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Evaluation of Motor Vehicles Using the Weighted Product Model Method

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ABSTRACT

A motor vehicle refers to any self-propelled vehicle built for transporting passengers or goods on roadways. Typically powered by internal combustion engines or electric motors, motor vehicles encompass cars, trucks, motorcycles, and buses. They are essential to modern life, providing convenient and efficient transportation and supporting both personal mobility and economic activities such as freight transport. Technological advancements have resulted in hybrid and electric vehicles, which seek to lower emissions and reduce reliance on fossil fuels. Motor vehicles play a crucial role in research across various fields, significantly impacting transportation, environmental studies, and urban planning. Their importance lies in their contribution to mobility and economic development. Research on motor vehicles helps to study traffic patterns, leading to the creation of traffic management systems that improve safety and reduce congestion. Environmental studies, on the other hand, focus on the impact of motor vehicles, particularly concerning greenhouse gas emissions and air quality, to inform policies that encourage cleaner alternatives like electric and hybrid vehicles, addressing issues like climate change and pollution. " While various normalization methods can be applied in WSM, the results can vary depending on the chosen method. In contrast, the WPM eliminates the need for normalization by using multiplication rather than addition to combine the data. Toyota Corolla, Honda Civic, Ford Focus, and Hyundai Elantra, Tesla Model 3, Mazda 3, Volkswagen Golf, Chevrolet Cruze. Fuel Efficiency (km/L), Safety Rating, Comfort, Resale Value (%), Price ($) CO2 Emission (g/km), Maintenance Cost ($/Year). The findings indicate that Volkswagen achieved the highest rank, whereas Hyundai was placed at the lowest.

1. INTRODUCTION

Injuries from motor vehicle accidents can lead to significant psychological issues, which are not necessarily linked to the severity of the physical injuries. Early signs of emotional and post-traumatic symptoms often predict ongoing challenges after one year. Motor vehicle accidents often lead to the development of post-traumatic stress disorder (PTSD)disorder resulting from traumatic stress. Although much of the research has concentrated on PTSD, there is also evidence of travel-related phobic anxiety, affecting individuals whether they are drivers or passengers, is both widespread and debilitating. Although several studies have examined the progression of symptoms within the first-year post-injury, little is known about long-term outcomes. Research has shown that travel anxiety is prevalent even five years after an accident and is often accompanied by significant changes in driving behavior. Additionally, other forms of trauma suggest that PTSD can have a prolonged course, though many individuals experiencing initial distress may improve quickly.[1] The authors sought to identify the predictors of one-year outcomes for patients who received treatment in a hospital emergency

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department following motor vehicle accidents, while also investigating the prevalence and progression of four types of psychiatric outcomes. Their study focused on consecutive patients aged 17 to 69 treated at a general hospital emergency department after such accidents. The four psychiatric outcomes observed were found to overlap, persist, and have distinct early predictors. This study specifically explores the range of psychiatric effects in individuals who experienced trauma from motor vehicle accidents and sought emergency care. The research provides insight into the relationship between these psychiatric results over a one-year period in a sizable patient sample involved in motor vehicle, bicycle, or pedestrian accidents..[2] Patients who came to the Accident and Emergency Department at John Radcliffe Hospital in Oxford following a motor vehicle accident—including vehicle occupants, motorcyclists, cyclists, and pedestrians—were invited to participate in the study and received a questionnaire either by mail or in person. Thirteen baseline factors were assessed, such as gender, hospital admission status, injury severity, accident type, prior confidence as a passenger, history of motor vehicle injuries, frequency of road use, past emotional issues, tendency to worry, and four immediate reactions to the accident (dissociation, self-blame, fear, and negative emotions). Injury severity was classified as either no injury or soft tissue injury. The findings emphasize the complex psychological effects of a motor vehicle accident, independent of any physical injuries. [3] Motor vehicles significantly contribute to the emissions of carbon dioxide, carbon monoxide, volatile organic compounds, nitrogen oxides, and particulate matter. In this study, the license plates of a specified number of vehicles passing through the tunnel each hour were recorded and compared with vehicle registration data from the California Department of Motor Vehicles. Motor vehicle emissions are influenced by engine load, with emission factors based on distance showing greater variability compared to those based on fuel consumption.[4] In the context of rising healthcare costs and efforts to contain expenses, accurately predicting who is vulnerable to developing a mental disorder" such as post-traumatic stress disorder (PTSD), can help allocate early intervention resources effectively. Given that PTSD is often triggered by highly stressful or traumatic events, identifying individuals likely to develop the disorder could lead to better use due to limited mental health resources. This paper outlines our attempts to identify potential predictors of short-term PTSD. development in individuals who have experienced motor vehicle accidents (MVAs) requiring medical care due to their severity. [5This paper utilizes state-level data from 1987 and least-squares regression to develop a model for motor vehicle fatalities in the United States. The model includes various factors previously studied in cross-sectional analyses of these deaths. The results indicate that income, the urban-to-rural driving ratio, funding for highway police and safety measures, motor vehicle inspection regulations, and adult seat belt laws with secondary enforcement are all negatively associated with motor vehicle death rates. In contrast, factors such as driving volume, speed, speed variability, driving density, alcohol consumption, temperature, and a variable representing western states show a positive correlation with these rates. [6] Studies on motor vehicle accidents have been carried out nearly since the introduction of the automobile. However, with a few exceptions, the methods and models used for investigation and reporting have not been adequately developed or applied to reliably identify the true direct causes of motor vehicle collisions.[7]A pilot survey involving participants indicated that a certain percentage did not drive during the specified period. According to the principles of conditional probability, this level of intermittent driving could inflate the perceived link between cellular phone use and motor vehicle accidents by a specific factor. Even if a causal relationship between phone use and accidents were confirmed, drivers remain susceptible to other distractions that could counteract any risk reduction achieved by reducing phone usage.[8] Furthermore, emissions from brake wear, tire wear, and resuspended road dust are associated with motor vehicle activity. The viewpoints presented in this paper do not necessarily represent those of HEI, nor do they reflect the opinions or policies of the EPA or manufacturers of motor vehicles and engines.[9] During the last 25 years, the United States has allocated billions of dollars to initiatives aimed at reduce emissions from both new and existing motor vehicles. This initiative has been especially effective for new vehicles, which now emit less than 4% of the hydrocarbons (HC) and carbon monoxide (CO) produced by those made before the introduction of emission control measures. [10] During the last decade, many epidemiological Research has aimed to explore the relationship between exposure to motor vehicle emissions and respiratory health. These studies have utilized various methodological approaches, including case-control, cross-sectional, and ecological designs.[11] In urban environments, motor vehicles significantly contribute to emissions of non-methane hydrocarbons (NMHC), nitrogen oxides (NOx), and carbon monoxide (CO). This study employs a fuel-based method to estimate motor vehicle emissions, assessing on-road vehicle activity based on fuel consumption instead of distance traveled, with emission factors calculated per unit of fuel consumed.[12]Motor vehicle accidents are a the primary cause of death among children, adolescents, and young adults aged 5 to 24, with more than 14,000 fatalities recorded in Japan according to vital statistics. Research indicates that seat belt legislation increases seat belt usage, resulting in a decrease in injuries and fatalities from motor vehicle accidents.[13]It is only in recent years that highway safety researchers have concentrated their efforts on developing models specifically aimed for forecasting motor vehicle crashes (refer to Oh et al., 2003; Xie et al., 2007).Due to the novelty of this research focus, there are currently very few effective methods available for accurately predicting motor vehicle accidents.[14]Drivers who test positive for marijuana or report using it are over twice as likely to be involved in motor vehicle accidents compared to other drivers. This elevated crash risk associated with marijuana use is consistently observed across various studies, regardless of geographic region, driver populations, research methods, or the techniques used to measure marijuana consumption.[15] Until recently, much of the literature has focused on estimating models of overall motor vehicle demand, typically using national time series data. Within this framework, the stock adjustment concept, first introduced by Chow, has played a key role.[16] In the United States, motor vehicle emission standards are explicitly defined by clean air laws and various government regulations. Aim to reduce car usage for specific activities, such as commuting. However, estimating the pollution costs from motor vehicles can play an important role in shaping broader pollution control policies. Road dust was not included as a motor vehicle emission in this analysis, partly because its emissions data is considered particularly unreliable and is currently under review.[17]A web-based survey was conducted with 2,737 interns, representing 80% of those who received it They provided a total from 19, 740 monthly reports documenting their work hours, motor vehicle crashes, near misses, and instances of involuntary sleep. Demographically, the participants were similar to all interns matched through the National Resident Matching Program in 2002. with slightly more than half identifying as female. [18] The study outcome, as established from the accident report file, was defined as a cohort member being involved as a driver in a motor vehicle crash in which at least one person, who may not necessarily be the driver, was impacted incurred bodily injury. Police complete accident report forms for all crashes that result in injury or property damage of $500 or more.[19]

2. MATERIAL AND METHODS

Alternatives:

- Toyota corolla: The Toyota Corolla is a compact vehicle recognized for its dependability, fuel economy, and cost-effectiveness. It enjoys worldwide popularity and comes equipped with contemporary features, safety measures, and hybrid alternatives for environmentally aware drivers.
- Honda Civic: The Honda Civic is a compact automobile celebrated for its athletic design, fuel economy, and dependability. It provides modern features, a cozy interior, and is available in both sedan and hatchback formats.
- Ford Focous: The Ford Focus is a compact vehicle that combines performance, fuel economy, and technology. Renowned for its nimble handling, it is available in both hatchback and sedan versions, equipped with modern features.
- Hyundai Elantra: The Hyundai Elantra is a compact sedan recognized for its stylish design, fuel economy, and cutting-edge technology. It provides a comfortable cabin, safety features, and hybrid variants for environmentally conscious driving.
- Tesla model3: The Tesla Model 3 is an electric sedan that delivers remarkable range, advanced technology, and rapid acceleration. Celebrated for its minimalist design, it includes autonomous driving features and operates with zero emissions.
- Mazda model3: Mazda is a Japanese car manufacturer recognized for its elegant designs, engaging driving experience, and innovative Skyactiv technology. Mazda vehicles provide fuel efficiency and performance while delivering a premium feel, emphasizing both comfort and sporty attributes.
- Volkswagen golf: The Volkswagen Golf Mk3, launched in the early 1990s, is a compact vehicle celebrated for its practicality, dependability, and comfort. It included enhanced safety features, better fuel efficiency, and came in

several trims, including GTI variants.

- Chervolet cruzeThe Chevrolet Cruze is a compact vehicle recognized for its fuel economy, contemporary design, and advanced safety features. It provides a comfortable driving experience, tech-friendly interiors, and is available in both sedan and hatchback formats.

Evaluation Preference:

- Fuel Efficiency (km/LFuel efficiency indicates how effectively a vehicle utilizes fuel to cover a specific distance. Enhancing fuel efficiency lowers fuel consumption, emissions, and expenses, which is advantageous for both the environment and drivers.
- Safety Rating: Safety ratings assess a vehicle's ability to withstand crashes and its protective features. Organizations such as the NHTSA and IIHS perform tests and provide scores, assisting consumers in selecting safer cars and minimizing the risks of accidents and injuries.
- Comfort: Comfort in vehicles encompasses seat design, cabin space, climate control, noise insulation, and ride smoothness. It improves the driving experience and passenger satisfaction, making long journeys more enjoyable and less exhausting.
- Resale Value (%):Resale value indicates how much a vehicle holds its worth as time passes. Factors such as brand reputation, maintenance history, mileage, and market demand affect this value, making it an important consideration for buyers.
- Price ($) CO2 Emission (g/km): Price CO2 emissions pertain to the costs linked to the release of carbon dioxide into the atmosphere, usually through carbon pricing approaches like carbon taxes or cap-and-trade systems, aimed at encouraging reductions in emissions.
- Maintenance Cost ($/Year): Maintenance cost per year denotes the annual expenditures for the upkeep, repairs, and routine servicing of equipment, machinery, or infrastructure, ensuring optimal performance and avoiding expensive breakdowns.

3. WEIGHTED PRODUCT MODEL

The objective of this study is to improve the employee recruitment process to better align with the company's standards. The research utilizes the Weighted Product Model as its methodology, offering an alternative framework for decision-making in recruitment activities. This approach enables companies to identify candidates who meet the specified criteria and demonstrate high job performance. The model takes into account various essential criteria for the employee selection process, offering alternative decisions that support recruitment in line with the company's requirements. It employs a multiplicative method for linking the attribute ratings, where each rating is elevated to the power of its respective weight. This method ultimately helps companies find employees that meet the necessary criteria.[20] The next steps involve data collection and analysis. This study uses employee data from PT. X for the year 2017, as the company encounters challenges in its recruitment process. After determining the required number of employees, the subsequent step is to evaluate candidate suitability using the Weighted Product Model (WPM). The initial stage of WPM entails identifying and assigning weights to the criteria based on job requirements. WPM features a limited selection of decision alternatives defined by various criteria. The decisions can be arranged in a matrix format, with each row representing a specific candidate and each column reflecting the relevant attributes. [21] Once the required number of employees is determined, the next step is to evaluate candidate suitability using WPM. The initial phase of WPM involves identifying the criteria and assigning weights based on job requirements. WPM includes a limited set of decision alternatives defined by various criteria. These decisions are organized in a matrix format, where each row represents a candidate and each column corresponds to the specified attributes. [22] The multi-criteria decision analysis (MCDA) method is used to tackle decision-making problems involving multiple criteria. In our proposed approach, we utilize the Weighted Product Model (WPM) to address challenges in routing decision-making. To assign dynamically weights to each criterion, we incorporate the Relative Rating method. Although MCDA has found applications in various fields, its use in wireless sensor network (WSN) routing has been limited.[23] MCDA has been effectively utilized in Geographical Information Systems (GIS) to tackle the challenges of making precise spatial and policy decisions. It has also been used in content delivery networks. Earlier attempts focused on developing routing schemes based on multiple criteria; however, the weights assigned in those schemes were static, and the rationale for specific weight choices was not clearly articulated. This paper explores the application of a multi-criteria routing approach using the Relative Rating method within the framework of the Weighted Product Model.[24] The Weighted Product Model (WPM) is a multi-criteria decision-making (MCDM) method used to assess and rank alternatives based on multiple attributes. This model is especially beneficial in situations where decisions involve multiple conflicting criteria, allowing decision-makers to obtain a thorough assessment of the available options. The WPM is based on the principle that each alternative can be evaluated using various attributes, each assigned a specific weight that reflects its significance in the decision-making process. Unlike basic scoring methods that simply add scores, WPM employs a multiplicative approach, allowing the performance in one criterion to greatly impact the overall score.[25]To begin, relevant criteria for evaluating alternatives must be identified, which may include cost, quality, performance, reliability, and other pertinent factors Each criterion is given a weight that reflects its relative significance, ensuring that the total of all weights adds up to 1 to maintain a normalized scale. The values for each alternative across all criteria are normalized to ensure they are comparable. This is usually achieved by transforming each criterion's values into a common scale, typically ranging from 0 to 1. For each alternative, the weighted product score is determined by multiplying the normalized values of the criteria, with each one raised to the power of its assigned weight. The formula is expressed as [26] Ultimately, the alternatives are ranked according to their calculated scores. with one receiving the score deemed the most favorable. By incorporating multiple criteria, the WPM offers a comprehensive perspective on the options, facilitating more informed decision-making. It can handle both qualitative and quantitative data, making it adaptable for various applications. The model enables decision-makers to prioritize certain criteria through weighting, ensuring that essential factors significantly impact the results. The Weighted Product Model is utilized across various domains, including finance, healthcare, engineering, and environmental management. For instance, it can help evaluate investment opportunities, choose suppliers, assess project feasibility, or select products based on consumer preferences.[27] Although WPM is a robust decision-making tool, it does have limitations. The process of assigning weights can be subjective, which may introduce biases. Additionally, the model assumes that the criteria are independent, a condition that might not hold true in real-world situations. Moreover, if an alternative performs poorly on a highly weighted criterion, it could negatively impact its overall score, reducing its competitiveness despite strong performance in other areas. The Weighted Product Model serves as a valuable structure for systematically assessing alternatives based on various criteria. By assigning weights and using a multiplicative approach, WPM provides a detailed perspective on complex decisions, making it a crucial component of the decision-making toolkit. Its versatility across various fields further emphasizes its significance in today's complex decision-making landscape.[28]

STEP 1: Design of Decision Matrix and Weight Matrix

For an MCDM problem consisting of m alternatives and n criteria, let $D = x_{ij}$ be a decision matrix, where $x_{ij} \in \mathbb{R}$:

$$D = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

The weight vector may be expressed as:

$$w_j = [w_1, w_2, \ldots, w_n], \quad \text{where} \sum_{j=1}^{n} w_j = 1$$

STEP 2: Performance Score

The Weighted Product Model (WPM) is similar to the Weighted Sum Model (WSM). The MCDM problem is expressed in the form of Equation (1), and the weights are given by Equation (2). The benefit and cost criteria are normalized using Equation (3).

Finally, the WPM ranking score is calculated as:

$$S_i^{\text{wpm}} = \prod_{j=1}^{n} (n_{ij})^{w_j}$$

The alternatives are then arranged in decreasing order based on the WPM ranking score.

STEP 3: Weighted Normalized Decision Matrix

$$W_{nij} = w_j\, n_{ij}$$

STEP 4: Ranking of Alternatives

$$S_i^{\text{wsm}} = \sum_{j=1}^{n} w_j\, n_{ij}$$

where S_i^{wsm} is the ranking score of the i^{th} alternative, and w_j is the weight of the j^{th} criterion. The alternatives are then ranked in descending order, with the highest S_i^{wsm} ranked first.

4. RESULT AND DISCUSSION

TABLE 1. Weight Product Model

Vehicle ID Name	Fuel Efficiency (km/L)	Safety Rating	Comfort	Resale Value (%)	Price ($)	CO_2 Emission (g/km)	Maintenance Cost ($/Year)
Toyota Corolla	18	5	8	75	25000	180	1200.0
Honda Civic	15	4	7	70	22000	210	1100.0
Ford Focus	20	5	9	80	30000	160	1300.0
Hyundai Elantra	12	3	6	65	18000	240	900.0
Tesla Model 3	22	5	8	78	32000	150	1250.0
Mazda 3	17	4	7	68	24000	190	1000.0
Volkswagen Golf	19	5	9	85	28000	170	1150.0
Chevrolet Cruze	14	3	6	60	20000	220	950.0

This table 1 compares various vehicles on fuel efficiency, safety rating, comfort, resale value, and CO2 emissions. The Toyota Corolla and Ford Focus offer strong performance with good fuel efficiency and safety ratings, but the Ford Focus has the best fuel efficiency and lowest CO_2 emissions. The Tesla Model 3, while the most fuel-efficient and environmentally friendly, has a slightly lower resale value. The Hyundai Elantra, with the lowest fuel efficiency and highest CO_2 emissions, ranks lower overall. The Volkswagen Golf stands out with the highest resale value and comfort, but has moderate fuel efficiency and emissions.

The Figure 1 compares different vehicles based on fuel efficiency, safety rating, comfort, resale value, and CO_2 emissions. Fuel efficiency (in blue) shows Tesla Model 3 and Ford Focus outperform the rest, while Hyundai Elantra has the lowest. Safety ratings (in orange) are highest for most cars except the Hyundai Elantra and Chevrolet Cruze. Comfort (in gray) varies, with Ford Focus and Volkswagen Golf leading. Resale value (in yellow) is highest for Volkswagen Golf. CO2 emissions (in light blue) are lowest for Tesla Model 3 and Ford Focus, while Hyundai Elantra and Chevrolet Cruze have the highest emissions

This table 2 normalizes various vehicle attributes (fuel efficiency, safety rating, comfort, resale value, price, CO2 emissions, and maintenance costs) on a scale from 0 to 1. Tesla Model 3 scores the highest in fuel efficiency, safety, and CO2 emissions, while Hyundai Elantra ranks the highest for price and maintenance costs but scores lower in other areas. Ford

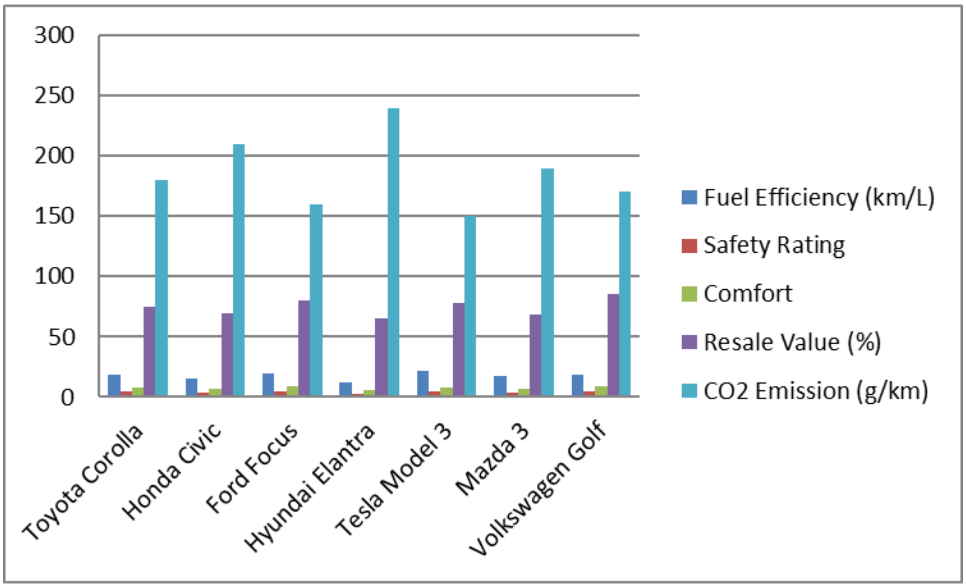

FIGURE 1. Weight product model

TABLE 2. Performance Value

Vehicle	Fuel Eff.	Safety	Comfort	Resale (%)	Price ($)	CO_2 (g/km)	Maint. ($/Yr)
Toyota Corolla	0.8182	1.0	0.8889	0.8824	0.72	0.8333	0.75
Honda Civic	0.6818	0.8	0.7778	0.8235	0.8182	0.7143	0.8182
Ford Focus	0.9091	1	1	0.9412	0.6	0.9375	0.6923
Hyundai Elantra	0.5455	0.6	0.6667	0.7647	1	0.625	1
Tesla Model 3	1	1	0.8889	0.9176	0.5625	1	0.72
Mazda 3	0.7727	0.8	0.7778	0.8	0.75	0.7895	0.9
Volkswagen Golf	0.8636	1	1	1	0.6429	0.8824	0.7826
Chevrolet Cruze	0.6364	0.6	0.6667	0.7059	0.9	0.6818	0.9474

Focus and Volkswagen Golf stand out with perfect comfort scores and high overall performance. Chevrolet Cruze and Hyundai Elantra, while affordable, rank lower in key areas like safety, comfort, and emissions. Overall, Tesla Model 3, Ford Focus, and Volkswagen Golf lead in sustainability and features.

The stacked bar chart titled “Performance Value” compares vehicles based on several factors: maintenance cost, CO_2 emissions, price, resale value, comfort, and safety rating. Each color represents a different category, allowing for easy comparison across vehicles.

Tesla Model 3 and Ford Focus show strong overall performance with lower CO_2 emissions and high resale value. Hyundai Elantra and Chevrolet Cruze, despite being cost-efficient, have lower safety ratings and higher emissions. Volkswagen Golf balances well across categories, with high comfort and resale value.

The chart visually demonstrates how each vehicle ranks in different aspects of performance and sustainability.

The table 3 presented shows a uniform weighting system where each factor is assigned an equal weight of 0.25. This suggests that all the criteria being considered (e.g., fuel efficiency, safety rating, comfort, resale value, price, CO2 emissions, and maintenance cost) are equally important in the overall evaluation of the vehicles. Each vehicle’s performance across these factors would be averaged or combined using these weights, treating no single aspect as more significant than another. This approach is commonly used in decision-making models to ensure balanced consideration of multiple factors without bias toward any one criterion.

The table 4 "Weighted Normalized Decision Matrix" shown here represents a decision-making process where different criteria (like fuel efficiency, safety, comfort, etc.) have been normalized and weighted for comparison. Each value reflects

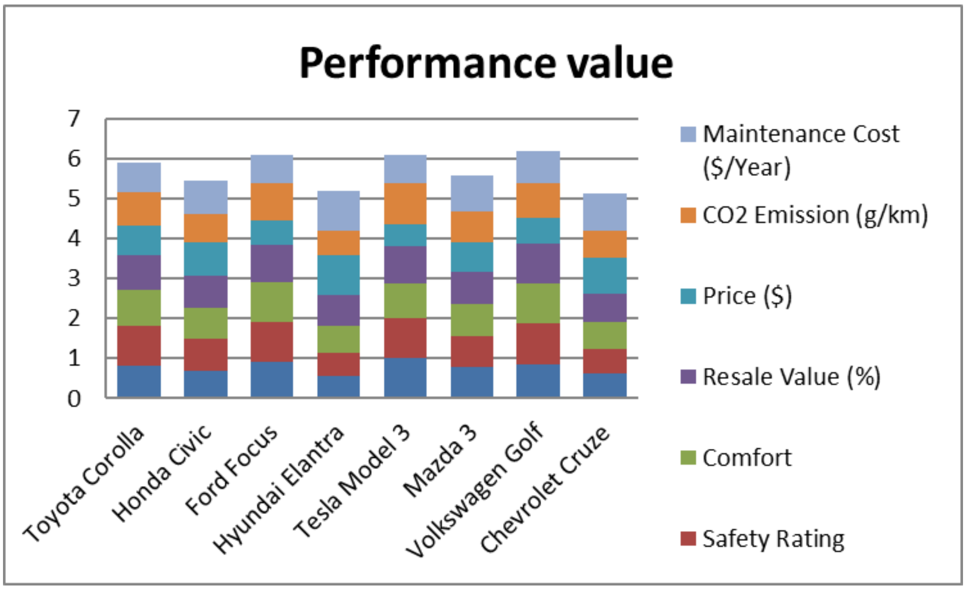

FIGURE 2. Performance value

TABLE 3. Weight

W1	W2	W3	W4	W5	W6	W7
0.25	0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25	0.25

how well a vehicle performs relative to others after applying weights to each criterion. A value of "1.00000" indicates the best performance in a given criterion, while lower values show lesser performance. For instance, Tesla Model 3 and Ford Focus perform well across many factors, while Hyundai Elantra and Chevrolet Cruze have lower scores in some areas. This matrix allows for clear comparison across multiple aspects using weighted averages.

The table 3" Decision Matrix with Weighted Normalization " bar chart compares vehicles based on multiple criteria, with each factor (maintenance cost, CO2 emissions, price, resale value, comfort, and safety rating) normalized and weighted. The chart highlights that all vehicles perform fairly similarly, with small differences in each category. Tesla Model 3, Ford Focus, and Volkswagen Golf generally perform well across most criteria, while Hyundai Elantra and Chevrolet Cruze have weaker performance in key areas like safety and emissions. By using weighted normalization, the chart allows for a balanced comparison, ensuring that no single factor dominates the decision-making process.

TABLE 4. Weighted Normalized Decision Matrix

C1	C2	C3	C4	C5	C6	C7
0.95107	1.00000	0.97098	0.96919	0.92116	0.95544	0.93060
0.90869	0.94574	0.93910	0.95262	0.95107	0.91932	0.95107
0.97645	1.00000	1.00000	0.98496	0.88011	0.98399	0.91217
0.85939	0.88011	0.90360	0.93513	1.00000	0.88914	1.00000
1.00000	1.00000	0.97098	0.97874	0.86603	1.00000	0.92116
0.93758	0.94574	0.93910	0.94574	0.93060	0.94262	0.97400
0.96401	1.00000	1.00000	1.00000	0.89542	0.96919	0.94056
0.89315	0.88011	0.90360	0.91661	0.97400	0.90869	0.98657

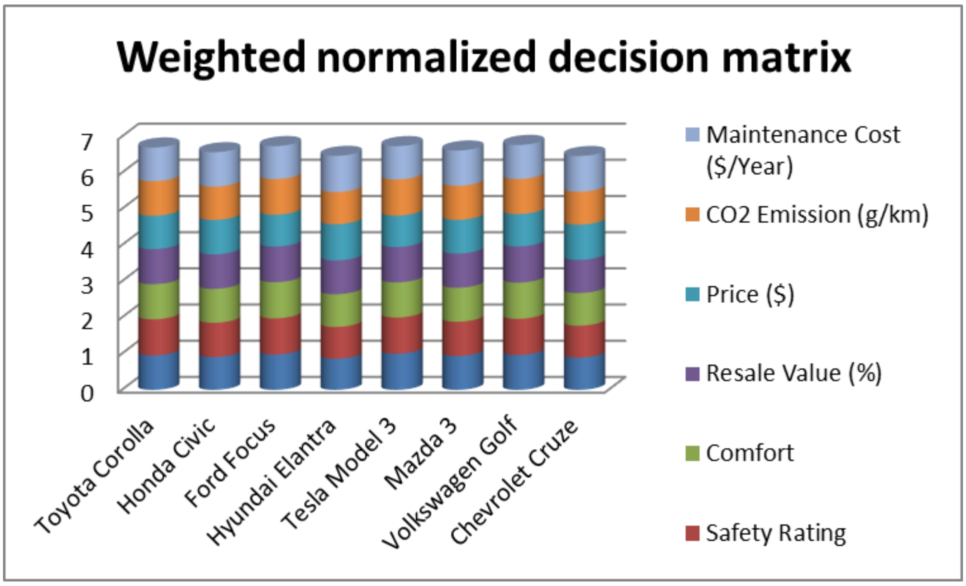

FIGURE 3. Weighted normalized decision matrix

TABLE 5. Preference Score

Vehicle	Preference Score
Toyota Corolla	0.733057
Honda Civic	0.639317
Ford Focus	0.759758
Hyundai Elantra	0.568262
Tesla Model 3	0.758132
Mazda 3	0.672862
Volkswagen Golf	0.786879
Chevrolet Cruze	0.568502

A Table 5 represents an individual's or group's affinity or liking for certain options, typically ranging from 0 to 1, where 1 indicates a strong preference. The given values represent different scores that quantify the strength of preference. Higher scores, such as 0.78688 or 0.75976, suggest a stronger preference for a particular option, while lower scores like 0.56826 indicate a weaker preference. These scores can be derived from various decision-making models or rating systems, such as in surveys, recommender systems, or multi-criteria decision analysis, reflecting how much a particular option is favored.

The figure 4 graph titled "Preference Score" compares various car models, showing how each scores in terms of user preference. The scores range from 0.5 to 0.8, with the Ford Focus and Volkswagen Golf achieving the highest preference scores, both around 0.8. The Chevrolet Cruze has the lowest preference score, just below 0.6. Other models, such as the Toyota Corolla, Honda Civic, and Tesla Model 3, hover around the 0.7 mark. The line graph displays fluctuations, with no steady increase or decrease across the models, reflecting varied user preferences for different cars.

TABLE 6. Rank

Vehicle	Rank
Toyota Corolla	4
Honda Civic	6
Ford Focus	2
Hyundai Elantra	8
Tesla Model 3	3
Mazda 3	5
Volkswagen Golf	1
Chevrolet Cruze	7

The table 6 list shows various compact cars ordered by preference or performance. The Volkswagen Golf holds the top

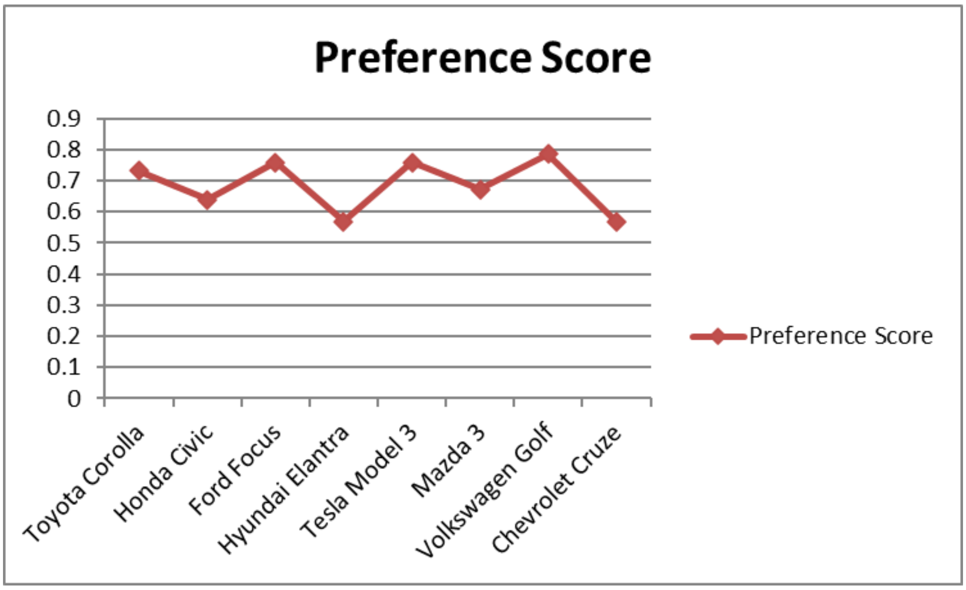

FIGURE 4. Preference Evaluation Score

spot (1), favored for its overall quality and versatility. The Ford Focus is in second place (2), appreciated for its driving dynamics. The Tesla Model 3 ranks third (3), known for its electric powertrain and advanced features. The Toyota Corolla is fourth (4), valued for its reliability. Mazda 3 (5) is ranked high for its driving experience. The Honda Civic (6) offers a balanced mix of performance and practicality. The Chevrolet Cruze (7) and Hyundai Elantra (8) follow, both offering good value but less favored.

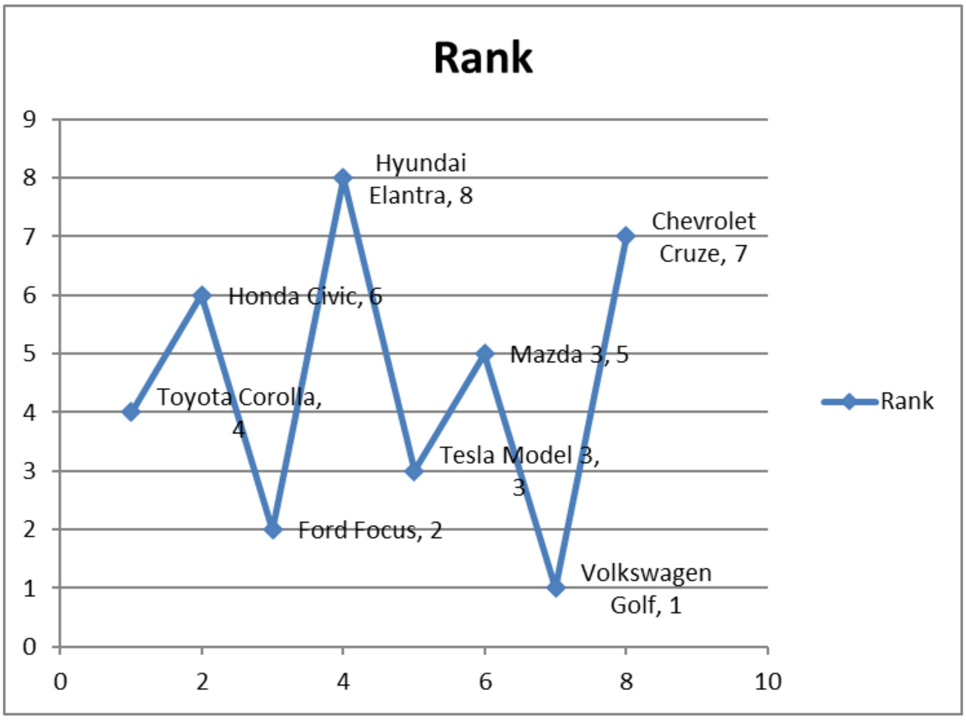

FIGURE 5. Rank

The table 5 graph shows the relative rankings of various car models, where a lower number represents a higher rank. Volkswagen Golf ranks the highest at 1, followed by Ford Focus at 2 and Tesla Model 3 at 3. Toyota Corolla takes the 4th place, while the Mazda 3 ranks 5th. The Honda Civic and Chevrolet Cruze hold 6th and 7th positions, respectively, with the Hyundai Elantra at the lowest rank of 8. The graph's sharp peaks and valleys indicate significant variations in rankings between the models.

5. CONCLUSION

Motor vehicles have become an essential component of modern life, transforming how people and goods are transported globally. Their development, from early steam-powered engines to today's advanced electric and autonomous vehicles, has significantly influenced the global economy, urban growth, and individual lifestyles. These vehicles provide convenience, freedom, and access to remote areas that would otherwise be challenging to reach. However, this progress also presents substantial challenges, particularly concerning environmental impact, safety issues, and social consequences. The motor vehicle is arguably one of the most impactful inventions of the 20th century, revolutionizing personal mobility and enabling individuals to travel long distances independently. This transformation has not only changed personal travel but also reshaped industries, created jobs, and spurred urbanization. Motor vehicles provide critical services through buses, taxis, ambulances, and delivery trucks, and they have played a vital role in globalization by facilitating trade and transport. However, motor vehicles also pose Although significant improvements have been made in safety technologies like airbags, anti-lock brakes, and electronic stability control, traffic accidents continue to be a major cause of injuries and fatalities around the globe. Contributing factors include driver error, poor road conditions, and vehicle malfunctions. In response, manufacturers are increasingly incorporating technologies for Advanced driver assistance systems (ADAS), such as lane departure warning, adaptive cruise control, and automatic emergency braking, aim to reduce accident rates. Autonomous vehicles have the potential to further improve road safety by eliminating human error, though concerns remain regarding the reliability of these technologies and the ethical dilemmas involved in decision-making during potential crash scenarios. Motor vehicles have had a profound impact on society, the economy, and the environment. While they provide many advantages, they also pose challenges related to environmental sustainability and safety. As technology progresses, particularly with a focus on electric and autonomous vehicles, the future of transportation appears to be moving toward greater efficiency, cleanliness, and safety. Nevertheless, overcoming existing challenges will require continuous efforts from governments, industries, and individuals alike.

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