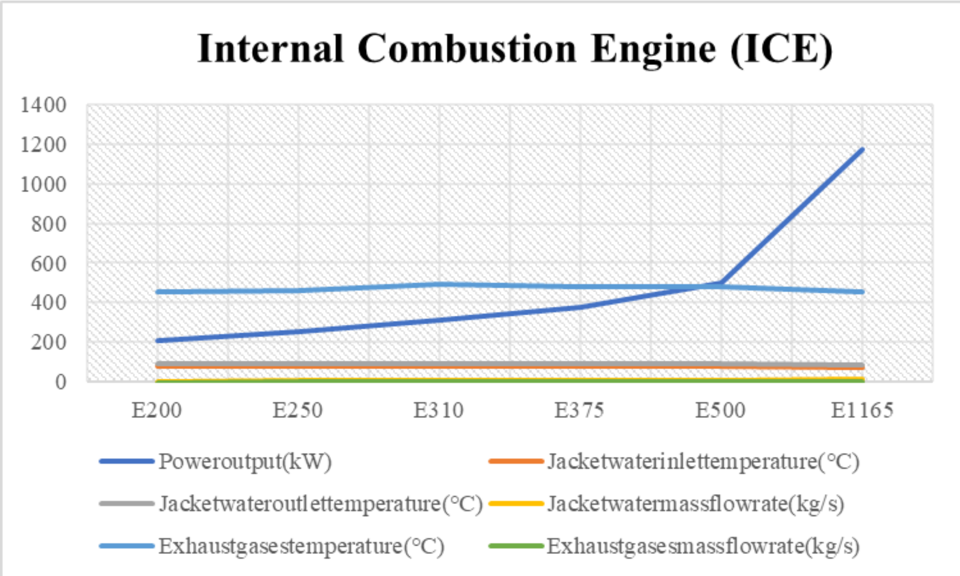

FIGURE 2. Internal Combustion Engine (ICE) using EDAS Method

Shows the figure 2 Evaluation of Internal Combustion Engine (ICE) using the Analysis method in EDAS. Power output (kW), Jacket water inlet temperature (°C), Jacket water outlet temperature (°C), Jacket water mass flowrate (kg/s), Exhaust gases temperature (°C) and Exhaust gases mass flow rate (kg/s) is seen all Average in Value.

TABLE 2. Positive Distance from Average (PDA)

	Positive Distance from Average (PDA)					
Power output (kW)	0.48	0.72	0.91	1.19	0.00	0.00
Jacket water inlet temperature (°C)	0.00	0.00	0.00	0.00	0.59	0.74
Jacket water outlet temperature (°C)	0.00	0.00	0.00	0.00	0.53	0.70
Jacket water mass flowrate (kg/s)	0.00	0.00	0.00	0.00	0.97	0.96
Exhaust gases temperature (°C)	2.27	2.10	2.02	1.80	0.00	0.00
Exhaust gases mass flow rate (kg/s)	0.00	0.00	0.00	0.00	1.00	0.99

Shows the table 2 Positive Distance from Average (PDA) in Evaluation of Internal Combustion Engine (ICE) using the Analysis method in EDAS Power output (kW), Jacket water inlet temperature (°C), Jacket water outlet temperature (°C), Jacket water mass flowrate (kg/s), Exhaust gases temperature (°C) and Exhaust gases mass flow rate (kg/s) is seen all Maximum Value.

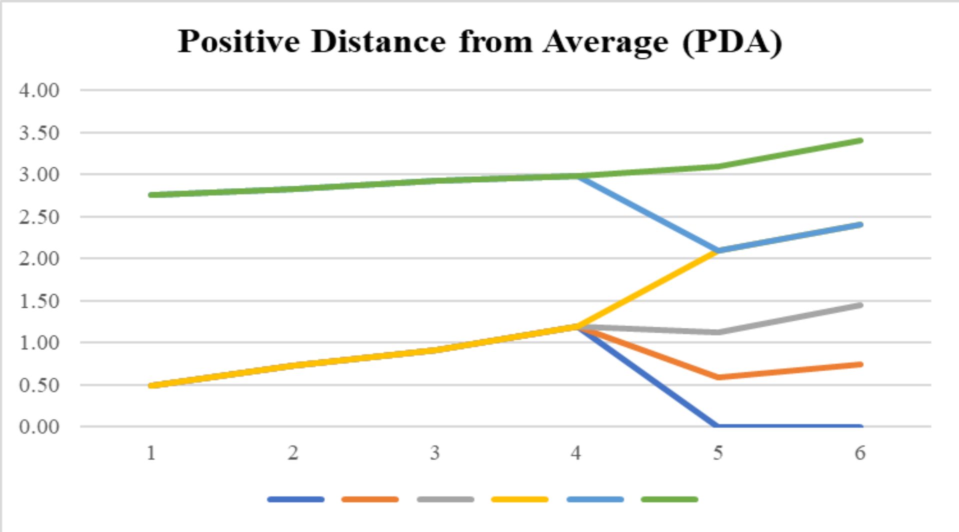

FIGURE 3. Positive Distance from Average (PDA)

Shows the figure 3 Positive Distance from Average (PDA) in Evaluation of Internal Combustion Engine (ICE) using the Analysis method in EDAS Power output (kW), Jacket water inlet temperature (°C), Jacket water outlet temperature (°C), Jacket water mass flowrate (kg/s), Exhaust gases temperature (°C) and Exhaust gases mass flow rate (kg/s) is seen all Maximum Value.

TABLE 3. Negative Distance from Average (NDA)

	Negative Distance from Average (NDA)					
Power output (kW)	0.00000	0.00000	0.00000	0.00000	1.59702	2.88126
Jacket water inlet temperature (°C)	0.42254	0.46043	0.50724	0.53506	0.00000	0.00000
Jacket water outlet temperature (°C)	0.35035	0.39298	0.44564	0.47695	0.00000	0.00000
Jacket water mass flowrate (kg/s)	0.97907	0.97167	0.97783	0.97792	0.00000	0.00000
Exhaust gases temperature (°C)	0.00000	0.00000	0.00000	0.00000	1.49355	0.51601
Exhaust gases mass flow rate (kg/s)	0.99769	0.99737	0.99692	0.99651	0.00000	0.00000

Table 3 shows the Negative Distance from Average (NDA) in Evaluation of Internal Combustion Engine (ICE) using the Analysis method in EDAS Power output (kW), Jacket water inlet temperature (°C), Jacket water outlet temperature (°C), Jacket water mass flowrate (kg/s), Exhaust gases temperature (°C) and Exhaust gases mass flow rate (kg/s) is seen all Maximum Value.

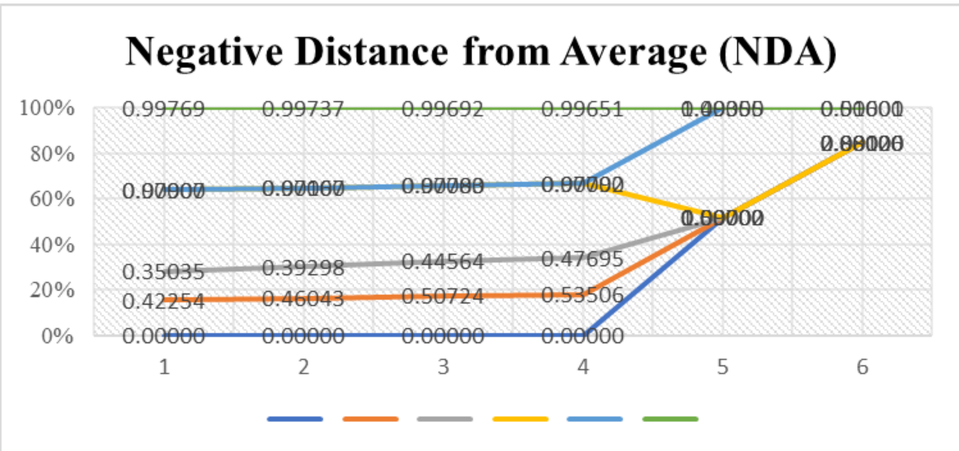

FIGURE 4. Negative Distance from Average (NDA)

Shows the figure 4 Negative Distance from Average (NDA) in Evaluation of Internal Combustion Engine (ICE) using the Analysis method in EDAS Power output (kW), Jacket water inlet temperature (°C), Jacket water outlet temperature (°C), Jacket water mass flowrate (kg/s), Exhaust gases temperature (°C) and Exhaust gases mass flow rate (kg/s) is seen all Maximum Value

TABLE 4. Weight

	Weight					
Power output (kW)	0.25	0.25	0.25	0.25	0.25	0.25
Jacket water inlet temperature (°C)	0.25	0.25	0.25	0.25	0.25	0.25
Jacket water outlet temperature (°C)	0.25	0.25	0.25	0.25	0.25	0.25
Jacket water mass flowrate (kg/s)	0.25	0.25	0.25	0.25	0.25	0.25
Exhaust gases temperature (°C)	0.25	0.25	0.25	0.25	0.25	0.25
Exhaust gases mass flow rate (kg/s)	0.25	0.25	0.25	0.25	0.25	0.25

Shows the table 4 Weightages used for the analysis. We take same weights for all the parameters for the analysis.

TABLE 5. Weighted PDA

	Weighted PDA						SPi
Power output (kW)	0.11994	0.17997	0.22736	0.29630	0.00000	0.00000	0.82358
Jacket water inlet temperature (°C)	0.00000	0.00000	0.00000	0.00000	0.14653	0.18531	0.33185
Jacket water outlet temperature (°C)	0.00000	0.00000	0.00000	0.00000	0.13360	0.17619	0.30979
Jacket water mass flowrate (kg/s)	0.00000	0.00000	0.00000	0.00000	0.24353	0.23922	0.48275
Exhaust gases temperature (°C)	0.56747	0.52564	0.50454	0.45031	0.00000	0.00000	2.04796
Exhaust gases mass flow rate (kg/s)	0.00000	0.00000	0.00000	0.00000	0.24898	0.24860	0.49758

Table 5 shows the Weighted PDA SPi in Evaluation of Internal Combustion Engine (ICE) using the Analysis method in EDAS Analysis is shown the Table 2 and Table 4 in Multiple Value. Power output (kW), Jacket water inlet temperature (°C), Jacket water outlet temperature (°C), Jacket water mass flowrate (kg/s), Exhaust gases temperature (°C) and Exhaust gases mass flow rate (kg/s) is seen all Multiple Value.

TABLE 6. Weighted NDA

	Weighted NDA						SNi
Power output (kW)	0.00000	0.00000	0.00000	0.00000	0.39926	0.72032	1.11957
Jacket water inlet temperature (°C)	0.10563	0.11511	0.12681	0.13377	0.00000	0.00000	0.48132
Jacket water outlet temperature (°C)	0.08759	0.09824	0.11141	0.11924	0.00000	0.00000	0.41648
Jacket water mass flowrate (kg/s)	0.24477	0.24292	0.24446	0.24448	0.00000	0.00000	0.97662
Exhaust gases temperature (°C)	0.00000	0.00000	0.00000	0.00000	0.37339	0.12900	0.50239
Exhaust gases mass flow rate (kg/s)	0.24942	0.24934	0.24923	0.24913	0.00000	0.00000	0.99712

Table 6 shows the Weighted PDA SPi in Evaluation of Internal Combustion Engine (ICE) using the Analysis method in EDAS Analysis is shown the Table 3 and Table 4 in Multiple Value. Power output (kW), Jacket water inlet temperature (°C), Jacket water outlet temperature (°C), Jacket water mass flowrate (kg/s), Exhaust gases temperature (°C) and Exhaust gases mass flow rate (kg/s) is seen all Multiple Value.

TABLE 7. NSPi, NSNi, ASi and Rank

	NSPi	NSNi	ASi	Rank
Power output (kW)	0.40214	0.00000	0.20107	4
Jacket water inlet temperature (°C)	0.16204	0.57009	0.36606	3
Jacket water outlet temperature (°C)	0.15127	0.62800	0.38963	2
Jacket water mass flowrate (kg/s)	0.23572	0.12768	0.18170	5
Exhaust gases temperature (°C)	1.00000	0.55126	0.77563	1
Exhaust gases mass flow rate (kg/s)	0.24296	0.10937	0.17617	6

Table 7 shows the Final Result of Evaluation of Internal Combustion Engine (ICE) using the Analysis for EDAS Method. NSPi in Entrepreneurs is calculated using the Exhaust gases temperature (°C) is having is Higher Value and Jacket water outlet temperature (°C) is having Lower value. NSNi in calculated using the Jacket water outlet temperature (°C) is having is Higher Value and Power output (kW) is having Lower value. ASi in calculated using the Exhaust gases temperature (°C) is having is Higher Value and Exhaust gases mass flow rate (kg/s) is having Lower value. Exhaust gases temperature (°C) is got first rank and Exhaust gases mass flow rate (kg/s) is got lowest rank.

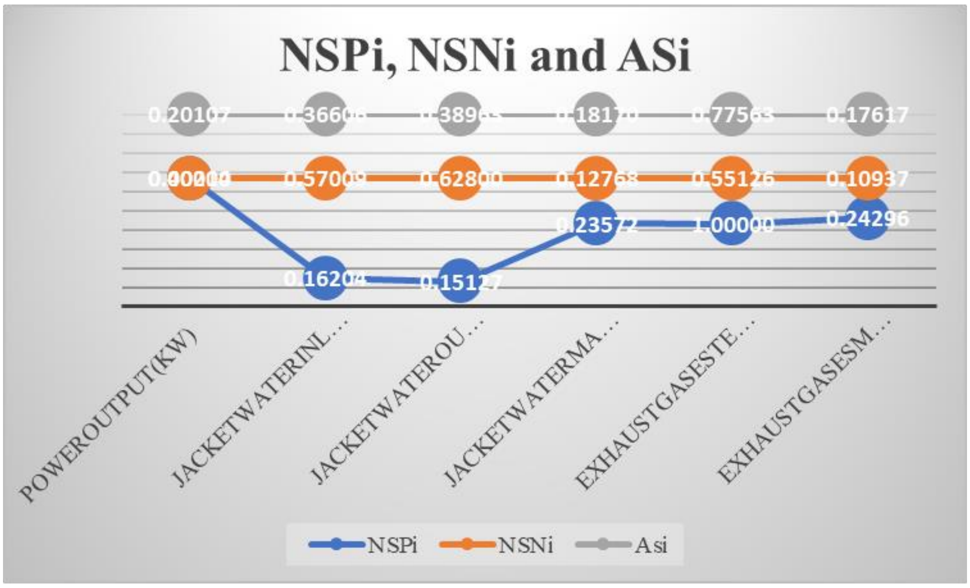

FIGURE 5. NSPi, NSNi and ASi

Shows the figure 5 Final Result of Evaluation of Internal Combustion Engine (ICE) using the Analysis for EDAS Method. NSPi in Entrepreneurs is calculated using the Exhaust gases temperature (°C) is having is Higher Value and Jacket water outlet temperature (°C) is having Lower value. NSNi in calculated using the Jacket water outlet temperature (°C) is having is Higher Value and Power output (kW) is having Lower value. ASi in calculated using the Exhaust gases temperature (°C) is having is Higher Value and Exhaust gases mass flow rate (kg/s) is having Lower value.

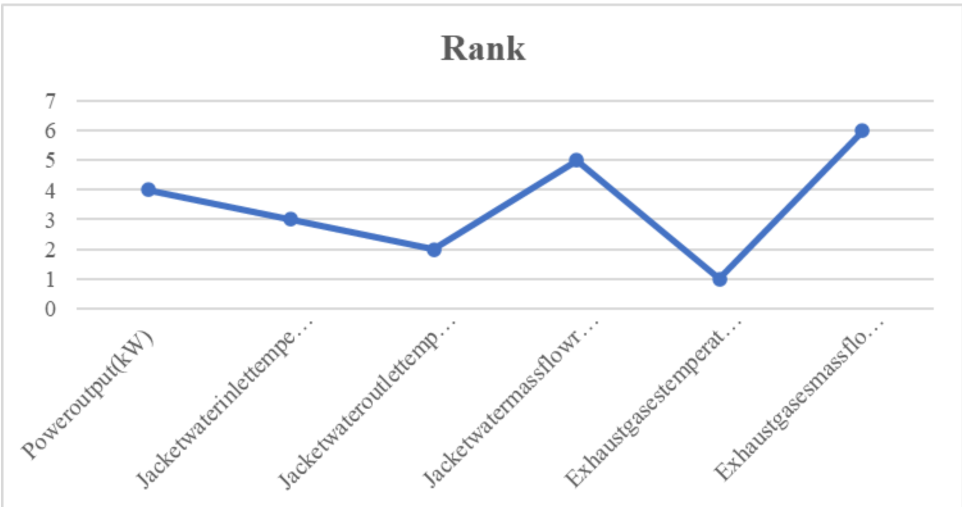

FIGURE 6. Final Result of ranking

Shows the figure 6. Internal Combustion Engine (ICE) using the Analysis for EDAS Method. Exhaust gases temperature (°C) is got first rank and Exhaust gases mass flow rate (kg/s) is got lowest rank.

5. CONCLUSION

In this study, a model for ICE-based home systems. in particular with electrical and thermal storage is created using the ESP-r structure simulation tool. The model includes two operational scenarios for the control of ICE and heat and power storage. The model can be used as a technology development tool for analysing and optimising system design variables as well as performing technical and commercial examination of ICE-based cogeneration systems. The functionality and adaptability of the model were demonstrated by the model results that were acquired utilising the model. The findings highlight the significance of ICE size, the effectiveness of heat and energy storage systems, as well as the operational perspective on the system dynamic performance in a specific application. The results of the indicates the proposed based on changing the percentages of the qualification clearly demonstrate that even when the balances of the qualities or criteria are changed, the recommended EDAS solution is very stable. The four fictitious/simulated weight sets produce overall ranking patterns that are extremely similar to one another. Even in a rapidly changing world, the approach's constancy and steadiness are confirmed by a sensitivity analysis under the influence from dynamic decision matrices. The rank turnaround does not happen, even if the original decision matrix is changed. The key benefit of the suggested approach is that it skips the difficult step of calculating the ideal and nadir solutions, in contrast to TOPSIS (and some other levels of MCDM, such VIKOR). Additionally, the suggested EDAS model is extremely adaptable, straightforward, and mathematically sound, allowing it to be used to solve additional multi-criteria decision analysis problems. Exhaust gases temperature (°C) is got first rank and Exhaust gases mass flow rate (kg/s) is got lowest rank

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