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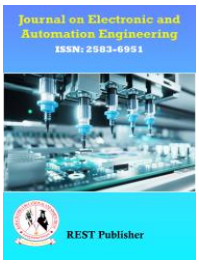

Optimization of Roadside Assistance Services: A MOORA-Based Performance Evaluation Framework for Vehicle Breakdown Management Systems

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Abstract. *The Vehicle Breakdown Assistance Management System (VBAMS) represents a comprehensive web-based solution designed to address the critical challenges faced by vehicle owners during mechanical emergencies. With the exponential growth in vehicular traffic and the inherent unpredictability of breakdowns, traditional assistance methods have proven inadequate, often leaving drivers stranded with limited, unreliable options. This study introduces VBAMS as a centralized digital platform that seamlessly connects distressed vehicle owners with verified, nearby mechanics through real-time, location-based services. The system architecture encompasses three distinct user roles: Users (vehicle owners), Mechanics (service providers), and Administrators (system controllers), each with specific functionalities to ensure coordinated breakdown assistance. Users can register, submit service requests using GPS-enabled location detection, browse verified mechanics with ratings and specializations, and provide feedback post-service. Mechanics undergo admin verification before gaining platform access, enabling them to manage availability and build credibility through user reviews. Administrators maintain system integrity by verifying mechanic credentials and monitoring platform activities. To evaluate existing roadside assistance providers, this research employs the Multi-Objective Optimization by Ratio Analysis (MOORA) method, analyzing eight major providers across six critical criteria: service coverage area, response time efficiency, service quality rating, annual membership cost, service call limitations, and wait time for support. The comparative analysis reveals USAA Roadside Assistance as the top performer with an assessment value of 0.1659, followed by AAA (0.0390) and GEICO (0.0236). VBAMS addresses market inefficiencies by providing transparency, accountability, and improved response times through digital integration. The platform's technical foundation utilizes PHP, MySQL, HTML, CSS, JavaScript, and Bootstrap framework, ensuring scalability and cross-device compatibility. This innovative solution transforms traditional roadside assistance by leveraging modern web technologies to create a reliable, accessible, and user-friendly emergency response system.*

Keywords: *VBAMS, MOORA, Roadside Assistance.*

1. INTRODUCTION

In the age of rapid urbanization and technological advancement, the number of vehicles on roads is increasing exponentially. With this growth comes an inevitable rise in vehicular malfunctions and breakdowns, often occurring in unpredictable and inconvenient circumstances. Whether on a busy city street, an isolated highway, or during adverse weather conditions, vehicle breakdowns can severely disrupt travel plans, cause undue stress, and, more critically, compromise the safety of both drivers and passengers. Traditionally, individuals encountering a vehicle malfunction have relied on a limited network of personal contacts, random roadside helpers, or laborious searches for local mechanics. These approaches are inefficient, unreliable, and highly variable in quality—especially in unfamiliar areas or during late-night emergencies. The need for a structured, dependable, and real-time solution for vehicle assistance has never been more vital. [1] The Vehicle Breakdown Assistance Management System (VBAMS) emerges as a modern response to these challenges. Designed as a centralized, web-based platform, VBAMS provides a seamless digital interface to connect stranded vehicle owners with verified, nearby mechanics. It transforms the traditional model of roadside assistance by offering users an organized, transparent, and secure means of requesting help in real time. With the growing accessibility of internet services and smartphone usage, this system capitalizes on digital connectivity to deliver prompt, location-based breakdown support to users whenever and wherever needed. The core aim of VBAMS is to eliminate the uncertainty and delays associated with conventional assistance methods, replacing them with a streamlined and user-friendly solution that leverages modern web technologies.[2] The automotive industry has led to a substantial

increase in the number of vehicles traversing roads around the world. While this growth has spurred convenience in transportation and enabled faster connectivity across regions, it has also introduced new challenges, especially with regard to vehicle reliability and road safety. Among these challenges, vehicle breakdowns have emerged as one of the most common and disruptive events encountered by drivers. Whether due to mechanical failure, flat tires, overheating, dead batteries, or unforeseen malfunctions, breakdowns are inherently unpredictable and often occur at the most inconvenient times. These events not only disrupt travel plans but can also pose serious risks to the safety and security of vehicle occupants. In particular, breakdowns occurring in isolated, unfamiliar, or high-risk environments can lead to elevated stress levels, delays, and potential harm. [3] Traditionally, when confronted with a vehicle breakdown, drivers have had limited options. They might attempt to fix the problem themselves, rely on the goodwill of passersby, contact known local mechanics, or search the internet for assistance—none of which guarantees timely or reliable service. The absence of a centralized system that can provide verified, accessible, and on-demand breakdown assistance exacerbates the situation. The inefficiencies of these traditional methods are especially pronounced in unfamiliar locales or during odd hours, where help may be scarce or entirely unavailable. This is further compounded by a lack of transparency in service quality, non-standard pricing, and minimal accountability on the part of roadside assistance providers. [4] With the advancement of digital technologies and the widespread adoption of mobile devices and internet connectivity, there arises an unprecedented opportunity to reimagine the way roadside assistance is provided. The Vehicle Breakdown Assistance Management System (VBAMS) is a comprehensive, web-based solution designed to bridge the critical gap between vehicle owners in distress and qualified mechanics in proximity. It offers a centralized platform that facilitates real-time, location-based assistance while ensuring service quality, transparency, and user satisfaction. By integrating digital technologies into roadside assistance workflows, VBAMS not only modernizes the support experience but also enhances safety, reduces response time, and improves the operational efficiency of service providers.[5] The primary goal of VBAMS is to develop a reliable, accessible, and easy-to-use platform that vehicle owners can depend on in times of mechanical emergencies. At its core, the system is structured around three key user roles: the User (vehicle owner), the Mechanic (service provider), and the admin (system administrator). Each role is defined by a distinct set of functionalities and responsibilities, ensuring that all aspects of the breakdown assistance process are well-coordinated and effectively managed. This role-based architecture promotes accountability and streamlines interactions across the platform.[6] The User module is designed to offer a seamless experience to individuals seeking help. Users can register with their personal and vehicle details and subsequently log in to access services. Once logged in, they can initiate a service request by entering their current location or allowing the system to detect it via browser-based geolocation services. The platform then displays a list of nearby, admin-approved mechanics, along with essential details such as their name, contact number, ratings, and service specializations. This enables users to make informed decisions while selecting a mechanic. Furthermore, users can directly contact the mechanic through the platform to request assistance. After the service is rendered, users are encouraged to provide feedback and rate the mechanic's performance. This feedback system contributes to the trustworthiness of the platform, promotes service quality, and informs future users about the reliability of mechanics.[7] The Mechanic module caters to the needs of service providers who wish to offer their skills via the platform. Mechanics can register by submitting their credentials, service areas, and professional background. However, their profiles are not made visible to users until they have been verified and approved by the system administrator. Once approved, mechanics gain access to a dashboard where they can view service requests in real time, manage their availability, and review feedback from previous jobs. This module not only provides a structured digital presence for mechanics but also opens up opportunities to reach a wider customer base, thereby boosting their business and reputation. The ability to receive feedback allows mechanics to continuously improve their services, address shortcomings, and build credibility within the system.[8] The Admin module serves as the control center of the platform. It is responsible for maintaining the integrity and smooth operation of the system. Admins verify mechanic registrations, ensuring that only competent and trustworthy service providers are listed. They also monitor user and mechanic activities, review feedback submissions, and address disputes or complaints. The admin dashboard provides insights into system performance, including service request trends, feedback analytics, and user statistics. By exercising oversight, the Admin module ensures that the platform remains secure, efficient, and reliable for all stakeholders.[9] One of the most significant features of VBAMS is its use of location-based services to improve response time and convenience. The system employs GPS and browser geolocation APIs to identify a user's current location and match them with mechanics in the nearby area. This eliminates the need for manual location entry and ensures that users are connected with the most relevant and accessible service providers. It is particularly valuable in emergency situations where time is of the essence, and users may not be in a state to describe their location accurately.[10] The technical architecture of VBAMS is designed to support scalability, modularity, and ease of maintenance. It utilizes PHP for backend development, managing the business logic and server-side processes. MySQL is employed as the relational database system, handling the storage of user records, mechanic profiles, feedback entries, and service histories. The front-end interface is built using HTML, CSS, JavaScript, and the Bootstrap framework, ensuring a responsive and visually appealing experience across all screen sizes and devices. The system is hosted in a local

development environment using tools such as XAMPP or WAMP, though it can be easily migrated to cloud infrastructure for broader deployment. Security features include input validation, session management, and authentication protocols to prevent unauthorized access and safeguard sensitive data.[11] From a functional perspective, the platform encompasses all the necessary capabilities to facilitate effective breakdown assistance. These include user registration and login, location-based search, service request initiation, real-time mechanic availability updates, direct calling functionality, and a feedback mechanism. Non-functional requirements such as usability, reliability, scalability, performance, and maintainability are also addressed through thoughtful design choices. For instance, the interface is optimized for minimal input during emergencies, ensuring that users can access critical services with just a few clicks.[12]

FIGURE 1. Vehicle Breakdown Assistance Management System

The need for a system like VBAMS is underscored by the widespread inefficiencies of current roadside assistance practices. In many regions, especially rural or underdeveloped areas, vehicle owners face considerable delays in finding help. Even in urban centers, the lack of a reliable and centralized assistance network can lead to prolonged wait times, high service charges, and unsatisfactory outcomes. The absence of verification mechanisms means that users may fall victim to fraudulent or unqualified service providers. Furthermore, mechanics without digital visibility struggle to reach potential clients, leading to underutilization of available services. VBAMS tackles these issues head-on by creating a trusted, transparent, and easily navigable environment that brings together all stakeholders on a single platform.[13] VBAMS extend beyond the immediate resolution of breakdown incidents. For users, the system instills a sense of confidence and preparedness, knowing that reliable help is readily accessible. It minimizes the disruption caused by vehicle failures and ensures that assistance is received promptly and professionally. For mechanics, the platform acts as a digital marketplace, expanding their reach and enabling consistent client acquisition. The feedback loop encourages service excellence and promotes fair competition. For administrators and system developers, VBAMS serves as a robust framework that can be extended with new features and integrated with complementary services such as towing, insurance support, and spare part delivery.[14] Looking to the future, the potential for enhancement and expansion is vast. VBAMS can evolve into a full-fledged mobile application with native support for Android and iOS platforms, providing an even more responsive and user-centric experience. Real-time GPS tracking, live location sharing, in-app messaging, and emergency SOS buttons can further improve user safety and communication. Integration with cloud platforms such as AWS or Firebase can enhance scalability, uptime, and data management capabilities. Payment gateway integration would allow for seamless transactions between users and mechanics. Additionally, multilingual support and accessibility features can ensure inclusivity for users across different geographies and abilities. Strategic partnerships with automobile manufacturers, insurance companies, and emergency services can create a comprehensive vehicle assistance ecosystem.[15] The Vehicle Breakdown Assistance Management System is a timely and innovative solution that addresses a critical need in modern transportation. By leveraging digital tools and user-centric design, it offers a reliable, transparent, and efficient alternative to traditional roadside assistance methods. Its modular architecture, real-time functionality, and emphasis on service quality position it as a transformative force in the automotive service industry. As the system continues to evolve, it holds the promise of not only improving the immediate breakdown experience for drivers but also reshaping the broader landscape of vehicular support and mobility solutions.[16]

2. MATERIALS AND METHODS

Materials (Alternative and Evolution Parameter)

1. AAA (American Automobile Association)

AAA is one of the oldest and most trusted names in roadside assistance. Founded in 1902, AAA offers comprehensive emergency services including towing, battery jump-starts, lockout services, tire changes, and fuel delivery. Membership plans vary by region and typically include Classic, Plus, and Premier levels, each with increasing benefits. AAA also provides members with travel discounts, insurance services, and travel planning tools, making it a well-rounded option for frequent travelers.

2. GEICO Emergency Roadside Service

GEICO offers affordable roadside assistance as an add-on to its auto insurance policies. This service includes towing (to the nearest repair facility), battery jump-starts, flat tire changes, lockout services, and fuel delivery. Unlike AAA, GEICO does not offer a stand-alone roadside membership—you must be a GEICO auto insurance policyholder to access this benefit. It's a convenient and cost-effective solution for those already insured with GEICO.

3. Allstate Motor Club

Allstate Motor Club provides roadside assistance not only to Allstate policyholders but also to non-policyholders through stand-alone plans. Services include towing, lockout assistance, jump-starts, tire changes, and trip interruption coverage. Their plans also offer perks like travel discounts and arrest bond coverage. Allstate's Motor Club has been around for decades and is recognized for its solid customer service and plan flexibility.

4. Good Sam Emergency Road Service

Geared primarily toward RV and camper owners, Good Sam offers specialized roadside assistance that accommodates the unique needs of large vehicles. Their coverage includes towing to the nearest service center, flat tire service, battery jump-starts, emergency fuel and fluid delivery, and trip interruption assistance. Good Sam's plans are ideal for people who frequently travel in RVs or trailers, but they also offer plans for standard vehicles.

5. USAA Roadside Assistance

USAA provides roadside assistance as an optional service with its auto insurance policies. Designed for military members and their families, USAA offers help with towing, jump-starts, flat tires, lockouts, and fuel delivery. The service is reasonably priced and known for its customer service excellence. However, availability is limited to USAA insurance customers, who must meet eligibility requirements related to military service.

6. Progressive Roadside Assistance

Progressive offers roadside assistance as an optional feature with its auto insurance plans. It includes towing, winching, battery jump-starts, fuel delivery, and lockout services. The coverage is affordable and integrates seamlessly with Progressive's digital tools, such as mobile app access and online claims. This makes it a convenient choice for tech-savvy users who want to manage everything from their phone.

7. State Farm Roadside Assistance

Available as an add-on to State Farm's auto insurance, this service includes towing, tire changes, fuel delivery, lockout service, and jump-starts. Customers can file roadside claims through the mobile app, online portal, or by phone. State Farm's service is basic compared to AAA or Good Sam, but it's reliable and typically inexpensive for policyholders.

8. OnStar Guardian

OnStar Guardian is a modern, app-based service provided by General Motors. It offers roadside assistance, emergency services, and location sharing via a mobile app, making it available even if you're not driving a GM vehicle. Services include towing, lockout assistance, fuel delivery, and battery jump-starts. It's especially appealing for families who want to track and assist loved ones via smartphone.

1. Service Coverage Area (Scale: 1–10)

This criterion measures the geographical breadth of a provider's network—essentially, how many locations the service covers and how available it is across urban and rural areas. A higher score means that the provider can reach customers in more places, which is crucial for travelers or those living in remote regions. For example, AAA tends to score high in this area because of its extensive nationwide network of affiliated service providers.

2. Response Time Efficiency (Scale: 1–10)

This measures how quickly help arrives once a service call is placed. Fast response times can reduce stress during a roadside emergency and indicate operational efficiency. A higher score here reflects a company's ability to dispatch help promptly—often influenced by fleet size, local partnerships, and technology integration like GPS tracking. Services with mobile apps that allow real-time updates typically perform better in this category.

3. Service Quality Rating (Scale: 1–10)

This is based on customer satisfaction and the perceived quality of service provided. It takes into account user reviews, reliability of service, professionalism of technicians, and whether issues are resolved successfully. A high rating in this category shows that users trust the service and have had consistently positive experiences. Companies like USAA and AAA often score well due to their longstanding reputations and customer-focused service models.

4. Annual Membership Cost (Scale: 1–10)

This metric evaluates the affordability of a provider's yearly membership or policy add-on. A lower score means a lower cost, which is more appealing to budget-conscious consumers. For example, adding roadside assistance to a GEICO or Progressive auto insurance policy is often less expensive than subscribing to a stand-alone service like AAA or Good Sam, resulting in lower scores for cost.

5. Service Call Limitations (Scale: 1–10)

This refers to restrictions on the number or type of service calls allowed per year. Lower scores in this category mean fewer limitations, giving users more flexibility and peace of mind. Services that limit the number of tows or lockout calls per year would score higher (worse) in this area. Unlimited or generous call allowances will score low, which is better from the customer's perspective.

6. Wait Time for Support (Scale: 1–10)

This measures how long it typically takes to get through to customer service when help is needed. Long hold times or poor customer service access can be very frustrating during emergencies. A lower score here indicates shorter wait times and more responsive customer support. Services with well-staffed call centers and efficient digital platforms (e.g., live chat, app-based support) tend to perform better.

MOORA (Multi-objective Optimization on the basis of Ratio Analysis): The Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method employs ratio-based calculations using dimensionless values as an initial optimization approach. When applied across various Lithuanian regions, this technique effectively assesses differences in objectives among ten districts. The analysis reveals that three districts perform well due to their economic strength, while economically disadvantaged districts show markedly different results. Worker movement between regions plays a significant role, as it can create economic disparities that might require interventions such as automated wealth redistribution or policies to limit migration. Alternatively, regions could pursue industrial development and commercial expansion as strategies for economic advancement. [17] The MOORA (Multi-Objective Optimization by Ratio Analysis) method serves as a valuable tool for handling situations where multiple objectives conflict with each other in optimization problems. This technique finds application across diverse fields including manufacturing processes, design optimization, environmental decision-making, and scenarios requiring balance between competing priorities. MOORA's significance within Multi-Criteria Decision-Making (MCDM) frameworks stems from three key advantages. It enhances traditional MCDM methods through sophisticated factor organization and structuring. The approach addresses computational efficiency concerns that commonly arise in MCDM research and practice. Additionally, MOORA demonstrates remarkable efficiency by minimizing both processing time and computational resource requirements. Beyond industrial applications, MOORA proves valuable in academic contexts. It can support automated assessment systems and selection processes, helping institutions rank students using multiple evaluation criteria when awarding scholarships or making university admissions decisions. This versatility makes MOORA particularly useful for educational administrators dealing with complex selection processes involving numerous competing factors. [18] MOORA serves as an adaptable and effective method for addressing complex scenarios involving

multiple attributes, criteria, and conflicting goals. This technique systematically approaches multi-criteria optimization challenges that typically require finding balance among contradictory requirements. The method proves particularly valuable for managing intricate and competing objectives because it can accommodate various attributes of different importance levels. Its straightforward nature and flexibility make it a practical choice across diverse applications. However, it's worth noting that MOORA may have limitations in addressing certain types of disruptions or uncertainties. [19] MOORA (Multi-Objective Optimization on the Basis of Ratio Analysis) is an effective method for solving optimization problems with multiple conflicting objectives. It balances competing factors and handles complex supply chain challenges well. The technique is versatile and applicable to various scenarios like supplier selection, system design, evaluations, and finding optimal solutions. MOORA can also be adapted for failure analysis by ranking failures based on severity and impact. Its extensions incorporate uncertainty analysis through different analytical approaches. The method provides practical, realistic results for decision-makers and demonstrates superior performance compared to traditional optimization techniques. [20] Upon detailed analysis, the MOORA method demonstrates high effectiveness. Both MOORA and MOOSRA methods are valuable for selection processes using current data and satisfy decision-making requirements, proving reliable in production settings. Compared to benefit-cost ratios, these models deliver superior financial performance. [21] MOORA and MOOSRA methods offer sophisticated performance evaluation frameworks that merge attitudinal factors with key features from Rate Engine and Reference MOORA components. These approaches were tested through detailed simulations covering port planning, objective setting, alternative categorization, and priority evaluation. The methods serve various stakeholders including businesses and government entities at multiple levels, with particular attention to sovereignty concerns in consumer production matters. [22] Legal interpretations by customers and officers can be subjective and prone to errors. The MOORA decision-making method addresses CNC device evaluation challenges by managing uncertain data through linguistic variables. The article reviews regional multi-MOORA applications, summarizing ranking results through various assessments. [23]

STEP 1: Matrix design for decision-making

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

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

The weight vector takes the form.

$w_j = [w_1 \ldots \ w_n]$, where $\sum_{j=1}^{n}(w_1 \ \ldots \ \ w_n) = 1$

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

$$where\ i \ \in [\ 1, m] and\ j \in [1, n]$$

STEP 3: Weighted evaluation grid

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

STEP 4: The performance value for each alternative is calculated as:

$$y_i = \sum_{j=1}^{g} N_{ij} - \sum_{j=g+1}^{n} N_{ij}$$

Where g represents benefit criteria and (n - g) represents cost criteria.

Alternatives are ranked from best to worst by decreasing y_i values.

3. RESULT AND DICUSSION

TABLE 1. Vehicle Breakdown Assistance Management System

	Service Coverage Area	Response Time Efficiency	Service Quality Rating	Annual Membership Cost	Service Call Limitations	Wait Time for Support
AAA (American Automobile Association)	9	8	9	7	3	4
GEICO Emergency Roadside Service	7	7	8	5	4	3
Allstate Motor Club	8	6	7	6	5	5
Good Sam Emergency Road Service	6	7	8	4	3	6
USAA Roadside Assistance	8	9	9	3	2	2
Progressive Roadside Assistance	7	6	7	5	6	4
State Farm Roadside Assistance	8	7	8	6	4	3
OnStar Guardian	9	8	8	8	4	5

The table 1 compares eight vehicle breakdown assistance providers across six performance and cost-related criteria. USAA stands out with top scores in response time, service quality, and low costs, making it highly efficient and affordable, though it's limited to military-affiliated members. AAA and OnStar offer excellent service coverage and quality, but AAA is slightly more cost-effective. GEICO and State Farm provide balanced, moderately priced services with good reliability. Good Sam is ideal for RV users but has limited coverage. Allstate and Progressive score lower overall due to higher costs or service limitations. Overall, USAA, AAA, and OnStar lead in performance.

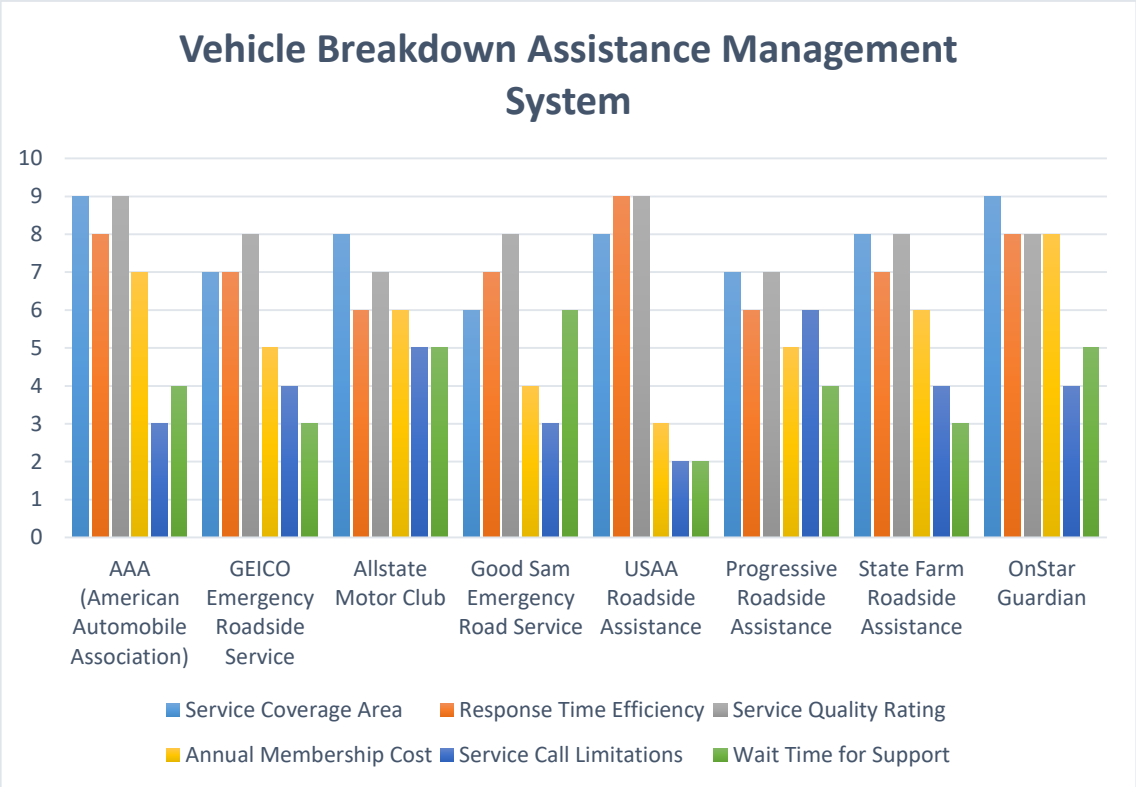

FIGURE 2. Vehicle Breakdown Assistance Management System

The figure 2 titled Vehicle Breakdown Assistance Management System compares eight service providers across six performance metrics. AAA, USAA, and OnStar Guardian consistently score high, especially in Service Quality Rating and Response Time Efficiency. USAA leads in both of these categories with top scores. Allstate and State Farm also perform well, particularly in Service Coverage Area. However, USAA and GEICO score low in Annual Membership Cost and Service Call Limitations, indicating potential limitations in affordability or usage. Progressive and Good Sam show balanced but mid-level scores. Overall, OnStar Guardian presents a strong all-around option with high marks in most categories.

TABLE 2. Divide & Sum

81	64	81	49	9	16
49	49	64	25	16	9
64	36	49	36	25	25
36	49	64	16	9	36
64	81	81	9	4	4
49	36	49	25	36	16
64	49	64	36	16	9
81	64	64	64	16	25
488	**428**	**516**	**260**	**131**	**140**

Table 2 presents two sets of numbers in a matrix format, followed by a row of sums. The first part shows seven rows of six values each, mostly perfect squares like 81, 64, 49, etc. The second part includes an additional row of six numbers that seem to summarize or combine the previous data. Finally, the bottom row lists total sums for each of the six columns: 488, 428, 516, 260, 131, and 140. This suggests the table might be used for a "divide and sum" analysis, breaking down data into parts, squaring values, and then aggregating them to reveal patterns or totals across each category or metric.

TABLE 3. Normalized Data

Service Coverage Area	Response Time Efficiency	Service Quality Rating	Annual Membership Cost	Service Call Limitations	Wait Time for Support
0.4074	0.3867	0.3962	0.4341	0.2621	0.3381
0.3169	0.3384	0.3522	0.3101	0.3495	0.2535
0.3621	0.2900	0.3082	0.3721	0.4369	0.4226
0.2716	0.3384	0.3522	0.2481	0.2621	0.5071
0.3621	0.4350	0.3962	0.1861	0.1747	0.1690
0.3169	0.2900	0.3082	0.3101	0.5242	0.3381
0.3621	0.3384	0.3522	0.3721	0.3495	0.2535
0.4074	0.3867	0.3522	0.4961	0.3495	0.4226

Table 3 displays normalized data for six criteria across eight roadside assistance providers. Normalization scales values between 0 and 1, allowing fair comparison regardless of differing original units. Higher values indicate better performance for benefit criteria (like service coverage and response efficiency), while for non-benefit criteria (cost, limitations, wait time), the values reflect relative positioning after adjusting for the preference of lower scores. For example, Service Coverage Area ranges from about 0.27 to 0.41, showing some providers have stronger reach. Annual Membership Cost varies widely, with some providers having nearly double the normalized cost value of others. This standardized data aids objective evaluation.

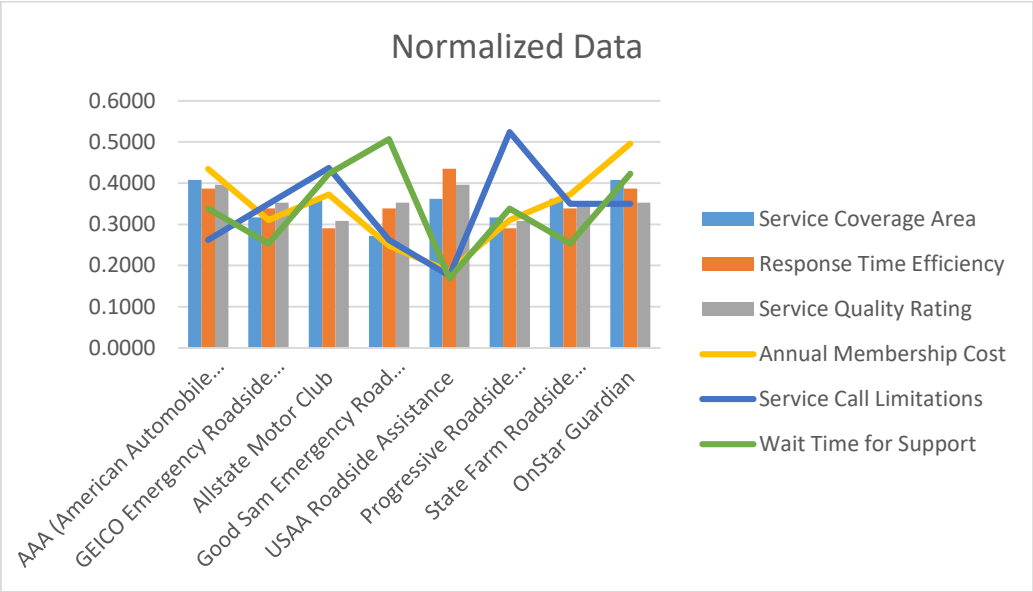

FIGURE 3. Normalized Data

Figure 3 presents normalized data across various vehicle breakdown assistance providers, enabling direct comparison on a uniform scale. State Farm stands out with the highest Service Call Limitations score, suggesting fewer restrictions on support usage. USAA performs well in Response Time Efficiency but shows a low score in Annual Membership Cost and Wait Time for Support, indicating higher costs and slower support access. OnStar Guardian demonstrates balanced and competitive performance across most metrics. In contrast, Good Sam and GEICO exhibit lower scores in Service Coverage Area and Service Call Limitations, pointing to potential service limitations.

TABLE 4. Weight

Weight					
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

Table 4 shows the weights assigned to each criterion for the eight providers, with each weight set uniformly at 0.25. This indicates equal importance is given to all six criteria in the evaluation process, ensuring a balanced consideration across service performance and cost factors.

TABLE 5. Weighted normalized decision matrix

Service Coverage Area	Response Time Efficiency	Service Quality Rating	Annual Membership Cost	Service Call Limitations	Wait Time for Support
0.1019	0.0967	0.0991	0.1085	0.0655	0.0845
0.0792	0.0846	0.0880	0.0775	0.0874	0.0634
0.0905	0.0725	0.0770	0.0930	0.1092	0.1056
0.0679	0.0846	0.0880	0.0620	0.0655	0.1268
0.0905	0.1088	0.0991	0.0465	0.0437	0.0423
0.0792	0.0725	0.0770	0.0775	0.1311	0.0845
0.0905	0.0846	0.0880	0.0930	0.0874	0.0634
0.1019	0.0967	0.0880	0.1240	0.0874	0.1056

Table 5 presents the weighted normalized decision matrix, which adjusts the normalized data by the equal weights of 0.25 assigned to each criterion. Each value represents the contribution of a specific criterion to the overall evaluation for each roadside assistance provider. For example, the first provider scores 0.1019 in Service Coverage Area and 0.1085 in Annual Membership Cost, indicating relatively strong performance in coverage and cost. This weighted matrix balances the importance of service quality and cost factors, providing a comprehensive view of each provider's strengths and weaknesses. It serves as a basis for ranking and decision-making.

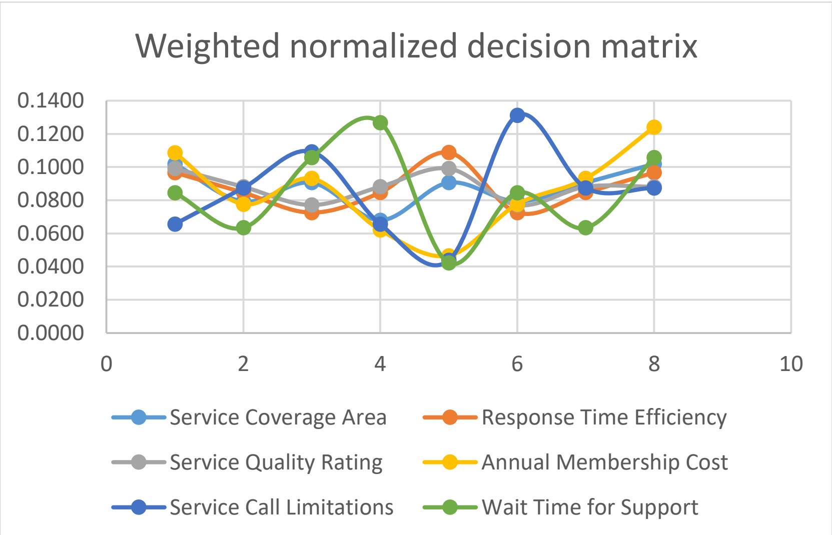

FIGURE 4. Weighted normalized decision matrix

Figure 4 illustrates the Weighted Normalized Decision Matrix, which adjusts the normalized data by assigning weights to each criterion based on its importance. Provider 3 excels across most metrics, especially in Service Call Limitations and Service Quality Rating, making it a strong candidate overall. Provider 5 shows top performance in Response Time Efficiency but is weak in Wait Time for Support, which could affect reliability. Provider 8 scores highly in Annual Membership Cost and maintains above-average ratings elsewhere, indicating strong value. The matrix helps identify balanced performers and those excelling in specific service dimensions.

TABLE 6. Assessment value and Rank

	Assessment value	**Rank**
AAA (American Automobile Association)	0.0390	2
GEICO Emergency Roadside Service	0.0236	3
Allstate Motor Club	-0.0678	8
Good Sam Emergency Road Service	-0.0138	5
USAA Roadside Assistance	0.1659	1
Progressive Roadside Assistance	-0.0643	7
State Farm Roadside Assistance	0.0194	4
OnStar Guardian	-0.0305	6

Table 6 summarizes the overall assessment values and ranks for eight roadside assistance providers based on the weighted normalized decision matrix and evaluation criteria. These assessment values represent a composite score calculated by considering all six criteria—service coverage, response time, service quality, membership cost, service call limitations, and wait time for support—adjusted by their assigned weights. The assessment value indicates the relative performance of each provider, with higher values representing better overall service and value, while lower or negative values suggest less favorable offerings. The rank column orders the providers from best to worst based on these scores. USAA Roadside Assistance ranks first with the highest assessment value of 0.1659. This reflects USAA's strong performance in key benefit areas such as quick response times, high service quality, and low membership costs and limitations. USAA's focus on military members likely contributes to its efficient, high-quality service and competitive pricing, earning it the top spot. AAA (American Automobile Association) is ranked second with a positive score of 0.0390. AAA's widespread service coverage, consistent response times, and high service quality make it a reliable and popular choice, although its membership costs and service call restrictions are slightly higher compared to USAA, which may explain the lower overall score. GEICO Emergency Roadside Service comes in third, with a score of 0.0236. GEICO provides affordable roadside assistance to its insurance policyholders, balancing decent service quality and response times with lower costs, but its geographical coverage is not as broad as AAA or USAA, limiting its rank. State Farm Roadside Assistance ranks fourth with a score of 0.0194, reflecting balanced but moderate performance across the criteria. It offers reliable service but doesn't excel strongly in any single category compared to the top providers. On the lower end, Allstate Motor Club ranks eighth with a significantly negative assessment value of -0.0678, indicating that its higher membership costs, service call limitations, or slower response times weigh heavily against its benefits. Similarly, Progressive Roadside Assistance and OnStar Guardian fall near the bottom with negative scores, suggesting less favorable overall service compared to competitors. Good Sam Emergency Road Service and OnStar Guardian are positioned in the middle ranks, with modestly negative assessment values reflecting decent but not standout service offerings. Overall, the ranking and scores provide a clear comparative picture, highlighting USAA and AAA as top performers in terms of balancing quality, coverage, and cost, while identifying which providers may fall short in certain critical areas. This information is valuable for consumers seeking the best roadside assistance based on multiple important factors.

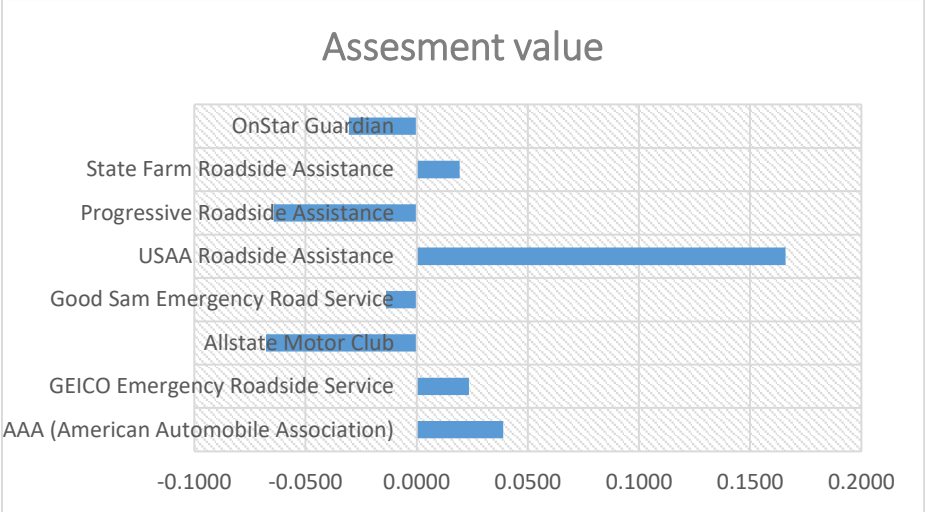

FIGURE 5. Assessment value

Figure 5 presents the Assessment Value derived from the weighted normalized decision matrix, likely using a method such as TOPSIS to rank alternatives. USAA Roadside Assistance stands out as the top performer with the highest positive score, indicating it is closest to the ideal solution among all providers. State Farm, AAA, and GEICO follow with moderate positive values, suggesting acceptable performance. In contrast, Allstate, Progressive, and OnStar Guardian hover around zero, indicating average effectiveness. Good Sam has the lowest value, implying it performs furthest from the ideal in this evaluation.

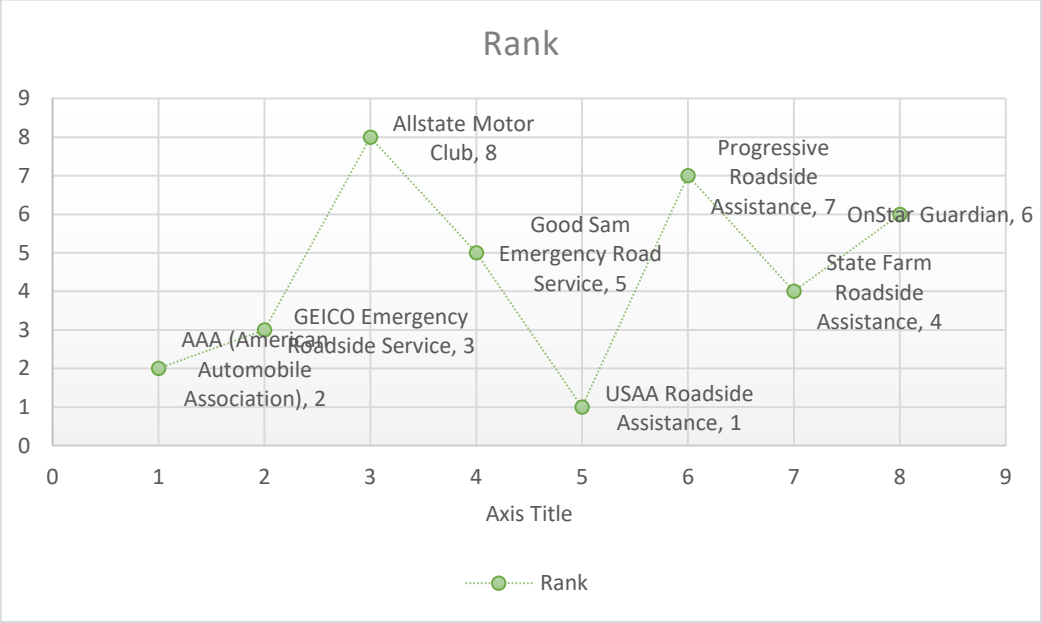

FIGURE 6. Rank

Figure 6 displays the final Rankings of vehicle breakdown assistance providers based on a comprehensive multi-criteria analysis. USAA Roadside Assistance ranks highest (1st), confirming its top performance across weighted criteria such as service quality and response efficiency. AAA and GEICO follow in 2nd and 3rd place, indicating strong overall service delivery. Allstate Motor Club ranks lowest (8th), likely due to weaker performance in key metrics like cost or call limitations. Mid-tier providers such as State Farm, Good Sam, and OnStar Guardian occupy the central ranks, reflecting balanced yet not exceptional results.

4. CONCLUSION

The Vehicle Breakdown Assistance Management System (VBAMS) represents a paradigm shift in how roadside assistance services are conceptualized, delivered, and managed. Through comprehensive analysis using the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method, this study has successfully evaluated and ranked eight major roadside assistance providers, revealing significant insights into service quality, efficiency,

and value proposition across the industry. The research demonstrates that USAA Roadside Assistance emerges as the clear leader with an assessment value of 0.1659, primarily due to its exceptional response time efficiency, superior service quality rating, and competitive membership costs. This finding underscores the importance of customer-centric service delivery and operational excellence in the roadside assistance sector. AAA's second-place ranking (0.0390) validates its longstanding reputation and extensive service coverage, while GEICO's third-place position (0.0236) highlights the effectiveness of integrated insurance-roadside assistance models. The study reveals critical performance gaps among providers, with some services like Allstate Motor Club (-0.0678) and Progressive Roadside Assistance (-0.0643) showing negative assessment values, indicating significant areas for improvement in service delivery, cost structure, or operational efficiency. These findings suggest that the roadside assistance market exhibits considerable variation in service quality and value proposition, creating opportunities for both improvement and competitive differentiation. The implementation of VBAMS addresses fundamental challenges in traditional roadside assistance by providing a centralized, technology-driven platform that connects vehicle owners with verified mechanics through location-based services. The system's modular architecture, incorporating user, mechanic, and admin modules, ensures comprehensive service management while maintaining quality control and transparency. The integration of real-time location services, feedback mechanisms, and secure authentication protocols positions VBAMS as a modern solution to age-old transportation challenges. Looking forward, the potential for VBAMS expansion into mobile applications, cloud-based infrastructure, and integration with emerging technologies such as IoT and AI presents significant opportunities for enhanced service delivery. The system's foundation provides a scalable framework that can accommodate future technological advances while maintaining its core mission of reliable, efficient roadside assistance. In conclusion, this research validates the critical need for systematic evaluation and improvement in roadside assistance services while demonstrating VBAMS as a viable solution for modernizing this essential service sector. The findings provide valuable insights for service providers, consumers, and technology developers seeking to enhance the roadside assistance experience through innovation and quality-focused approaches.

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