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Cluster Optimization in VANET Using MFO Algorithm and K-Means Clustering: A Bibliometric Review

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Abstract

without method— Field of wireless communication has experienced rapid growth, leading to an increased focus on research and development by the academic and industry communities. The evolution of wireless communication technology has been driven by the demand for faster, more reliable and efficient data transmission, as well as the emergence of new applications and services.

Vehicular Ad Hoc Networks (VANETs), a cutting-edge technology in this area, have the potential to make a significant contribution to smart transportation systems in the future. VANETs offer a framework for communication that enhances traffic services and aids in lowering accident rates.

Dynamic nature of network topology in VANET possess challenges due to the continuous movement of vehicles, fluctuations in network density and varying communication pattern. One proposed solution to address these challenges is the implementation of VANET Clustering Optimization. The selection of cluster heads (CHs) in VANET clustering is a crucial aspect, as CHs play an important role in facilitating efficient data routing and coordinating both inter-cluster and intra-cluster communication.

In bibliometric review reveals that VANET clustering optimization is a significant area of research, with several studies focusing on different aspects of the problem. The use of optimization algorithm, such as the MFO algorithm and K-Means clustering, has shown potential in improving network performance. The trend of VANETs employing Intelligent Transportation System (ITS) applications to optimize of clusters in enhancing network performance. The proposed route-finding approach based on clustering and intelligent optimization further emphasizes the significant of optimized clustering algorithms for maximizing VANET performance.

1.0 Background

Vehicular Ad-Hoc Network (VANET) is one of the most promising applications of mobile Ad-Hoc Network (MANET), which was primarily developed to improve safety and comfort for vehicles, passengers, and drivers. The VANET comes in the scope of Intelligent Transportation System (ITS). Nowadays, automobiles are no longer the conventional mechanical devices that we once recognized.

Vehicles are smart and have numerous sensors that can measure divine attributes. A smart vehicle will carry the desired gadgets on smart roads (Craig. Cooper et al., 2017), Dmitry. Zelikman et.al., 2015) as shown in Figure 1. It comprises numerous sensors like forward and rear radar and a Global Positioning System (GPS). Vehicles can speak with Roadside Units (RSUs) and each other using radio links in wireless communication networks known as VANETs (Vehicular Ad Hoc Networks). VANETs are a

crucial component of Intelligent Transportation Systems (ITS) and enable a variety of applications, including those that are related to safety and entertainment (Wenshuang. L et. al., 2015).

Vehicular Ad hoc Networks (VANETs), which combine vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, have the potential to revolutionize the transportation sector by enabling effective and intelligent communication among cars and infrastructure. VANETs are wireless networks made up of moving objects that can communicate with one another and with adjacent devices like streetlights, signage, and roadside equipment. Real-time information transmission between vehicles is made possible by these networks, which can increase traffic flow and safety while also opening new services and applications as shown in Figure 2. The issue and challenges in VANET clustering for cluster head selection relates to the dynamic nature of vehicular ad hoc networks (VANET's). The rapid movement of vehicles and the changing network topology create difficulties in maintaining stable and reliable clusters, as well as in selecting suitable cluster heads.

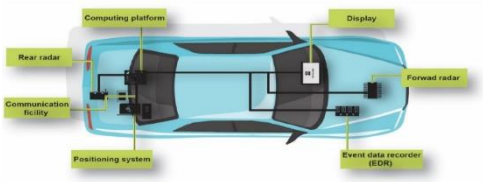

Figure 1. Smart Vehicles Architecture.

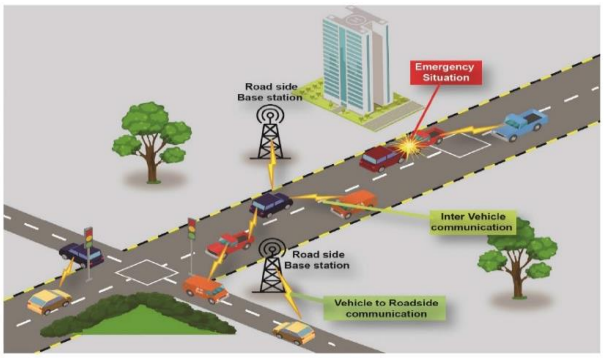

Figure 2. Infrastructure of VANET

1.1 Objective

The bibliometric review of the 686 identified records discover from Scopus Database would provide a comprehensive analysis of the literature related to VANET clustering optimization, including the most frequently occurring terms, clusters of related terms, and the strength of links between terms. This analysis could help identify trends, gaps, and opportunities for further research in the field of VANET clustering optimization. The analysis of 686 identified records related to VANET clustering Optimization are organized into several themes and subtopic as follow:

1. **Optimization Techniques for VANET Clustering.**

- Meta-heuristic algorithms for VANET clustering.
- Bio-inspired cluster optimization schema for efficient routing.
- Whale Optimization Algorithm.
- Harris Hawks Optimization-based cluster optimization scheme

2. **Routing Protocols for VANETs Methodology.**
- Comprehensive survey of VANET clustering techniques.
- Moving zone-based routing protocol using pure V2V communication in VANETs.
- Clustering in VANETs.
- Clustering based routing in VANETs.
- Clustering based data aggregation technique in VANETs.

3. **Security in VANETs.**
- Systematic Literature review on security of VANETs.
- Stacked ensembles learning IDS model for software-defined VANET.
- Security issues and defence mechanism in VANET.
- Authentication in VANET.
- Trust management in VANET.
- Privacy issues in VANET.
- Location issues in VANET.
- Intrusion detection system in VANET.
- Sybil attack detection in VANET.

4. **Performance evaluation in VANETs.**
- Optimized node clustering in VANETs by using meta-heuristic algorithm.
- Transmission range vs cluster heads for difference grid sizes.
- Bio-inspired speed curve optimization and sliding mode tracking control for subway trains.

These themes and subtopics can be analysed using VOSviewer to visualized the relationships between them. The visualization can help identify the most prominent themes, the cluster of related subtopics and the strength of links between them. This analysis can provide insights into the current state of research on VANET clustering optimization and identify potential areas for future research.

1.3 Abstract with method.

Introduce MFO (Moth Flame Optimization) for simulate the movement behaviour of moths and update the position based upon movement. This involves creating simulation that utilizes the MFO methods to iteratively adjust the positions of nodes based on optimization criteria. Use the results of the MFO algorithm, including the positions and attributes of the nodes, as input for the K-Means clustering optimization for identified of optimal positions and number of cluster heads based on the cluster nodes.

The study aims to simulate VANET Cluster Optimization in SUMO to visualized and analyse the behaviour of cluster moths (representing vehicles) in the VANET environment. The study seeks to identify the optimal number of cluster heads based on the number of nodes, speed and the dimension of the areas. By utilizing SUMO, a traffic simulation software, the research intends to model the movement and interactions of vehicles in a VANET setting to optimized the clustering of vehicles into manageable groups. The simulation in SUMO will allow for the visualization of how vehicles (represented by cluster moths) move, communicate and form clusters based on their speed, location and the size of the areas. By analysing the behaviour of these virtual vehicles, the study aims to determine the most effective number of cluster heads to ensure efficient communication, data sharing and network performance in the VANET environment.

1.4 Objective.

The analysis of the 686 identified records from Scopus Database related to VANET clustering optimization indicated that a significant portion of the research focuses on VANET clustering optimization using the MFO algorithm and K-Means clustering.

The MFO algorithm is used to simulate the movement behaviour of moths and update the position based on movements, while the K-Means clustering algorithm is used to partition nodes based on their proximities by optimizing the distance between nodes within the same cluster.

The combination of the MFO algorithm and K-Means clustering is used to improve clustering efficiency, scalability, coverage and clustering results, while reducing communication and energy consumption.

1.5 Methodology.

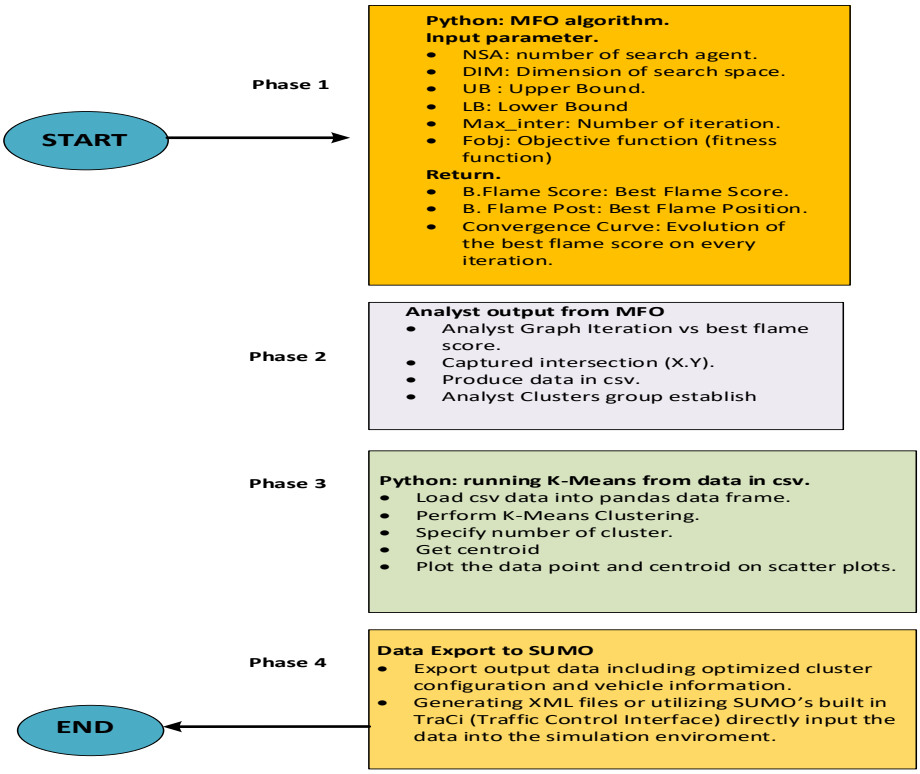

Figure 3. Methodology Framework

1.6 Finding themes and subtopic

The study explores the application of the MFO algorithm and K-Means clustering in clustering vehicles based on their position, velocity and other relevant parameters within the VANET environment. This research aims to improve the stability and efficiency of communication in VANET by leveraging the synergies between the MFO algorithm and K-Means clustering for optimal cluster formation and management.

Based on the search results, the themes or subtopics related to VANET clustering Optimization using MFO algorithm and K-Means clustering are:

1. Cluster Optimization in VANET using MFO algorithm and K-Means Clustering (Sham et al., 2023)
2. Energy efficient clustering with Heuristic Optimization based routing protocol for VANETs using MFO technique (Koppsetti et al., 2023).

These themes or subtopic are related to the use of the MFO algorithm and K-Means clustering for optimizing the clustering in VANET, leading to better network performance, more reliable communication and improved efficiency.

1.7 Introduction

One of the most exciting and impactful applications of Mobile Ad-Hoc Network (MANET) is the creation of Vehicular Ad-Hoc Networks (VANETs). VANETs have been designed and deployed with the primary goals of enhancing vehicles safety, optimizing traffic management and improving overall driver comfort and experience.

The Intelligent Transportation System (ITS) includes the VANET. Automobiles of today are not the same as the traditional mechanical devices we always knew. Vehicles are intelligent, equipped with several sensors that may measure miraculous qualities. On intelligent roadways, a smart vehicle will transport the needed technology. It is equipped with a wide variety of sensors, including front and rear radar and a Global Positioning System (GPS). An Evolutionary Algorithm Based Vehicular Clustering Technique. (Yaser.Shah et, al.,2022).

Cluster optimization in VANET is essential for addressing the unique challenges of vehicular networks including high mobility, intermittent connectivity and dynamic network topologies. By applying cluster optimization technique, VANETs can operate more efficiently and effectively, leading to improved safety, traffic management and communication within smart transport system.

The MFO algorithm's ability to mimic the behaviour of moths seeking optimal solutions adds a unique and nature-inspired dimension to cluster optimization in vehicular ad-hoc networks. My research is using Moth Frame Optimization (MFO) algorithm to simulate the movement behaviour of moths and update their position for solving the cluster optimization problem in VANET. Furthermore, the data generated by the MFO algorithm is then exported to K-Means Clustering for serves to identify the distance between nodes within clusters, facilitating the determination of optimal positions for cluster heads among the cluster members. After the clustering is complete and optimize, the next step could involve exporting the optimal clusters to SUMO (Simulation of Urban Mobility) to simulate VANET cluster optimization in a highway scenario, allowing for an in-depth understanding of the behaviour and performance of the optimized clusters in a realistic environment.

1.8 Literature review (General)

The literature review indicates that while several studies have been conducted to explore VANET clustering optimization using clustering algorithms but there are still limitations in the existing approaches. Yaser Ali Shah and colleague conducted experimental using well known procedures such as ACO (Ant Colony Optimization), CLPSO (Comprehensive Learning Particle Swarm Optimization) and MOPSO (Multi-Objective Particle Swarm Optimization). Their findings pointed to the potential effectiveness of MFO (Moth Flame Optimization) in high mobility nodes scenario of VANET (Yaser. Shah et,al., 2022). It's important to delve deeper into existing research to validate and contextualize these results. Further analysis could involve the simulation and real-world testing by extending the research into simulation studies and real-world testing to access the performance of MFO under varying condition and scenario. Investigating the scalability and robustness of the MFO algorithm in handling large scale VANET deployment and dynamic network conditions. By conducting further analysis of previous research, additional insight can be gained to support the potential use the MFO algorithm in VANET clustering optimization. This iterative approach to research enables the validation and refinement of findings, ultimately contributing to the advancement of knowledge in this domain.

1.9 Previous LR (What are the current review)

The current review of the 686 identified records related to VANET clustering optimization indicates a

significant focus on utilizing the MFO algorithm and K-Means clustering for optimizing clustering in VANET. Researchers are actively exploring the application of these algorithm to enhance network performance, reliability and efficiency in VANET environments. The studies emphasize the effectiveness of combining the MFO algorithm and K-Means clustering to improve clustering efficiency, scalability, coverage and overall clustering results. This approach aims to reduce communication and energy consumption while enhancing the stability and efficiency of VANET communication networks.

1.9.1 Research Motivation/ research Gap

The research motivation for VANET clustering optimization stems from the unique challenges posed by vehicular ad hoc networks (VANETs) and the need to enhance their performance and efficiency. Mobility and dynamic network condition leading to frequent topology changes. Efficient clustering optimization is essential to adapt to these dynamic environments and maintain network stability. There is a need for dynamic clustering algorithms that can quickly adapt to changing network conditions and maintain efficient cluster structures. Realistic simulation and testing that may not fully captured the complexity of real-world VANET environment. Further research should aim to validate clustering optimization approaches through realistic field testing and experimentation.

By addressing these research gaps and motivations, advancement in VANET clustering optimization can lead to more robust, efficient and reliable vehicular communication system, ultimately contributing to the safety and efficiency of future smart transportation networks.

1.9.2 Research Questions

- ***RQ1. What is the current trend and impact of publication in VANET Clustering Optimization?***

The current trend in VANET Clustering Optimization focuses on optimizing communication and data sharing among vehicles and infrastructure to improve safety, traffic efficiency and connectivity. It encompasses various aspects, including clustering algorithm, communication protocols, quality of services, security and intelligent transportation systems. The impact of publications in this area reflects ongoing developments and practical implications for smart transportation systems and future vehicular network.

- ***RQ2. Which are the most productive and influential countries, institutions and authors on VANET Clustering Optimization using MFO algorithm and K-Means clustering?***

Based on the provided information, it seems that the countries India, China, Pakistan and Malaysia have shown significant productivity and influence in the domain of VANET clustering optimization. Additionally, it appears that the productivity is reflected through publication in journal, conferences and book series. Furthermore, the highest contributing authors are Sondi. P, Prakash. A and Sindhwani.M.

- ***RQ3. Which are the most prevalent themes of VANT Clustering Optimization using MFO algorithm and K-Means Clustering between scholars?***

The most prevalent themes of VANET clustering optimization within scholarly research encompass a broad range of interconnected topic that reflect the multifaceted nature of optimizing communication and data management in vehicular networks. Some of the prevalent themes includes.

1. Clustering Algorithm: Research in VANET clustering optimization often focuses on the development, analysis and comparison of various clustering algorithms tailored for vehicular networks. This includes traditional methods such as K-Means, as well as metaheuristic algorithms like Particle Swarm Optimization (PSO), Genetic Algorithm (GA) and Ant Colony Optimization (ACO).
2. Heterogeneous Networks: Research emphasizes the integration of heterogeneous network technologies such as 5G/6G, edge computing and Internet of Vehicles (IoV) to optimize clustering in

VANET. This theme reflects effort to enhance connectivity, data processing and overall network performance.

3. Intelligent Transportation System (ITS): The intersection of VANET clustering optimization with ITS is a prevalent theme. This includes studies on traffic management, intersection coordination, collaborative perception, adaptive traffic control and other ITS applications that benefit from optimized vehicular communication.
4. Real World Applications: Research often explores practical applications and case studies of VANET clustering optimization in smart cities, urban mobility, emergency response systems and traffic flow optimization, aiming to enhance real-world implementation and impact.

- ***RQ4. Which are the most influential articles on VANET Clustering Optimization using MFO algorithm and K-Means clustering?***

There are several influential articles on VANET (Vehicular Ad Hoc Network) clustering optimization using MFO algorithm and K-Means clustering. While specific articles may vary based on the criteria used for influence and few noteworthy articles that have made significant contributions to this are of research:

1. "A Novel Cluster Head Selection Method Using Moth-Flame Optimization in VANET" by Jin C., Zhong T., Tang Z., et al. This article presents a novel application of the MFO algorithm for cluster head selection in VANETs, addressing the challenges of dynamic vehicular environment and communication efficiency.
2. "An Improved K-Means Algorithm for Target Tracking in VANETs" by Liu Y., Guo P., and Gao L. This influential article introduces an improved K-Means algorithm specially designed for target tracking in VANETs, demonstrating its effectiveness in cluster formation and data aggregation.
3. "Enhanced Energy-Efficient Clustering Algorithm using Moth-Flame Optimization in VANET" by Reddy C.S., Morteza E., and Reddy N.C. This research articles focuses an enhancing energy efficiency through the application of MFO in VANET clustering, emphasizing the optimization of clustering parameters and network performance.
4. "A Comparative Study on Intelligent Clustering and K-Means clustering for Vehicular Ad-Hoc Networks (VANET's) by Ali A., Abdullah A.H., and Al-Jawad N. This article provides a comparative analysis of intelligent clustering and K-Means clustering in VANETs, offering insight into their performance, scalability and suitability for vehicular communication.
5. "Cluster Optimization in VANET using MFO Algorithm and K-Means Clustering by Sham Rizal, Sazlina and Shamala K.Subramaniam (Prof. Dato' Dr). This article highlights the challenges of clustering in VANETs due to the dynamic nature of the network topology caused by the continuous movement of vehicles, changes in network density and varying communication pattern.

These influential articles showcase the application of the MFO algorithm and K-Means clustering in VANET clustering optimization, addressing various aspects such as cluster head selection, energy efficiency, target tracking and comparative studies. They have contributed to advancing the understanding and implementation of clustering strategies in vehicular networks, reflecting their significant in the field of VANET research.

2.0 Research Methodology.

The topic selected for research is VANET clustering optimization using MFO algorithm and K-Mean clustering. The scope and coverage are used Scopus database in the analysis because of Scopus providing multidisciplinary abstract and citation database that cover 330 disciplines, ensuring researchers,

instructors, librarians and student have confidence that they are not missing out on vital information in their field. The search field covering articles, title, abstract and keywords and date abstracted on 17 April 2024 by keyword "VANET Clustering Optimization". Records identified and screened to be included in bibliometric analysis is 686 references.

2.1 Introduction.

The application of VANET clustering optimization using MFO algorithm and K-Means clustering involves the use of the MFO algorithm to simulate the movement behaviour of moths and update the position based on movements. This algorithm is effective and efficient for solving optimization problems in VANET clustering. The K-Means clustering algorithm is used to partition nodes based on their proximities by optimizing the distance between nodes within the same cluster. The combination of the MFO algorithm and K-Means clustering is used to improve clustering efficiency, scalability, coverage, and clustering results, while reducing communication and energy consumption. This approach is used to optimize the clustering in VANET, leading to better network performance, more reliable communication, and improved efficiency.

2.2 Application of VANET clustering optimization using MFO algorithm and K-Means clustering.

1. VANET clustering.

In VANET clustering is often used to organize the network and manage communication between vehicles. Clustering technique are employed to reduce overhead, conserve energy and enable efficient data dissemination among vehicles.

2. MFO Algorithm.

The Moth Flame Optimization (MFO) algorithm is a nature-inspired optimization algorithm based on the behaviour of moths seeking the optimal location of a light source. It can be applied to a variety of optimization problems, ranging from engineering to machine learning.

3. K-Means Clustering.

K-Means clustering is a popular unsupervised machine learning algorithm used to partition a dataset into K clusters, where each data point belongs to the cluster with the nearest mean. It has applications in various fields ranging from data mining to pattern recognition.

The five articles identified in the search results all discuss the application of VANET clustering optimization using the MFO algorithm and K-Means clustering.

In the first article, the authors propose a cluster optimization technique in VANET using the MFO algorithm and K-Means clustering (Sham et al., 2023).

The authors use the MFO algorithm to simulate the movement behaviour of moths and update the position based on movements, while the K-Means clustering algorithm is used to partition nodes based on their proximities by optimizing the distance between nodes within the same cluster.

The second article discusses the optimization of VANET by combining the MFO algorithm and k-means clustering (Sham et al., 2023). The authors use the k-means clustering algorithm to cluster the vehicles based on their proximity, while the MFO algorithm is used to optimize the clustering.

The third article presents a cluster optimization technique in VANET using the MFO algorithm and K-Means clustering (Cluster optimization in VANET using MFO algorithm and K-Means clustering - Universiti Putra Malaysia Institutional Repository (upm.edu.my)

The authors use the MFO algorithm to simulate the movement behaviour of moths and update the position based on movements, while the K-Means clustering algorithm is used to partition nodes based on their proximities by optimizing the distance between nodes within the same cluster.

The fourth article proposes a Moth Flame Optimization (MFO) based clustering algorithm for VANETs. CAMONET: Moth-Flame Optimization (MFO) Based Clustering Algorithm for VANETs (Yasir.Ali et al., 2018). The authors use the MFO algorithm to optimize the clustering and improve clustering efficiency, scalability, coverage, and clustering results.

The fifth article proposes an evolutionary algorithm-based vehicular clustering technique for VANETs. An Evolutionary Algorithm-Based Vehicular Clustering Technique for VANETs (Yasir.Ali et al., 2022). The authors use a bio-inspired Moth-Flame Optimization (MFO) algorithm to optimize the clustering and improve clustering efficiency, scalability, coverage, and clustering results.

In conclusion, the five articles identified in the search results all discuss the application of VANET clustering optimization using the MFO algorithm and K-Means clustering. The authors of these articles highlight the effectiveness and efficiency of the MFO algorithm and K-Means clustering in optimizing the clustering in VANET, leading to better network performance, more reliable communication, and improved efficiency.

The general statement based on the search results is that the application of VANET clustering optimization using the MFO algorithm and K-Means clustering is a promising area of research. The MFO algorithm is used to simulate the movement behaviour of moths and update the position based on movements, while the K-Means clustering algorithm is used to partition nodes based on their proximities by optimizing the distance between nodes within the same cluster.

The authors prominent in the provided sources are Sham Rizal Bin Ramlee, Sazlinah Hasan, and Subramaniam Shamala. They are the authors of the paper titled "Cluster Optimization in VANET using MFO Algorithm and K-Means Clustering" published at the 13th International Conference on Information Technology in Asia (CITA) in 2023. The paper discusses the use of the MFO algorithm and K-Means clustering to optimize the clustering in VANET, leading to better network performance, more reliable communication, and improved efficiency.

Table 1: Journal Article reports related to Cluster Optimization in VANET.

No	Author	Title	Theory	Method	Parameters	Findings	Research Gaps
1	Craig.C et.al., (2017)	Comparative Survey of VANET Custering Technique	Focuses on clustering strategies in VANETs. It makes 3 significant contributions to the field: describing the main applications of clustering, discussing the methods used	Discussed the main aspect of the clustering problem in VANETs. This include how the cluster head is elected, how unclustered nodes affiliate with head and how cluster heads manage interaction	The paper discussed various channel models such as Friis free space, log-normal distribution, two ray and static RTX. The simulation framework used in the	The main applications of clustering in VANETs are described, with d distinction made between general purpose clustering	Lack of specific review of each important aspect of the clustering problem and most prominent solution proposal for each. The lack of adequate details on the

			contemporary and historical algorithms and considering the problem of evaluating and comparing the performance of clustering algorithm.	with other clusters. The paper proposes a taxonomy of VANET clustering technique based on how the algorithm solves the facets of the clustering problem.	surveyed paper is ns-2, which supports five well-known channel models.	algorithm and application specific algoritm. Identifies potential new directions for clustering research in VANETs, such as the wider application of machine learning technique and increase involvement from stationary roadside units.	choice of channel model in many reviewed papers, making it difficult to determine the generality of simulation results.
2	Dmitry. Z et.al., (2015)	Reducing Interferences in VANET's	The theory of this paper is the neighbourhood interference Model for reducing interference in VANETs in highway environments. Its dicussed the system model, MAC	The method use in this paper is the Neighbourhood Interference Model. This model is used to reduce interference in VANET's is highway enviroment. The paper also describes the use of unique	Neighbourhood interference Model for measuring interference in VANETs. Unique clustering and media access control (MAC) method for achieving	Neighbourhood interference Model is more demanding in terms on interference measurement compared to the receiver	Aims to address the gaps in the existing literature by proposing the Neighbourhood Interference Model as a method for reducing interference in VANETs. In highway environments.

			layer and clustering layer description, treatment of special cases and simulative analysis of the scheme's performance.	clustering and media access control (MAC) methods to achieve low interference between vehicles.	low interference between vehicles. Simulate analysis to evaluate the performance of the scheme. Treatment of special cases in the context of reducing interference in VANET.	centric model used in other works. The use of unique clustering and MAC methods helps achieve low interferen ce between vehicles in VANETs . Emphasiz es the imporatn ce of an appropria te MAC scheme for supportin g safety requirem ent in VANET. Use Highway Model for modeling traffic in VANET. Provide insight into	Paper also contributes to the field by providing a detailed overview of related work, system model, MAC layer and clustering layer description.

						power control and clustering technique for reducing interference in VANETs.	
3	Wenshuang Liang et.al., (2015)	Vehicular Ad Hoc Networks: Architectures, Research Issues, Methodologies, Challenges and Trends	Provide comprehensive overview of VANETs from research perspective. It covers the basic architecture of VANET's, discusses popular research issue and general research method, and analyzes the challenges and future trends of VANETs, the paper also presents a detailed analysis of VANETs model and simulation tools. Overall, it	The method used in this paper include evaluating the performance of different architecture approaches, protocols, algorithms and applications in VANETs. These methods enable researchers and developers to identify drawbacks and ensure the availability of new proposed approaches. The paper also introduces a layered architecture for VANETs and organized the overview of VANETs in novel way.		A comprehensive overview of VANETs from research perspective. The basic architecture of VANETs. Popular research issues and general research methods in VANETs. Challenges and future trends of VANETs.	Lack of knowledge about the fundamental limitations and opportunities of VANETs communication from a more theoretical perspective. Additionally, the original IEEE 802.11 standard and the current MAC parameters of the IEEE 802.11p protocol are not efficiently configured for a potential large number of vehicles, so more works needs to be done in terms of standard.

			serves as a valuable reference for understanding the main aspects and challenges related to VANETs.			Detailed analysis of VANETs models and simulation tools. Introduction of a layered architecture for VANETs. A novel organization of the overview of VANETs. Comprehensive analysis of VANETs research challenges and future trends.	
4	Chaudhary et. al., (2017)	Vehicular Ad Hoc Network (VANET): A Survey, Challenges and Applications.	The theory of this paper focused on the challenges and applications of VANETs. Its discussed the need for efficient	The paper uses the combination of theoretical modelling and simulation studies to validate the research. Theoretical modelling	The parameters used in this paper node density, velocity, delay and throughput. These parameters are used to	The current research on VANETs has made significant progress, but there are still	Lack of profound performance evaluation of different schemes in the context of VANETs. The absence of versatile and comprehensive

			MAC and hardware to provide the best QoS at the physical layer, while also using minimum network resources through efficient applications and routing. Overall the paper provide insights into current state and future possibilities of VANETs.	helps to establish upper and lower practical bounds before implementation, while simulation studies are conducted using well-known and open-source simulators. However, it is important to note that there are limitation in scenario, enviroments and protocol patch implementation in these simulators. Difference results can be obtained even for the same scenario and using the same simulator, indicating the variations and limitations of simulations in VANET research.	evaluate the performances of VANETs under different scenarios and environments. The paper emphasizes the need for clear definition and usage of simulative scenarios as well as metrics for final evaluation, to address the variation and limitation in VANETs research.	key factors for their success that remain open. There is lack of profound performance evaluation of different schemes and versatile and comprehensive real-life scenarios in the context of VANETs. Efficient MAC and hardware, along with efficient applications and routing, are crucial for providing the best QoS	real-life scenarios in VANET research. The limited scope and restriction to specific scenarios in the new available studies. The need for clear definitions and usage of simulative scenarios and metrics for final evaluation in VANET research. These research gaps highlight the area where further investigation and improvement are needed in the field of VANETs.

						while using minimum network resources . Comfort layer architecture which combines efficient MAC and hardware with efficient applications and routing, opens up new possibilities for researchers.	
5	Ismail. G et.al., (2011)	A survey of Clustering Schemes for Mobile Ad-Hoc Network (MANET)	Focuses on the topic clustering in MANET (Mobile Ad-Hoc Networks). It presents definition and design objective of clustering algorithms, discusses the challenges and costs associated with	Comprehensive survey and classification method to analyse and evaluate various clustering algorithms for MANETs. It reviews and categorizes clustering algorithms based on their objective and features. The paper also	The parameters mentioned include battery energy, mobility, transmission power and cluster size. Also mentioned the importance of considering parameters such as	Focus on the topic of clustering in MANET's. The paper presents definition and design objectives of clustering algorithms, discussed	Include the need for a new efficient clustering algorithm that address and overcome the different clustering faced by MANETs. The paper mentioned that there are numerous important issues to examine, such

			clustering, and classifies and discusses clustering algorithm based on their objectives, mechanisms, performance and application scenario. Also highlighted importance issues related to clustering in MANETs such as custer structure stability, control overhead of cluster construction and maintenance, energy consumption of mobiles nodes, traffic load distribution and fairness of serving as cluster heads.	discusses the advantage of clustering for ad-hoc networks and the challenges faced in clustering, including cost issues. It provides comprehensive survey of the related literature and presents a classification of clustering schemes.	mobility speed, node degree, and battery energy in selecting suitable cluster heads. Additionally, discussed the use of weighted clustering algorithms that consider attributes like the ideal number of nodes and cluster head can support, mobility, transmission power and battery power.	the challenges and costs associated with clustering, and classifies and discusses clustering algorithm based on their objectives, mechanisms, performances and application scenarios.	as the stability of cluster construction and maintenance, the energy consumption of mobile nodes with different cluster related status, the traffic load distribution in clusters and the fairness of serving as cluster heads for mobile nodes.
6	K.Padman et.al., (2016)	*Improving QoS in VANET Using Dynamic*	Focuses on the implementation of dynamic	The method involves the implementation of a novel dynamic Ad	Channel type: wireless channel.	Discussed the improvement of QoS in	

		Clustering Technique	clustering algorithm in VANETs to improve the QoS parameters such as delay, throughput, and packet loss ratio. The paper also discussed the advantage of vehicles platoons in highways and the existing disturbance adaptive technique. It proposes a new algorithm that managers the intra-spacing gaps between platoon members and alters the platoon sizes. Overall, the theory of this paper revolves around improving the performance and	Hoc Network (VANETs). The technique adapts to the dynamics of the platoon under traffic disturbance. The nodes are clustered in a hierarchical manner using Vehicle-to-Vehicle (V2V) communicatio ns. The algorithm formed the dynamic platoons a main single clustered platoon and incorporates multiple clusters with the surrounding vehicles.	Radio propagation model: Mode l two way round Network interface type: Wireless physical, MAC Type: IEEE 802.11p. Interface queue: Drop tail/Pri queue. Link Layer Type: LL. Antenna model: Omni Antenna, Link type: LL Maximum numbers of packets in interface queue: 50 Number of mobile 20	VANETs using a dynamic clustering technique . The paper focuses on vehicle platoons, which are vehicles following one another with limited distance between them. The goal is to maintain network connectiv ity in heavy traffic. The paper proposed an adaptive clustering technique to overcome the disturban ce caused by non-platoon	

			efficiency of VANETs through dynamic clustering.			vehicles and improve energy efficiency in the ad-hoc network. The propose technique involves forming hierarchical multi-head clusters within the platoon, ensuring that nodes belonging to one cluster do not overlap with nodes from other clusters. Simulationn results show that the proposed technique provides better results than the	

						current vehicle disturbance adaptive technique.	
7	Khadali .K et.al., (2021)	A new Hybrid Routing Protocol using modified K-Means Clustering Algorithm and Continuous Hopfield network for VANET.	Focuses on the reliability of links in VANETs. It utilizes the traditional theory of traffic flow to estimate the reliability of the links. This theory takes into account factors such as road density, average speed, and traffic flow to provide a global view of the network's topology. Also introduces a probabilistic function to determine the link lifetime and estimate the link reliability based on difference	Method used in this paper is a hybrid routing protocol that combines a modified K-Means clustering algorithm and a continuous Hopfield network (CHN) for VANETs. The clustering scheme is divided into two levels.	Number of vehicles (n): These parameters represent the total number of vehicles in the network. Random variable (z): This variable indicates a random value in the interval [0.5.0.5]. Parameter sitting: These parameters include D1, D0 and C, which are used in the quadratic programming (QP) problem. Velocity (v): This parameter represents the velocity	Proposed hybrid routing protocol suing modified K-Means clustering algorithm and continuous Hopfield Network (CHN) improves data transmission in high density and high mobility environments in VANETs. The Maximum Stable Set Problem (MSSP) solved by CHN is effective in	Not explicitly mentioned what the research gaps are. The document mainly focuses on discussing a new hybrid routing protocol using a modified K-Means clustering algorithm and a continuous Hopfield network for VANET networks. Also mention the challenges and problems in the field of transportation and the need for autonomous wireless communication between different platforms.

			mobility models.		of a vehicles. Position (x,y). This parameter represents the position of a vehicles or centroid. Traffic density: This parameter indicates the number of vehicles on a part of the road and affects the speed of vehicles. Link reliability, buffer sizes, speed, node degree, maximum stable set problem (MSSP), Energetic function, Packet Delivery Ration (PDR), throughput.	selecting appropriate cluster head and determining the number of clusters. The findings suggest that the hybrid routing protocols can enhance the performance of VANETs by improving data transmission efficiency and reliability.	
8	M. Sheh et.al., (2021)	Enhanced a Hybrid Moths Flame Optimization Algorithm	This paper focuses on enhancing the MFO algorithm by introducing two levels of	The methods used in this paper include the hybridization of the MFO algorithm with	The parameters used in this paper is the population size (n) for the MFO	The finding of this paper includes the development of a	Need further investigation and improvement of the proposed hybrid algorithm.

		using new selection scheme.	improvements. The first levels involve hybridizing MFO with the local based algorithm called Hill Climbing (HC), resulting in a new algorithm called MFOHC. This hybridization aims to speed up the searching process and enhance the learning technique for finding candidates solutions. The second level of improvement involves investigation six popular selection schemes to improve the quality of the selected solution. The proposed algorithm	the Hill Climbing (HC) algorithm, resulting in a new algorithm called MFOHC. This hybridization aims to improve the exploitation search. Additionally, six popular selection schemes are investigated to maintain the diversity of solutions and improve their quality. The performance of the proposed algorithms is tested using thirty basic benchmark and five real-world problems from the IEEE CEC 2011 datasheet.	algorithm. The experiments were conducted using several values for population sizes such as 5,10,15,20,50,100 and 500. The result for difference population sizes are shown in Table 6.	hybrid algorithm called MFOCH, which combines the MFO algorithm with the Hill Climbing (HC) search strategy to improve the exploitation search. Additionally, several selection schemes were investigated to enhance the quality of the selected solutions. The experiments conducted showed that the proposed MFOCH algorithm	Specifically, the author suggests exploring new search technique, such as stochastic hill climbing and opposition based learning, to enhance the limitation of the proposed methods. Additionally, author proposed utilizing different optimization problems as well as multi-objective problems, to achieve better results. These research gaps highlight the potential for further advancements in the field of optimization algorithms.

			called PMFOHC aims to balance the exploration and exploitation phases while maintaining diversity of solutions.			outperformed other method in terms of solution quality and converge speed.	
9	Moni.J et.al., (2017)	Overview VANET: Requirement and its routing protocol.	The theory of this paper is focused on VANET. It's discussed the requirement of VANET, it routing protocols and the advantage and disadvantage of each protocol. The paper also includes a comparative study of the routing protocols in terms of packet delivery ration and throughput metrics. Additionally, it mentions the future scope of VANET and	Discussed various routing protocols for VANETs. Its compares and analyse the advantage and disadvantages of different protocols. The routing protocols considered in the paper include proactive protocols, reactive protocols, delay bounded protocols, sparse cluster-based protocol and broadcast protocols. Each protocol has its own forwarding method, such as wireless multi-hop forwarding,	Parameter used in this paper include packet delivery ration and throughput metrics. These parameters are used to evaluate the performance of the different routing protocols in VANET. The paper also discussed other parameters such as scalability, recovery strategy, delay time, packet retransmission overhead	Proactive protocol in VANET have advantage of wireless multi-hop forwarding, but they do not support carry and forwarding – suitable for urban scenario. Reactive protocol in VANET also have wireless multi-hop forwarding, but they support carry and	The need to further investigation into the security attacks and delay in message delivery in VANET. Develop solution to address the different types of security attacks in VANET. Improving packet delivery ration and throughput metrics of position-based routing protocol in VANET. Addressing the issues related to different types of security attacks and delay in delivering

			address issues such as security attacks and message delivery delay.	carry and forward and geo cast. Also discussed requirement of VANET, such as realistic traffic flow, digital map and virtual infrastructure.	and bandwidth reservation for message in the future.	forwarding. Suitable for Urban scenario. The delay bounded protocol in VANET support carry & forward. They are not suitable for multi-hop forwarding. Sparse cluster-based protocols in VANET has wireless multi-hop forwarding. Its suitable for urban scenario. The broadcast protocol in VANET has wireless multi-hop forwardin	message in VANET. Need comparative study of various routing protocol in VANET. Evaluating the performance of routing protocols in VANET in terms of scalability, recovery strategy, delay time, packet retransmission overhead and bandwidth reservation for future messages.

						g and support carry & forward. Suitable for highway scenario. The main requirement of VANET is to provide safety and driving comfort to users.	
10	Moham .M et.al., (2020)	Clustering in Vehicular Ad Hoc Network: Algorithm and Challenges	Focuses on VANET clustering algorithm. Discusses intelligent based, mobility based and multi hop based strategies for clustering in VANET. Provides classification of these algorithm based on their characteristics and compares their	Classification of VANET clustering algorithms based on their characteristic. Comparison of the performance of different clustering algorithm. Analysis of the strengths and weaknesses of clustering algorithms, including those that combine machine learning and fuzzy logic.	Relative speed for selecting the cluster head (CH). Acceleration and direction are ignored in the CH selection process. RSU dependency in the algorithm. Multiple metrics such as throughput, stability and bandwidth efficiency for date	The classification of VANET clustering algorithms into intelligent based, mobility based and multi hop based categories. The comparison of the performance of different clustering algorithm.	Lack of comprehensive studies on machine learning, fuzzy logic, mobility, NEMO and multi-hop strategies in VANET clustering. Additionally, there is a lack of detailed classification for intelligence based and multi-hop-based strategies. Overall, the paper highlights the need for

			performances . Also highlights the strength and weaknesses of different clustering algorithms, including thos that combine machine learning and fuzzy logic.	Discussion of the importance of cluster formation and CH selection in VANET clustering. Examine of the role of mobility-based strategies in improving cluster stability.	storage scheme. Vehicle velocity, degree node and channel condition for selecting slow vehicles as CH. Consideration of vehicles speed, distance acceleration, direction and previous history in CH selection. Evaluate of CH duration, number of clusters, packet delivery ratio (PDR), and clustering overhead as parameters for clustering efficiency.	Identified the strengths and weaknesses of clustering algorithm , including those that combine machine learning and fuzzy logic. The importance of cluster formation and CH selection in VANET clustering . The role of mobility based strategies in improving cluster stability.	further research in these areas to develop efficient and stable clustering algorithm for VANET.
11	Samira. J et,al., (2016)	A cluster Based Routing Algorithm for VANET	Focusses on VANETs and specifically address the issues of routing in these	Proposing a cluster-based routing algorithm for VANETs. In this algorithm a cluster head	The parameters used in this paper include:	The paper focus on VANETs and specifically on	Some potential research gaps could include the need for further investigation into the

			networks. It highlights the importance of routing due to the dynamic nature of mobile nodes in network. The paper proposes a cluster-based algorithm for VANETs based on V2V communication. The algorithm aims to reduce the End-to-End delay in network.	is selected for each cluster to maintain cluster membership information. The algorithm takes into account the high mobility and speed variation of nodes in VANETs. Also mentions that the proposed algorithm has been simulated using NS2.29 on a system running Ubuntu with 4 Gigabyte RAM.The simulation parameters are summarized in Table I. The avarage End-to-End delay metric is used to evaluate the performance of the propose algorithm.	Simulation area: 2000m * 1500m. Channel type: Wireless Channel. Radio-Propagation model: Workaround. Network interface type: Wireless Hy. MAC type: 802.11 DropTailPri Queue. Antenna model: OmniAntenna. Distance between cars: 20m. CBR intervals in s: 0.3s. Data packet size: 512 bytes. Simulation end time: 180s	routing algorithm for VANET based on V2V communication. They propose a cluster-based algorithm that aims to reduce end-to-end delay. The paper also discusses the characteristic of VANETs, existing routing protocols for VANET and simulation results of the proposed algorithm.	performance and effectiveness of the proposed cluster-based algorithm in real world scenarios, the comparison of the proposed algorithm with other existing routing protocols for VANETs and the exploration of potential improvements or modification to the algorithm to address specific challenges or limitation in VANETs.
12	Sadeep. N et.al., (2020)	Vehicular Ad-Hoc Network (VANET). A brief	Focuses on VANETs, which are wireless communicati	Discusses VANETs and their applications, challenges and	Some of the parameters mentioned include the mobile	Its highlight safety applications such	Some of the gaps mentioned include the need for

		knowledge.	on networks where vehicles and other devices exchange information to improve highway safety and provide information services. The paper discusses the architecture and protocols used in VANETs as well as the application areas and future research directions. Its also highlights the challenges faced by VANETs such as security and network management. Overall, the paper aims to enhance traffic safety and efficiency through the use of VANETs.	future research directions. It provides and overview of the architecture and communication protocols used in VANETs. The paper also explores the various application area of VANETs, including safety, convenience, commercial and productive applications. Additionally, it highlights the challenges faced by VANETs, such as security, network management, technical aspects. The paper concludes by emphasizing the potential of VANETs to enhance traffic safety and efficiency.	domain, which comprises the vehicle domain (including vehicles like buses, cars and trucks) and the mobile device domain (including portable devices like PDAs, laptop, GPS and smartphones). The paper also mentions the onboard sensors that VANETs nodes are assumed to be equipped with for transmitting information to other devices or nodes. Addition, the paper outlines the architecture of a VANET system according to IEEE 1417-	as real-time traffic monitoring, cooperative message transfer, post-crash notification, road hazard control, notification, cooperative collision warning and traffic vigilance. It also mentions convenience applications like route diversions, electronic toll collection, parking availability and active prediction. The paper	addressing security challenges in VANETs such as developing effective measures to counter network attacks, denial of service attacks, sybil attacks, alteration attacks, social attacks, tunnel attacks, monitoring attacks and eavesdropping. Another gaps is the need to improve network scalability in VANETs, considering the mobility and volatility of vehicles in the network.

					2000 and ISO/IEC 42010 standards, which includes the mobile domain, infrastructure domain and generic domain.	also addresses the challenge and future research directions for VANETs, including security challenges, network scalability and vehicle-to-infrastructure communication.	
13	Saroj.K et.al., (2022)	Moth Flame Optimization: Theory, Modification, Hybridization and Application.	The theory of this paper is focused on the MFO algorithm and its various aspects. It discussed the need for nature inspired optimization methods and introduce MFO as one such algorithm. The paper	The method used in this paper include the MFO algorithm, Kapor's threshold image segmentation, Marine Predators Algorithm (MPA), multi-level thresholding (MLT), CAD model, swarm algorithms, opposition	Load demand, solar and wind power generation, AFPID parameters, distributed generators (DG) position and sizes, impulse response coefficients of FIR, machining parameters, FACTS	The finding on this paper include efficiency, accuracy and f-scored performances of the method proposed using the MFO algorithm for	Need further investigation into the performance and effectiveness of the MFO algorithm compared to other optimization algorithms. Additionally, there is a gap in research regarding the applications of MFO in specific fields

			provides a detailed review of MFO, including its origin, working process and mathematical formulation. Explores the development, variants, modifications and hybridizations of MFO.	learning technique, Gaussian mutation, position updating mechanism, K-means algorithm, fuzzy c means (FCM), hybrid symbiotic DE, and hybrid microgrid system (HMGS)	devices, direction overcurrent relays, data stream, congestion control, JAYA blended moth flame optimization, transmission loss minimization, optimal machining parameters, RGB colour image segmentation, minimum cross entropy thresholding, fitness value.	distinguishing between three classes (Normal, AD and Cognitive features) based on selection algorithm features. The author also found that the enhanced MFO, which incorporates Kapur's threshold image segmentation, is superior to other models in locating tumours in clinical grade MRI slices.	such as web services composition, steel frame structure and web-based communities.
14	Sanaz. K et.al., (2016)	Using Clustering for target in Vehicular Ad Hoc	The theory of this paper focuses on the use of clustering for target	Include clustering for target tracking in VANETs. The paper proposes two	The parameters used in this paper include VANETs,	Demonstrate that the proposed clustering schemes	One possible research gaps could be the need for further investigation

		Network (VANETs)	tracking in VANETs. It discussed the challenges of dynamic networks and proposes two cluster-based algorithms for reliable and stable target tracking. The paper also highlights the potential applications of VANETs in Intelligent Transportation Systems (ITS) and the need for low-delay, low-overhead and precise tracking systems.	cluster-based algorithms for reliable and stable target tracking. Performance evaluation and testing results are presented, comparing the proposed algorithms to centralized cluster-based algorithms. The paper also discussed the potential applications of VANETs in Intelligent Transportation System (ITS) and the need for low-delay, low-overhead and precise tracking systems.	Intelligent Transportations System (ITS), Wireless Ad Hoc Network, Mobile Ad Hoc Network (MANETs), Wireless Sensors Network (WSN), Clustering, Target Tracking, Flooding Multi-hop Routing, Performance Evaluation, Algorithms Design and network protocols.	provide better performance for target tracking applications in VANETs compared to other cluster-based algorithms. The performances evaluation and testing results show the reliability and stability of the proposed algorithms. Addtionally, the paper highlights the potential applications of VANETs in Intelligent Transportation	and development of novel technique to guarantee performance and reduce network congestion in VANETs for target tracking applications. Additionally, there amy be a need for more research on the comparison and evaluation of distributed algorithms versus centralized cluster-based target tracking algorithm in VANETs.

						System (ITS) and emphasizes the need for low-delay, low overhead and precise tracking systems in VANETs.	
15	Yaser. A et.al., (2022)	An Evolutionary Algorithm Based on Vehicular Clustering Technique for VANET.	The theory of this paper is based on the use of and evolutionary algorithm called MFOs to solve the vehicular algorithm problem in VANETs. The paper explains that MFO has been proven to be an efficient method in solving optimization problems and has achieved successful results in various domains such	The paper explains that MFO is bio-inspired procedure that creates optimized clusters for reliable and efficient communication in VANETs. The algorithm works by using moths as search agents that fly in the search space, while the flames represent the best solutions found so far. The moths explore the search space near the flame	The parameter used in this paper include transmission range of the vehicles (adjusted from 100m to 600m), the number of nodes modified from 30 to 60 and the dimension of the road sections (ranging from 1km2 to 4km2). These parameters were used in the experimental	The findings of this paper indicate that the proposed algorithm, AMONET based on MFO, generates a small number of clusters compared to other algorithm such as ACO,CLPSO,MOPSO. This lead to reduce hops and	

			as medical diagnosis and image segmentation . The paper proposes a clustering algorithm called AMONET, which based on MFO to improve communication efficiency in VANETs. The experimental results show that AMONET generates a smaller number of clusters compared to other algorithms, leading to reduced hops and improved message delivery rates.	and revise it whenever they find a superior solution. The algorithm also employs a linearly decreasing factor to converge towards the solution. The paper provides a block diagram that illustrates the general steps of the algorithm. The paper describes experimental setup and compares the results of the AMONET algorithm with other well-known procedures such as Ant Colony Optimization (ACO), Comprehensive Learning Particle Swam Optimization (CLPSO) AND Multi-Objective Particle Swarm	setup to assess the performance of the proposed algorithm.	improved message delivery rates in VANETs . The experimental results demonstrate that AMONET is efficient and adaptable in different scenario, outperforming other approaches.	

				Optimization (MOPSO). The result shown that AMONET generates a smaller number of clusters compared to other technique.			
16	Sham.R et.al., (2023)	Cluster Optimization in VANET by using MFO and K-Means Clustering .	The theory of this paper revolves around the development of wireless technology, specifically focusing on VANETs. VANETs have the potential to significantly contribute to smart transportation systems in the future by enhancing traffic services and reducing accident rates. However, clustering in VANETs comes with compromise such as	The method used in this paper include MFO algorithms is based on the transverse orientation behaviour of moths and is used for optimization purposes. It helps resolve challenging optimization issues by utilizing the behaviour of moths. K-means Clustering, on the other hands is a popular clustering algorithm used for cluster head selection in VANETs. Its partitions a	The parameter used in this paper include grid sizes ranging from 1km2 to 4km2, transmission range from 100m to 600m, and a total of 30 nodes. These parameters were used to test the efficiency of the clustering algorithm in terms of the percentage of cluster heads and the ratio of cluster members.	The finding of this paper includes the analysis pf clusters generated for differenc e grid sizes, transmiss ion ranges and nodes counts. The analysis provides insight into the impact of these paramete rs on cluster formation and the	The research gaps in this paper include the need for further investigation and improvement in the following areas: The impact of different clustering algorithms on VANET performance, while the paper focuses on the MFO algorithm and K-Means clustering, there may be other clustering algorithm that can be explored for their

			increased latency and overhead. The paper discussed the use of the MFO algorithm and K-Means Clustering to optimize the VANET network.	dataset into a predetermined number of clusters based on the similarity of the data points can represent the vehicles' location, velocity and other relevant information. K-Means clustering is an effective approach for cluster head as it helps identify cluster of vehicles that are similar in term of their location and other parameter.		resulting network characteristic. It helps in understanding the relationship between these factors and optimizing the configuration for better network performance in VANET. The paper also addresses issues such as increasing interference, overlapping clusters, scalability concerns, mobility issues and inaccurate distance	effectiveness in VANETs. **Scalability concern**: The paper mentions that clustering in VANETs can lead to increase overhead. Further research can explore ways to optimize clustering algorithms to reduce overhead and improve scalability. **Mobility issue**: The high mobility of nides in VANETs can pose challenges in maintaining stable clustering. Future research can focus on developing algorithms or techniques that can handle the dynamic nature of VANETs more effectively. **Interference reduction:** The paper

						metrics that can arise with increasing transmission range and number of nodes. The introduction of clustering and optimization technique based on the MFO algorithm and K-Means Clustering can be helpful in resolving these optimization challenges in VANET clustering.	briefly mentions that issues of increasing interference with larger transmission ranges. Further research can investigate methods to mitigate interference and improve the overall performance of VANETs. **Accuracy of distance metrics:** The paper does not delve into specific distance metrics used in the clustering algorithms. Future research can explore the accuracy and reliability of difference distance metrics in VANET environments
17	Yasir Ali et. al., (2018)	Camonet: MFO based clustering Algorithm for VANET	The paper involves around the concept of VANETs. It discusses posed by	It is motivated by navigating procedure of moths, specifically their traverse orientation.	The parameters used in this paper include the vehicle direction,	The findings of this paper indicate that the Camonet	The research gap mentioned in the document is scalability problem in VANETs. This

			VANETs for routing and introduces the idea of clustering as a solution to enhance reliability and scalability. The paper also presents the CAMONET algorithm, a nature inspired algorithm for vehicular clustering, which is motivated by the navigating procedure of moth called transverse orientation. The algorithm is compared with other meta-heuristic algorithm and is shown to produce near-optimal results for vehicular clustering.	The algorithm creates a network of autonomous vehicles by randomly initializing their position within a certain region called their grid size. It also allocates arbitrary speeds and directions to the vehicles. The algorithm then measures the Euclidean distance between all the nodes to form a complete distance matrix of the network. The search space if formed using the position of moths, and its depend on parameters such as dimensions, lower bound and upper bound. The Camonet algorithm is compared with other well-known meta-	transmission range, grid size, the number of nodes in a network and the speed vehicles. These parameters are considered in the vehicular process. Additionally, the paper explores the use of other parameters such as dimension, lower bound, and upper bound in forming the search space for the Camonet algorithm,	algorithm, a nature-inspired algorithm for vehicular clustering, produces optimal result for clustering in VANET's. The algorithm is compared with other well-known meta-heuristic algorithm, and the result show that simulation results are presented graphically for enhanced analysis and the effectiveness of Camonet in producin	is considered a significant issue in network design and researchers have been working on finding new framework and methods to address this problem. One of the vital research issues is how to cluster or group the vehicles in VANET to maintain network connectivity.

				heuristic algorithm and the result indicate that it delivers optimal results for clustering in VANETs.		g optimal results is highlight ed.	
18	Asad Ali et. al., (2019)	VANET Clustering Using Whale Optimizati on Algorithm	The theory of this paper is the use of the Whale Optimization Algorithm (WOA) in clustering VANET networks. WOA is inspired by the feeding bahavior of humpback whales, specifically the spiral bubble- net attacking methods. The algorithm utilizes the behaviour of whales in searching for prey as a basis for finding optimal solutions in forming vehicles clusters. The research	The method use in this paper is the Whale Optimization Algorithm (WOA)	The parameter used in this paper include the distance between whales and the best whales obtained, the distance between cluster cluster head and cluster member, the location of the best agent obtained, the position vector of search agents, the cluster members of each cluster, and the coefficient vector used to choose between exploration and	The finding of this paper show that the whale optimizat ion algorithm (WOA) performs better that the Compreh ensive Learning Particle Swarm Optimiza tion (CLPSO) in reducing the number of clusters in VANETs . The result also demonstr ates that WOA optimizes	The research gaps in this paper is the need to find the upper and lower bound for creating vehicular clusters in emergent 5G vehicular scenarios using realistic discrete-event simulations. This is mentioned as a future work proposal in paper.

			compares the results of GOA with other clustering algorithm and shows that WOA is better at reducing the number of clusters in VANET network.		exploitation behaviour for updating the position of search agents.	the formation of vehicular cluster and decrease the end-to-end delays in communication.	
19	Muhammad Fahad et. al., (2017)	Optimization of Vehicular Node Clustering Process using Evolutionary Algorithm	The theory used in this paper is the implementation and comparison of the ICGWO (Improved Gray Wolf Optimizer) algorithm in VANET. The paper also discussed the comparison of ICGWO with CLPSO (Comprehensive Learning Particle Swarm Optimization) and MOPSO (Multi Objective Particle Swarm	The method used in this paper is the Gray Wolf Optimization (GWO) based algorithm for VANET.	The parameter used in this paper are follow: Population size (particle): 100 Maximum iteration: 150 Inertia weight (W): 0.694 C112,C212 Simulation area: 100m,200m, 300m,400m. Lower Bound (lb):0 Upper Bound (ub): 100 Dimension: 2	The finding of this paper show that the proposed ICGWO algorithm in VANET requires the minimum number of clusters compared to CLPSO and MOPSO algorithm. This led to reduced resources and improved network	The research gap in this paper is that the proposed method, ICGWO is a novel method that uses Gray Wolf Optimization for clustering in VANET environments for the first time. The paper also mentions that other meta-heuristics such as Moth Flame Optimization and Dragon Fly optimizer can be implemented for the same problem in future enhancement.

			Optimization) algorithm.		Transmissio n range: 10m – 60m Mobility model: freeway mobility model. Simulation runs: 10 W1 (weight of first objective function): 0.5 W2 (weight of second objective function):0.5 Nodes: 30,40,50 and 60	performa nce. This result also indicate that the packet delays and routing costs are minimize due to reduced number of clusters. The graphical result demonstr ate that the proposed methodol ogy provides optimize d results compared to competit ors.	
20	Ghada H et. al., (2019)	An Evolution ary Approach for Optimized VANET Clustering	The theory of this paper is to optimize the clustering algorithm in VANET's by formulating it as a many-objective optimization	The method of this paper is to optimize the clustering algorithm in VANET's by formulating it as a many-objective optimization	The parameters include thresholds, coefficients, timers and counters that govern the behaviour of the	The finding of this paper indicates that the proposed optimizat ion approach, using the	The research gap on this papers is that there is a need for optimization technique to improve the performance of clustering

			problem. The authors propose an approach to optimize the configuration parameters of the clustering algorithm using the NSGA-III many-objective optimization algorithm. The approach consists of two steps: a metaheuristic optimization stage and a solution evaluation stage. In the optimization stage, the NSGA-III algorithm is applied to the clustering problem, and in the solution evaluation stage, each suggested solution is evaluated using a network simulator. The experimental	problem. The author proposes an approach to optimize the configuration parameters of the clustering algorithm using the NSGA -III may-objective optimization algorithm. The approach consists of two stages: a metaheuristic optimization stage and a solution evaluation stage. In the optimization stage, the NSGA-III algorithm is applied to the clustering problem, and in the solution evaluation stage, each suggested solution is evaluated using a network simulator. The experimental results demonstrate that the	clustering algorithm. These parameters are optimized to improve the performance of the clustering algorithm in terms of cluster lifetime and clustering packet overhead.	NSGA-III algorithm, improves the performance of the Double Head Clustering (DHC) algorithm in VANET's. The optimal configuration obtained through the optimization process increase the cluster lifetime by up to 134% and reduce the clustering packet overhead by up to 30%. The experimental results show that	algorithm in VANETs network on Highway. The author address this gap by proposing a many-objective optimization approach using the NSGA-III algorithm. They evaluate the performance of the optimize clustering algorithm using a network simulator and compare it with the non-optimized algorithm. The results show significant improvements in cluster lifetime and clustering packet overhead.

			results demonstrate that the optimal configuration can significantly improve the cluster lifetime by up to 134% and reduce the clustering packet overhead by up to 30%.	optimal configuration can significantly improve the cluster lifetime by up to 134% and reduce the clustering packet overhead by up to 30%.		the optimized configuration of the clustering algorithm outperforms other clustering schemes in term of cluster stability and packet overhead.	

2.3 Conclusion.

The current review focuses on the application of VANET clustering optimization using the MFO algorithm and K-Means clustering. The MFO algorithm is used to simulate the movement behavior of moths and update the position based on movements, while the K-Means clustering algorithm is used to partition nodes based on their proximities by optimizing the distance between nodes within the same cluster. The combination of the MFO algorithm and K-Means clustering is used to improve clustering efficiency, scalability, coverage, and clustering results, while reducing communication and energy consumption. This approach is used to optimize the clustering in VANET, leading to better network performance, more reliable communication, and improved efficiency.

The limitations of the studies include the lack of real-world implementation and the limited coverage of the database search. The studies are based on simulations and do not provide real-world implementation results. The database search is limited to Scopus, which may not cover all relevant studies in the field.

For future research, it is recommended to conduct real-world implementation studies to evaluate the effectiveness of VANET clustering optimization algorithms in real-world scenarios. Additionally, expanding the database search to include more sources may provide a more comprehensive view of the field.

2.4 Issue and Challenging.

The main issues and challenges for VANET clustering optimization revolve around cluster head selection, high mode mobility, stability in clustering and the need to enhance efficiency and communication within VANET networks. Addressing these challenges is crucial for optimizing clustering algorithms and improving the performance and reliability of VANET communication system.

2.4.1 Dynamic nature of the network topology in Vehicular Ad-Hoc Networks (VANETs) presents challenges due to the continuous movement of vehicles, changes in the network density and varying communication pattern.

To address these challenges, the introduction of the MFO (Moth-Flame Optimization) algorithm and K-Means clustering techniques has been proposed in research related to VANET clustering optimization. These algorithms aim to optimize clustering efficiency, scalability, coverage, and clustering results in VANET environments. The MFO algorithm simulates the movement behaviour of moths to update node positions based on movements, while the K-Means clustering algorithm partitions nodes based on their proximities, optimizing the distance between nodes within the same cluster. By combining these techniques, researchers seek to enhance network performance, reliability, and efficiency in VANET communication systems amidst the dynamic and challenging nature of vehicular networks.

2.4.2 The Cluster Head's role in Clustering and Optimization in VANETs is encompassing communication coordination, inter and intra clusters communication and mobility management. The selection of Cluster Heads in VANET's indeed challenging due to dynamic nature of vehicular environments.

The search results show that the K-Means clustering algorithm is an effective method for multi-clusters in VANETs. The algorithm can be used to partition nodes based on their proximities by optimizing the distance between nodes within the same cluster. The selection of Cluster Heads in VANETs is indeed challenging due to the dynamic nature of vehicular environments. To address this, the MFO (Moth-Flame Optimization) algorithm can be used to simulate the movement behaviour of moths and update the position based on movements. This algorithm has been proven to be effective and efficient for solving optimization problems in VANET clustering. By combining the MFO algorithm and K-Means clustering, researchers aim to improve clustering efficiency, scalability, coverage, and clustering results, while reducing communication and energy consumption. This approach can lead to better network performance, more reliable communication, and improved efficiency in VANET communication systems.

2.4.3 Optimizing the number of Clusters Heads to maintain the stability of VANET clustering in a highway scenario in both directions. Highlighted in experimental transmission range adjustment, node configuration and movement pattern.

To address this issue, the introduction of SUMO (Simulation of Urban Mobility) for simulating the highway environment is crucial. SUMO is a widely used traffic simulation software that can accurately model vehicular movement, interactions, and communication patterns in complex urban environments, including highways. By utilizing SUMO, researchers can simulate realistic highway scenarios, adjust parameters such as transmission range and node configurations, and analyze the impact of different movement patterns on clustering stability in VANETs. This comprehensive simulation approach can provide valuable insights into optimizing the number of Cluster Heads and enhancing the stability of VANET clustering in highway scenarios.

2.5 Conclusion/Significant of Study

The conclusion and significant of study utilizing the Scopus Database for research on VANET clustering optimization using MFO algorithm and K-Means clustering for emphasize the following key points.

1. Comprehensive Literature Review: Utilizing the Scopus database allows researchers to conduct a comprehensive literature review, ensuring access to a wide range of peer-reviewed journals,

conference proceeding and scholarly articles. This promotes a thorough understanding of existing knowledge, trends and advancements in the field of VANET clustering optimization.

2. Identification of influential Works: Scopus enables researchers to identify the most influential articles, authors and research contribution related to VANET clustering optimization. This ensure that the study is built upon a solid foundation of impactful and relevant literature.
3. Enhanced Credibility and Validity: Utilizing a reputable database such as Scopus enhances the credibility and validity of the study, as it ensures that the research is grounded in high-quality, peer-reviewed literature and adheres to established academic standards.

In conclusion, the use of the Scopus database in a study on VANET clustering optimization using the MFO algorithm and K-Means clustering facilitates a robust, evidence-based approach that adds depth and credibility to the research. Scopus indexes publications from around the world, offering a global perspective on research and scholarly communications.

2.6 Results and Findings

The trend of publications in VANET Clustering Optimization from 2017 to 2024 shows a fluctuation, with a significant increase in the number of publications from 2017 to 2018, followed by a decrease from 2018 to 2019. The number of publications then increased from 2019 to 2020, followed by a decrease from 2020 to 2021. The number of publications increased significantly from 2021 to 2022, but then decreased significantly from 2022 to 2023 and again from 2023 to 2024.

In summary, the trend of publications in VANET Clustering Optimization from 2017 to 2024 shows a fluctuation, with a need for optimizing the clustering process in VANETs to enhance the overall network performance. This can be achieved through the implementation of bio-inspired node clustering optimized approaches, such as the Moth Flame Optimization (MFO) and environment-aware clustering algorithms that can adapt themselves to follow the changes in the environment features. The search result provides insights into the growth of scientific publications over time, particularly focusing on Scopus data and output trends from 2017 to 2024.

Table 2: Growth of publication by year

Year	Total number of publications
2024	25
2023	114
2022	119
2021	91
2020	95
2019	88
2018	80
2017	74

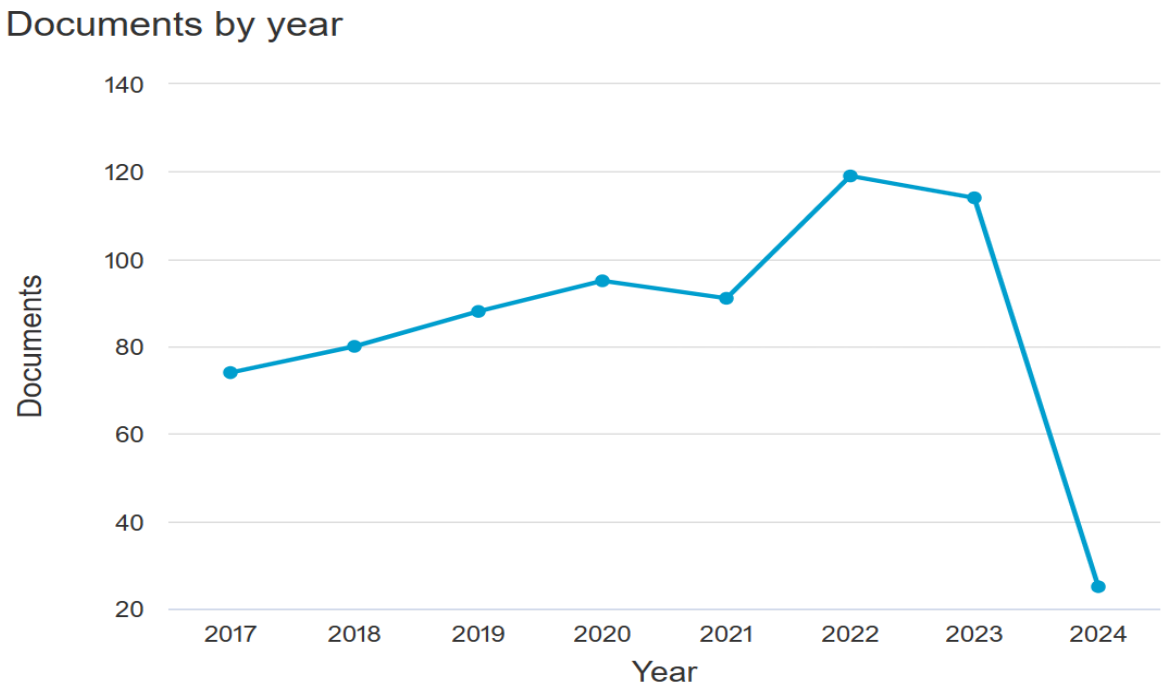

Figure 3: Total publications by year

2.5.1 Type of Documents.

The documents related to VANET Clustering Optimization is that there is a significant amount of research and development focused on optimizing clustering strategies in Vehicular Ad hoc Networks (VANETs). The documents encompass a variety of document types, with a substantial number of articles (368), conference papers (246), conference reviews (37), book chapters (22), reviews (9), letters (2), and short surveys (2) dedicated to exploring and enhancing clustering algorithms in VANETs. These documents highlight the importance of clustering in improving the quality of service in various VANET protocols and applications, such as data dissemination, media access control, Internet of vehicles, and intrusion detection systems. Researchers are exploring innovative approaches, including machine learning-based frameworks and bio-inspired optimization algorithms like the Moth Flame Optimization (MFO), to optimize clustering algorithms by considering environmental factors and adapting to changes in the network environment.

Table 3: Types of Documents.

Source Type	Total Publication
Article	368
Conference Paper	246
Conference Review	37
Book Chapter	22
Review	9
Short Survey	2
Letter	2

2.5.2 Source Type of Documents.

These documents cover a range of topics related to VANET Clustering Optimization, including modelling and verifying clustering properties in VANET protocols, detailed analysis of VANET clustering strategies

from intelligence, mobility, and multi-hop perspectives, and optimization of environment-aware VANET clustering using machine learning. The documents also discuss the use of intelligent clustering approaches to optimize the routing of data packets throughout VANETs and the optimization of clustering algorithms' parameters based on the surrounding environment.

Table 4: Sources Type

Source Type	Documents
Journal	382
Conference Proceeding	205
Book Series	93
Book	6

2.5.3 Language used for Publications

The majority of publications related to VANET Clustering Optimization are in English, with a total of 682 documents. This indicates that the research and development in this field are primarily conducted in English-speaking countries or by researchers who prefer to publish in English. The low number of publications in Chinese, only 4 documents, suggests that the research in this field is not as active in Chinese-speaking countries or that researchers in these countries prefer to publish in their native language. The language distribution also indicates the global nature of research in VANET Clustering Optimization, with contributions from researchers around the world.

Table 5: Languages used for Publications

Language	Number of Publication
English	682
Chinese	4

2.5.4 Subject Area.

The conclusion drawn from this distribution is that the majority of publications related to clustering algorithms in VANETs are concentrated in the fields of Computer Science and Engineering, indicating a strong focus on technological advancements and practical applications in these areas. Mathematics also plays a significant role in contributing to the research on VANET clustering algorithms. Additionally, there is a notable presence of publications in Decision Sciences, Physics and Astronomy, Materials Science, and other interdisciplinary fields, showcasing the diverse range of disciplines involved in studying and optimizing clustering algorithms in VANETs

Table 6: Subject Area

Subject Area	Total Publication
Computer Science	582
Engineering	396
Mathematic	115
Decision Sciences	75
Physics and Astronomy	53
Materials Science	47
Social Sciences	42
Energy	35

Medicine	26
Environmental Science	18
Business, Management and Accounting	17
Biochemistry, Genetics and Molecular Biology	11
Multidisciplinary	8
Chemistry	7
Chemical Engineering	7
Economics, Econometrics and Finance	4
Neuroscience	2
Agricultural and Biological Sciences	2
Pharmacology, Toxicology and Pharmaceutics	1
Immunology and Microbiology	1
Earth and Planetary Sciences	1
Arts and Humanities	1

2.5.6 Authorship Analysis.

The search results show a list of authors and their total publications related to VANET Clustering Optimization. The authors with the most publications are "Undefined" with 37 publications, followed by "Sondi, P." with 8 publications, and "Singh, D.", "Sindhwani, M.", "Prakash, A.", "Yadav, R.S.", "Wahl, M.", "Tripathi, R.", "Trabelsi, H.", "Khattab, A.", "Hasson, S.T.", "Hamdi, M.M.", "Aliouat, Z.", "Aadil, F.", and "Senouci, O." with 7 publications each.

Overall, the search results show a significant amount of research and development in the area of VANET Clustering Optimization, with a focus on optimizing the clustering algorithms' performance, adapting to changes in the environment features, and considering various perspectives such as intelligence, mobility, and multi-hop. The documents also highlight the importance of using advanced techniques such as machine learning and many-objective optimization to improve the clustering algorithms' performance and adaptability.

Table 7: Authorship Analysis.

No	Author Name	Total Publication	No	Author Name	Total Publication
1	Undefined	37	35	Kadoch, M.	4
2	Sondi, P.	8	36	Hosmani, S	4
3	Singh, D.	7	37	Hassan, A.	4
4	Sindhwani, M.	7	38	Ghaffari, A.	4
5	Prakash, A.	7	39	Ge, M.	4
6	Yadav, R.S.	6	40	Buhnova, B.	4
7	Wahl, M.	6	41	Bennis, H.	4
8	Tripathi, R.	6	42	Bangui, H.	4
9	Trabelsi, H.	6	43	Atiquzzaman, M.	4
10	Khattab, A.	6	44	Anitha, A.	4
11	Hasson, S.T.	6	45	Zhang, J.	3

12	Hamdi, M.M.	6	46	Zhang, D.	3
13	Aliouat, Z.	6	47	Wu, W.	3
14	Aadil, F.	6	48	Villas, L.A.	3
15	Senouci, O.	5	49	Touil, A.	3
16	Rivoirard, L.	5	50	Tanwar, S.	3
17	Rashid, S.A.	5	51	Sulistyo, S.	3
18	Jabbar, M.K.	5	52	Srinivasan, S.	3
19	Harous, S.	5	53	Singh, R.	3
20	Gupta, N.	5	54	Singh, C.	3
21	Fahmy, Y.A.	5	55	Singh, B.K	3
22	Audah, L.	5	56	Shrivastava, P.K.	3
23	Alsuhli, G.H.	5	57	Shankar, K.	3
24	Alaya, B.	5	58	Sellami, L.	3
25	Abassi, R.	5	59	Ramat, E.	3
26	Zhang, T.	4	60	Radhika, D.	3
27	Talib, M.S.	4	61	Peixoto, M.L.M.	3
28	Pal, R.	4	62	Patil, R.	3
29	Noor, R.M.	4	63	Patheja, P.S.	3
30	Moussaoui, S.	4	64	Ozera, K.	3
31	Kchaou, A.	4	65	Ouahou, S.	3
32	Katiyar, A.	4	66	Ngo, D.T.	3
33	Kandali, K.	4	67	Mukhtaruzzaman, M.	3
34	Kakkar, D.	4	68	Moulahi, T.	3
69	Kadoch, M.	4	139	Mohanty, A.	3
70	Hosmani, S	4	140	Mohammed, S.J.	3
71	Hassan, A.	4	141	Mathapati, B	3
72	Ghaffari, A.	4	142	Maqsood, M.	3
73	Ge, M.	4	143	Malik, A.W.	3
74	Buhnova, B.	4	144	Maia, A.H.O.	3
75	Bennis, H.	4	145	Liu, Y.	3
76	Bangui, H.	4	146	Kumar, P.	3
77	Atiquzzaman, M.	4	147	Krishnaraj, N.	3
78	Anitha, A.	4	148	Khan, M.F.	3
79	Zhang, J.	3	149	Khan, J.Y.	3
80	Zhang, D.	3	150	Kandar, D.	3
81	Wu, W.	3	151	Joshi, G.P.	3
82	Villas, L.A.	3	152	Ikeda, M.	3
83	Touil, A.	3	153	Hussin, B.	3
84	Tanwar, S.	3	154	Hajlaoui, R.	3
85	Sulistyo, S.	3	155	Gupta, S.K.	3
86	Srinivasan, S.	3	156	Guemara, S.	3

87	Singh, R.	3	157	Gruyer, D.	3
88	Singh, C.	3	158	Ghadi, F.	3
89	Singh, B.K	3	159	Elhoseny, M.	3
90	Shrivastava, P.K.	3	160	Chyne, P.	3
91	Shankar, K.	3	161	Chebbi, E.	3
92	Sellami, L.	3	162	Bylykbashi, K.	3
93	Ramat, E.	3	163	Bhuvaneswari, A.	3
94	Radhika, D.	3	164	Bennis, L.	3
95	Peixoto, M.L.M.	3	165	Aravindhan, K.	3
96	Patil, R.	3	166	Darabkh, K.A	2
97	Patheja, P.S.	3	167	Dahiya, P.K.	2
98	Ozera, K.	3	168	Choo, K.K.R.	2
99	Ouahou, S.	3	169	Cho, W.	2
100	Ngo, D.T.	3	170	Cheng, X.	2
101	Mukhtaruzzaman, M.	3	171	Cheng, J.	2
102	Moulahi, T.	3	172	Chen, Y.	2
103	Mohanty, A.	3	173	Chaurasia, B.K.	2
104	Mohammed, S.J.	3	174	Alioua, A.	2
105	Mathapati, B	3	175	Ali, A.	2
106	Maqsood, M.	3	176	AlQahtani, O.	2
107	Malik, A.W.	3	177	Ahmad, M.	2
108	Maia, A.H.O.	3	178	Abdulrazzak, H.N.	2
109	Liu, Y.	3	179	Abdulelah, A.J.	2
110	Kumar, P.	3	180	Abbas, Z.H.	2
111	Krishnaraj, N.	3	181	Abbas, G.	2
112	Khan, M.F.	3			
113	Khan, J.Y.	3			
114	Kandar, D.	3			
115	Joshi, G.P.	3			
116	Ikeda, M.	3			
117	Hussin, B.	3			
118	Hajlaoui, R.	3			
119	Gupta, S.K.	3			
120	Guemara, S.	3			
121	Gruyer, D.	3			
122	Ghadi, F.	3			
123	Elhoseny, M.	3			
124	Chyne, P.	3			
125	Chebbi, E.	3			

126	Bylykbashi, K.	3			
127	Bhuvaneswari, A.	3			
128	Bennis, L.	3			
129	Aravindhan, K.	3			
130	Ali, A.	3			
131	Alam, S.	3			
132	Ahmad, I.	3			
133	Adrian, R.	3			
134	Abbas, A.H.	3			
135	Dwivedy, B.	2			
136	Ding, X.	2			
137	De Grande, R.E.	2			
138	Das, D.	2			

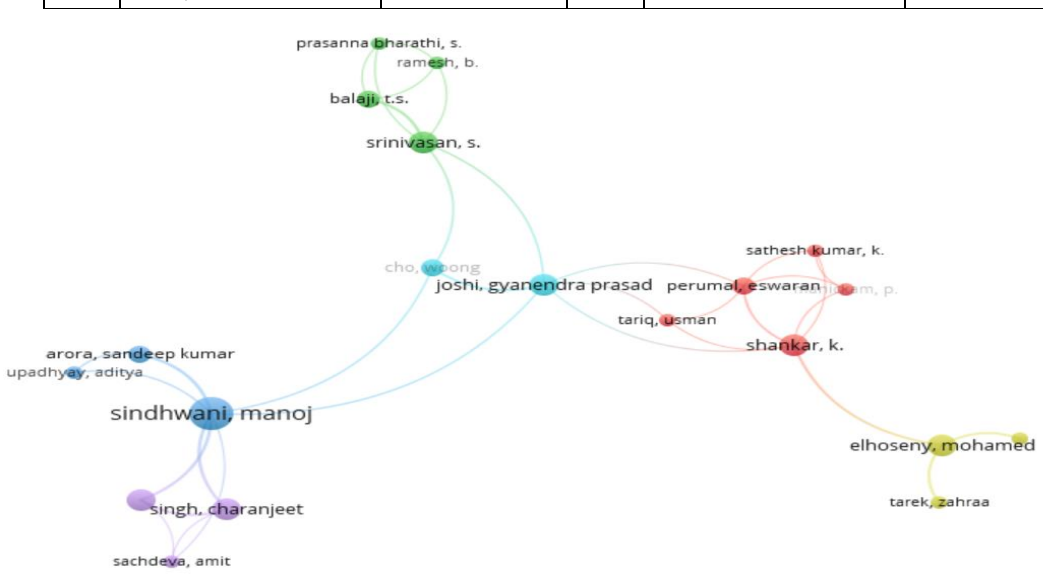

Figure 3: Network visualisation map of the co-authorship based on authors

Network visualization map of authors' co-authorship analysis. The size of the node indicates co-authorship frequency. A line between two nodes indicates collaboration between two authors. The line thickness between two nodes corresponds to the line strength, which varied depending on the number of papers co-authored. Stronger collaboration is indicated by thicker lines. Authors with high levels of collaboration are depicted by nodes of the same colour.

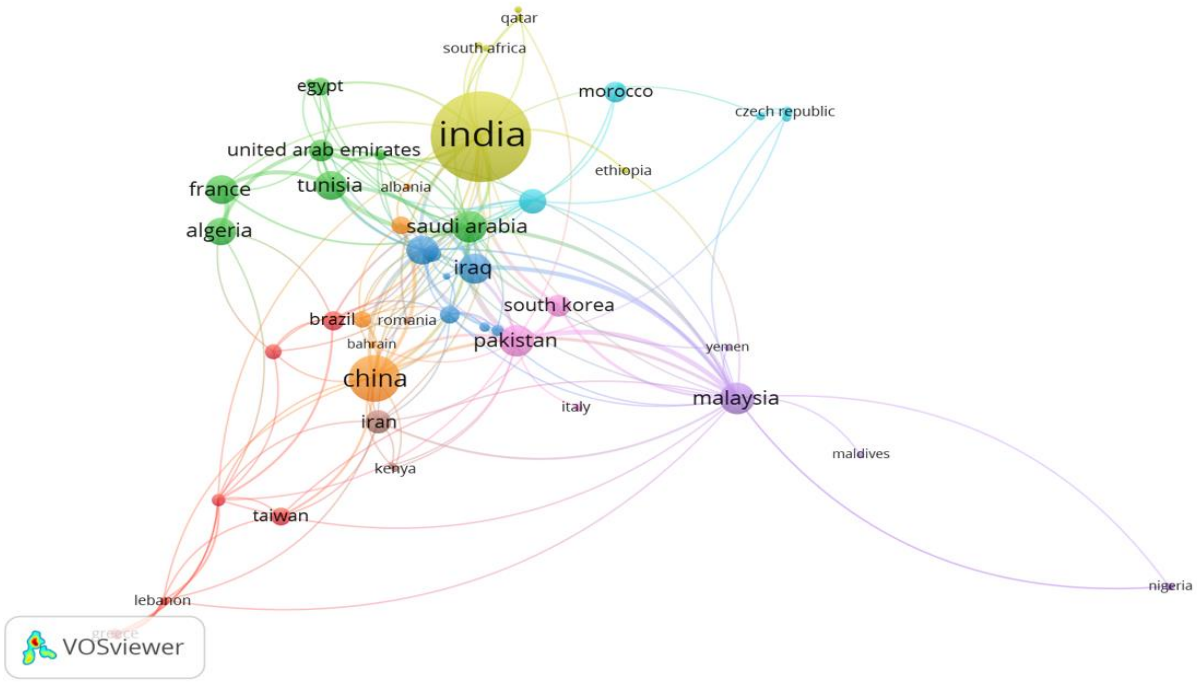

Figure 4 Network visualisation map of the co-authorship based on countries

Based on the provided sources, the network visualization map of co-authorship based on countries includes the following information for "Arab Saudi":

- Clusters 9.
- Links 22.
- Total links strength 36000.
- Documents 36.

In this context, “Arab Saudi” is part of a network visualization map that involves 36 documents and is clustered into 9 clusters with 22 links and a total link strength of 36,000. This information indicates the collaborative relationship and intensity of co-authorship involving “Arab Saudi” within the network visualization map based on countries.

2.5.7 Most active institutions.

The total publication on VANET clustering optimization from Malaysia universities is as follows:

- University Malaya: 7 publications
- University Tun Hussein Onn: 5 publications
- University Technology Malaysia: 4 publications
- University Kebangsaan Malaysia: 4 publications
- **University Technical Malaysia (UTeM): 4 publications**
- University Tenaga Nasional: 2 publications

These publications cover various aspects of VANET clustering optimization, including the use of machine learning-based frameworks to enhance clustering algorithms, optimizing environment-aware VANET clustering, and exploring different strategies and challenges related to VANET clustering.

The research output from these universities reflects a significant focus on improving the quality of service in VANET protocols and applications through innovative clustering approaches that adapt to changing environmental features and road structures to enhance clustering performance.

Table 9: Most active institutions.

Institutions	Total Publication
Motilal Nehru National Institute of Technology Allahabad	14
Lovely Professional University	13
University of Sfax	11
University of Babylon	11
Ministry of Education of the People's Republic of China	10
Université Gustave Eiffel	10
SRM Institute of Science and Technology	9
Université du Littoral Côte d'Opale	9
K L Deemed to be University	9
Saveetha School of Engineering	9
Laboratoire d'Informatique Signal et Image de la Côte d'Opale	9
United Arab Emirates University	8
Vellore Institute of Technology	8
Anna University	8
Al Qassim University	8
Ecole Nationale d'Ingénieurs de Sfax	8
King Saud University	7
Annamalai University	7
Universiti Malaya	7
Université Ferhat Abbas Sétif 1	7
Université des Sciences et de la Technologie Houari Boumediene	7
Université de Lille	7
Saveetha Institute of Medical and Technical Sciences	7
Laboratoire Électronique Ondes et Signaux pour les Transports (COSYS-LEOST)	7
CNRS Centre National de la Recherche Scientifique	6
Cairo University	6
Beijing University of Posts and Telecommunications	6
École de Technologie Supérieure	6
Université de Gabès	6
Tongji University	6
Noorul Islam University	6
University of Misan	6
The Islamic University, Najaf	6
Faculty of Engineering	5
Dr. B.R. Ambedkar National Institute of Technology	5
Harbin Institute of Technology	5

Beijing Jiaotong University	5
Sejong University	5
The University of Oklahoma	5
University of Carthage, Ecole Supérieure des Communications de Tunis	5
Universiti Tun Hussein Onn Malaysia	5
University of Engineering and Technology, Peshawar	5
Imam Ja'afar Al-Sadiq University	5
Al Maarif University College	5
COMSATS University Islamabad, Attock Campus	5
Yeungnam University	4
College of Sciences	4
University of Electronic Science and Technology of China	4
Mansoura University	4
Université Moulay Ismaïl	4
Alagappa University	4
Universiti Teknologi Malaysia	4
Sun Yat-Sen University	4
Islamic Azad University, Tabriz Branch	4
Tianjin University of Technology	4
Masaryk University	4
Universiti Teknikal Malaysia Melaka	4
Faculty of Computer and Information	3
Universiti Kebangsaan Malaysia	2
Universiti Tenaga Nasional	2

Keywords analysis

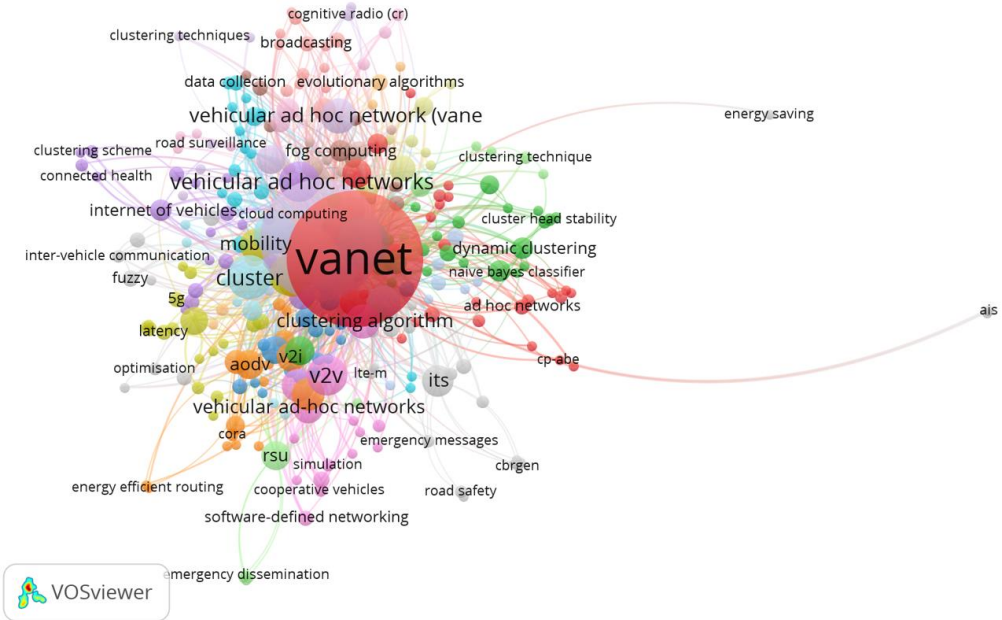

Figure 5 Network visualisation map of the author keywords.

In the specific example provided, the network visualization map includes 53 nodes, 12 clusters, 174 links, and a total link strength of 187,000. This indicates that there are 53 unique keywords in the publications, which are grouped into 12 clusters based on their co-occurrence. There are 174 pairs of keywords that co-occur in the same publication, and the total link strength of 187,000 indicates the overall strength of the co-occurrence relationships between the keywords.The network visualization map of author keywords can be used to identify the most frequently occurring keywords, the clusters of keywords that are closely related, and the strength of the relationships between the keywords. This information can be used to identify trends and patterns in the research related to social justice and social injustice, and to identify areas for further research

2.5.8 Top 20 Keywords.

These keywords are frequently used in research papers, articles, and studies related to VANET Clustering Optimization. The purposes for their use are to discuss various aspects of VANET Clustering Optimization, such as optimizing the clustering process, improving network performance, and including environment-awareness in clustering algorithms. The keywords also cover the use of meta-heuristic algorithms and machine learning techniques to optimize the clustering process in VANET.

Table 10: Top 20 keywords

No	Keywords	Total Publications	No	Keywords	Total Publications
1	Vehicular Ad Hoc Networks	480	9	Intelligent Systems	98
2	VANET	311	10	Intelligent Vehicle Highway Systems	66
3	Clustering	246	11	Roads And Streets	59
4	Clustering Algorithms	235	12	Intelligent Transportation Systems	57
5	Vehicular Adhoc Networks (VANETs)	212	13	Cluster Analysis	54
6	Vehicles	196	14	Routing	53
7	Vehicle To Vehicle Communications	148	15	Traffic Congestion	52
8	Clustering	115	16	Vehicle Transmissions	49
17	Ad Hoc Networks	49	74	V2I	14
18	Mobile Telecommunication Systems	48	75	Medium Access Control	14
19	Vehicular Networks	47	76	Cluster-based	14
20	Quality Of Service	47	77	AODV	14
21	Network Security	47	78	Transportation	13

22	Vehicular Ad Hoc Network	44	79	Number Of Vehicles	13
23	VANETs	44	80	Multi-hop Clustering	13
24	Optimization	44	81	Clustering Approach	13
25	Topology	43	82	Cluster Head Selection	13
26	Motor Transportation	42	83	Accident Prevention	13
27	Cluster Head	41	84	Roadside	12
28	Security	38	85	Dynamic Clustering	12
29	K-means Clustering	36	86	Vehicular Communication	11
30	Internet Protocols	36	87	Vehicle To Infrastructure	11
31	Cluster-heads	34	88	V2V Communications	11
32	Cluster	34	89	Smart City	11
33	Network Routing	33	90	Simulation	11
34	Information Dissemination	33	91	Traffic Information	10
35	Routing-protocol	32	92	Scalability	10
36	Internet Of Things	31	93	Intelligent Transport System	10
37	Accidents	31	94	Street Traffic Control	9
38	Routing Algorithms	29	95	Road Vehicles	9
39	Cluster-head Selections	29	96	MATLAB	9
40	Routings	28	97	Internet Of Vehicle	9
41	Network Architecture	28	98	Gateways (computer Networks)	9
42	Energy Efficiency	28	99	Dynamic Topologies	9
43	Packet Delivery Ratio	27	100	Evolutionary Algorithms	8
44	Machine Learning	27	101	Edge Computing	8
45	V2V	26	102	Comparative Analysis	8

46	Data Dissemination	26			
47	Vehicular Communications	24			
49	Clustering Techniques	24			
50	Vehicle To Vehicles	23			
51	Stability	23			
52	Particle Swarm Optimization (PSO	22			
53	Optimisations	22			
54	Mobile Ad Hoc Networks	22			
55	5G Mobile Communication Systems	22			
56	Vehicular Ad Hoc Network (VANET)	21			
57	Traffic Control	21			
58	Fuzzy Logic	21			
59	Data Transfer	21			
60	Clustering Algorithm	21			
61	Wireless Telecommunication Systems	20			
62	Optimization Algorithms	19			
63	Mobility	19			
64	MANET	19			
65	Ad-hoc Networks	19			
66	K-means	18			
67	Cluster Stability	18			
68	Vehicle Ad-hoc Networks	17			
69	ITS	17			
70	Cluster Computing	16			
71	RSU	15			
72	Fog	15			
73	Clustering Scheme	15			

2.5.9 Citation analysis

Top cited articles in VANET Clustering Optimization research.

1. “Optimizing Environment-aware VANET Clustering using Machine Learning” by Yasser Fahmy, Ghazi Alsuhli and Afnan Khattb, published in the International Journal of Intelligent Transportation System Research in 2023. This paper proposed a machine learning-based framework to include environment-awareness in clustering algorithms, optimizing the clustering algorithms parameters

based on road structure and traffic features to improve the quality of service in VANET protocols and applications.

2. "Optimized Node Clustering in VANETs by using Meta-Heuristic Algorithms" by Waleed Ahsan, Muhammand Fahad Khan, Farhan Aadil, Muazzam Maqsood, Staissh Ashraf, Yunyoung Nam and Seungmin Rho, published in electronic in 2020. This paper propose a grasshoppers optimized-based node clustering algorithm for VANETs (GAO) for optimal cluster head selection.
3. "An Evolutionary Approach for Optimized VANET Clustering" by Muhammad Fahad Khan, Khurram Shahzad and Muhammad Zeeshan Shakir, published in IEEE Access in 2021. This paper formulates the clustering algorithm optimization problem as a many-objective's parameters using a multi-objective optimization algorithm.
4. "Increasing Cluster Stability in VANET by Candidate Cluster Head Nomination Algorithm" by Muhammad Fahad Khan, Khurram Shahzad and Muhammad Zeeshan Shakir, published in the International Journal of Intelligent Transportation Systems Research in 2023. This paper proposes a candidate's cluster head nomination algorithm to select the optimal clusters head and stabilize the VANET environment, improving the routing efficiency.

2.6.0 Publication by source title.

This summary outlines the distribution of publications related to VANET clustering optimization across different source types, indicating the varying levels of research output in this area.

Table 12 Most active source title

No	Source Title	Total Publication	No	Source Title	Total Publication
1	IEEE Access	23	25	International Journal Of Intelligent Networks	4
2	Wireless Personal Communications	22	26	International Journal Of Computer Networks And Applications	4
3	Advances In Intelligent Systems And Computing	19	27	Intelligent Automation And Soft Computing	4
4	Lecture Notes In Networks And Systems	16	28	IEEE Vehicular Technology Conference	4
5	Communications In Computer And Information Science	12	29	Annales Des Telecommunications Annals Of Telecommunications	4
6	Vehicular Communications	11	30	Ad Hoc And Sensor Wireless Networks	4
7	International Journal Of Communication Systems	11	31	Sensors	3
8	IEEE Transactions On Intelligent Transportation System	11	32	Mobile Networks And Applications	3

9	Ad Hoc Networks	11	33	Mathematics	3
10	Lecture Notes Of The Institute For Computer Sciences Social Informatics And Telecommunications Engineering Lnicst	10	34	Ksii Transactions On Internet And Information Systems	3
11	Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics	10	35	Journal Of Ambient Intelligence And Humanized Computing	3
12	Journal Of Advanced Research In Dynamical And Control Systems	10	36	International Journal Of Scientific And Technology Research	3
13	Procedia Computer Science	9	37	International Journal Of Interactive Mobile Technologies	3
14	Wireless Networks	8	38	International Journal Of Intelligent Engineering And Systems	3
15	Wireless Communications And Mobile Computing	8	39	International Journal Of Information Technology Singapore	3
16	ACM International Conference Proceeding Series	7	40	International Journal Of Engineering Trends And Technology	3
17	Lecture Notes In Electrical Engineering	6	41	IFIP Advances In Information And Communication Technology	3
18	International Journal Of Advanced Computer Science And Applications	6	42	IEEE Transactions On Vehicular Technology	3
19	Electronics Switzerland	6	43	Computer Systems Science And Engineering3	3
20	Computers Materials And Continua	6	44	Computer Networks	3
21	Transactions On Emerging Telecommunications Technologies	5	45	Computer Communications	3
22	Sustainability Switzerland	5	46	China Communications	3

23	Measurement Sensors	5	47	Telecommunication Systems	3
24	International Journal Of Innovative Technology And Exploring Engineering	5	48	Scientific Reports	2
49	Proceedings Of The International Conference On Electronics Communication And Aerospace Technology Iceca 2017	2	73	Bulletin Of Electrical Engineering And Informatics	2
50	Proceedings Of The 2018 International Conference On System Modeling And Advancement In Research Trends Smart 2018	2	74	Applied Sciences Switzerland	2
51	Proceedings 2023 12th IEEE International Conference On Communication Systems And Network Technologies Csnt 2023	2	75	6th Iraqi International Conference On Engineering Technology And Its Applications Iiceta 2023	2
52	Proceedings 2022 International Conference On Algorithms Data Mining And Information Technology Admit 2022	2	76	4th International Conference On Electrical Communication And Computer Engineering Icecce 2023	2
53	Proceedings 2021 IEEE 10th International Conference On Communication Systems And Network Technologies Csnt 2021	2	77	**2023 13th International Conference On Information Technology In Asia Cita 2023**	2
54	Proceedings 2017 3rd International Conference On Advances In Computing Communication And Automation Fall Icacca 2017	2	78	2022 2nd International Conference On Intelligent Technologies Conit 2022	2
55	Plos One	2	79	2020 IEEE 19th International Symposium On Network	1

				Computing And Applications NCA 2020	
56	Pdgc 2022 2022 7th International Conference On Parallel Distributed And Grid Computing	2	80	2023 31st International Conference On Software Telecommunications And Computer Networks Softcom 2023	1
57	Mobile Information Systems	2	81	2023 2nd International Conference On Advances In Computational Intelligence And Communication Icacic 2023	1
58	Materials Today Proceedings	2	82	2023 1st International Conference On Advances In Electrical Electronics And Computational Intelligence Icaeeci 2023	1
59	Journal Of Physics Conference Series	2	83	2023 1st IEEE Afro Mediterranean Conference On Artificial Intelligence Amcai 2023 Proceedings	1
60	Journal Of Network And Systems Management	2	84	2022 International Wireless Communications And Mobile Computing Iwcmc 2022	1
61	Journal Of High Speed Networks	2	85	2022 International Mobile And Embedded Technology Conference Mecon 2022	1
62	Journal Of Green Engineering	2	86	2022 International Conference On Information Science And Communications Technologies Icisct 2022	1
63	Journal Of Communications	2	87	2022 3rd International Conference For Emerging Technology Incet 2022	1

64	Journal Of Circuits Systems And Computers	2	88	2022 3rd International Conference For Emerging Technology Incet 2022	1
65	Internet Technology Letters	2	89	2022 2nd Asian Conference On Innovation In Technology Asiancon 2022	1
66	Internet Of Things Energy Industry And Healthcare	2	90	2022 19th IEEE International Multi Conference On Systems Signals And Devices Ssd 2022	1
67	International Journal On Technical And Physical Problems Of Engineering	2	91	2022 2nd Asian Conference On Innovation In Technology Asiancon 2022	1
68	International Journal Of Vehicle Information And Communication Systems	2	92	2022 19th IEEE International Multi Conference On Systems Signals And Devices Ssd 2022	1
69	International Journal Of Communication Networks And Distributed Systems	2	93	2021 International Symposium On Networks Computers And Communications Isncc 2021	1
70	International Journal Of Applied Engineering Research	2	94	2021 IEEE International Conference On Computing Icoco 2021	1
71	International Journal Of Advanced Science And Technology	2	95	2021 9th International Conference On Reliability Infocom Technologies And Optimization Trends And Future Directions Icrito 2021	1
96	International Conference On Communication Technology Proceedings ICCT	1	116	2021 4th International Seminar On Research Of Information Technology	1

				And Intelligent Systems Isriti 2021	
97	2022 2nd Asian Conference On Innovation In Technology Asiancon 2022	1	117	2017 International Conference On Energy Communication Data Analytics And Soft Computing Icecds 2017	1
98	2022 19th IEEE International Multi Conference On Systems Signals And Devices Ssd 2022	1	118	2017 Intelligent Systems Conference Intellisys 2017	1
99	2021 International Symposium On Networks Computers And Communications Isncc 2021	1	119	2017 IEEE Symposium On Communications And Vehicular Technology Scvt 2017	1
100	2021 IEEE International Conference On Computing Icoco 2021	1	120	2017 IEEE Smartworld Ubiquitous Intelligence And Computing Advanced And Trusted Computed Scalable Computing And Communications Cloud And Big Data Computing Internet Of People And Smart City Innovation Smartworld Scalcom Uic Atc Cbdcom Iop SCI 2017 Conference Proceedings	1
101	2021 9th International Conference On Reliability Infocom Technologies And Optimization Trends And Future Directions Icrito 2021	1	121	2017 IEEE 8th Annual Ubiquitous Computing Electronics And Mobile Communication Conference Uemcon 2017	1
102	2021 4th International Seminar On Research Of Information Technology And Intelligent Systems Isriti 2021	1	122	2017 2nd International Conference On Emerging Computation And Information Technologies Icecit 201	1
103	2021 29th International Conference On Software Telecommunications And	1	123	2016 International Conference On Information Technology Incite 2016 The Next	1

	Computer Networks Softcom 2021			Generation IT Summit On The Theme Internet Of Things Connect Your Worlds	
104	2020 Systems Of Signal Synchronization Generating And Processing In Telecommunications Synchroinfo 2020	1			
105	2020 International Wireless Communications And Mobile Computing Iwcmc 2020	1			
106	2020 International Conference On Intelligent Systems And Computer Vision Iscv 2020	1			
107	2019 International Conference On Automation Computational And Technology Management Icactm 2019	1			
108	2019 IEEE Student Conference On Research And Development Scored 2019	1			
109	2019 IEEE International Conference On Vehicular Electronics And Safety Icves 2019	1			
110	2019 IEEE International Conference On Consumer Electronics Taiwan Icce TW 2019	1			
111	2018 Proceedings Of The Japan Africa Conference On Electronics Communications And Computations Jac Ecc 2018	1			
112	2018 International Conference On Smart Communications In Network Technologies Saconet 2018	1			
113	2018 International Conference On Emerging Trends And Innovations In Engineering	1			

	And Technological Research Icetietr 2018				
114	2018 IEEE Wireless Communications And Networking Conference Workshops Wcncw 2018	1			
115	2018 10th International Conference On Advanced Computing Icoac 2018	1			

Title and abstract analysis

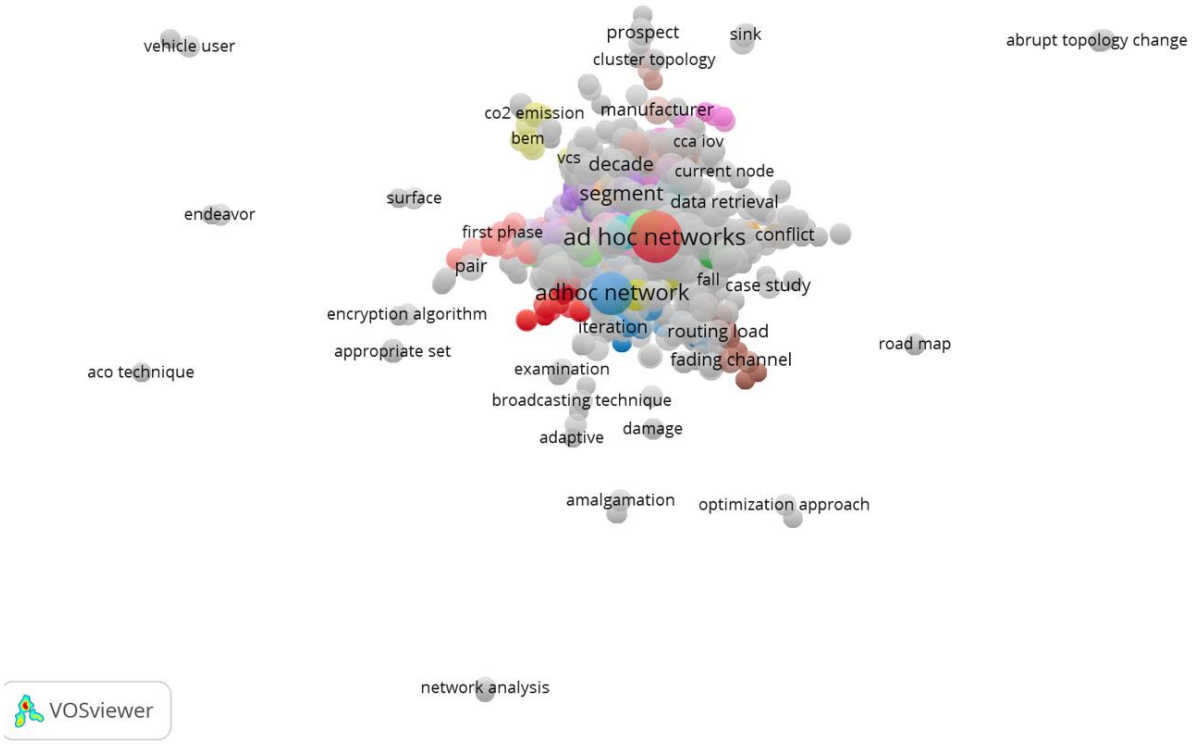

Figure 6: VOS viewer visualisation of a term co-occurrence network based on title and abstract fields.

Interpreting a VOSviewer visualization of a term co-occurrence network based on title and abstract fields involves understanding the relationships between terms extracted from the titles and abstracts of academic publications. Interpreting a VOSviewer visualization of a term co-occurrence network based on title and abstract fields involves analysing the size and proximity of nodes, identifying clusters, understanding thematic patterns, and gaining insights into the relationships between terms extracted from academic publications.

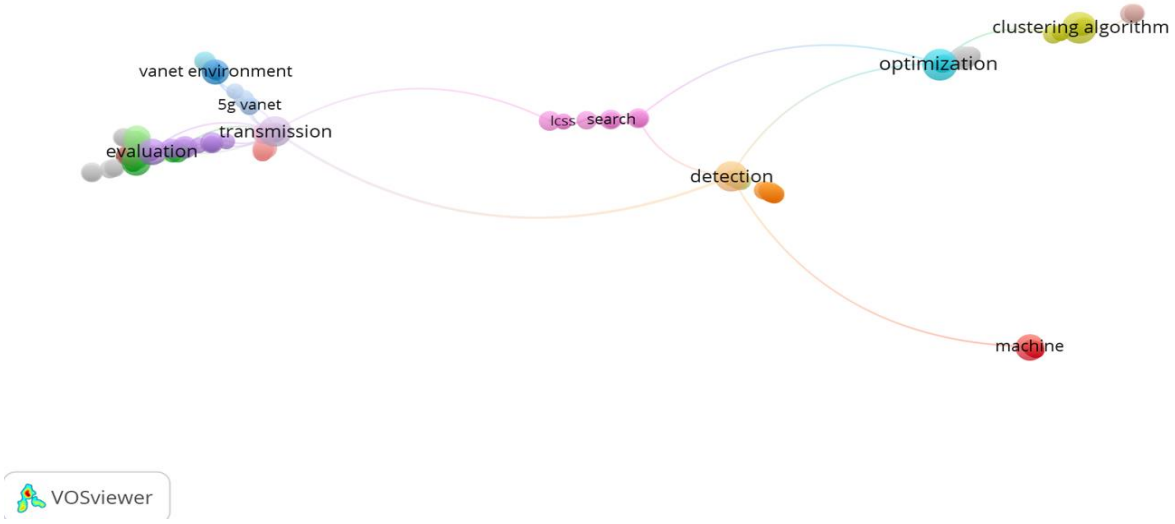

Figure 7: VOS viewer visualisation of a Term co-occurrence network based on title fields

By analysing the terms, clusters, links, and total link strength, you can gain insights into the relationships between the terms and the structure of the network. This can help you identify key terms, clusters of related terms, and the overall connectedness of the network. The size variation and network density parameters can be adjusted to customize the visualization to your needs.

2.7 Conclusion and future recommendation.

The research on VANET clustering optimization using the MFO algorithm and K-Means clustering has shown promising results, but there is still a need for further research and development to address the challenges and limitations of VANET clustering optimization. Integrating advanced optimization techniques, developing dynamic clustering algorithms, exploring hybrid clustering, conducting real-world implementation studies, and addressing security and privacy concerns are key areas for future research and development in VANET clustering optimization.

References

1. Craig Cooper, Daneil Franklin, Montserrat Ros, Farzad Safei, Mehran Albolhassan (2017), A Comparative Survey of VANET Custering Technique. DOI: 10.1109/COMST.2016.2611524. *IEEE Communication Surveys & tutorial.*
2. Dmitry Zelikman and Michael Segal (2015). Reducing Interferences in VANET's. DOI: 10.1109/TITS.2014.2348498. *IEEE Transcations on Intelligent Transportation System.*
3. Wenshuang Liang, Zhuorong Li, Hongyang Zhang, Shenling Wang, and Rongfang Bie (2015), Vehicular Ad Hoc Networks: Architectures, Research Issues, Methodologies, Challenges and Trends. https://dx.doi.org/10.1155/2015/745303. *International Journal of Distribution Sensor Network, Volume 2015, Article ID 745303, 11 pages.*
4. Chaudhary, Saira Gilani, Sana Ajmal and Amir Qayyum (2017), Vehicular Ad Hoc Network (VANET): A Survey, Challenges and Applications. DOI: 10.1007/978-981-10-3503-6_4. *Advances in Intelligent Systems and Computing*. (Access on: https://www. researchgate.net/publication/315512136.

5. Ismail Ghazi Shayeb, Abdel Rahman Hamzah Hussein, Ayman Bassam Nassuora (2011) . A survey of Clustering Schemes for Mobile Ad-Hoc Network (MANET). Access on: https://www.researchgate.net/publications/316058967.
6. Kaushik Padmanabhan, Ilango Jeyasubramanian, Jagadish Pandian, Jai Vaignesh Rajendran (2016). *Improving QoS in VANET Using Dynamic Clustering Technique. Conference International Journal of Networks and Communications 2016, 6(4):72-79 DOI: 10.5923/j.ijnc.20160604.02. Access to: http://journal.sapub.org/ijnc.*
7. Kandali, K., Bennis L., and Bennisi H. (2021) A new Hybrid Routing Protocol using Modified K-Means Clustering Algorithm and Continuos Hopfield Network for VANET. DOI 10.1109/ACCESS.2021.3068074. *IEEE Volume 9. Access to: https://www.researchgate.net/publication/350301258.*
8. Mohammed Shehab, Laith Abualingah, Hanadi Al Shawabkah, Nagham Azmi (2021). Enhanced a Hybrid Moths Flame Optimization Algorithm using new selection scheme. *Engineering with Computers October 2021. DOI:10.1007/s00366-020-00971-7. Access to: https://www.researchgate.net/publication/339416829.*
9. Monika Jain and Rahul Saxena (2017), Overview of VANET: Requirement and its Routing Protocol. DOI: 10.1109/ICCSP.2017.8286742T. *International Conference on Communication and Signal Processing. April 6-8, 2017 India.*
10. Mohammad Mukhtaruzzaman and Mohammed Atiquzzaman (2020). Clustering in Vehicular Ad-Hoc Network: Algorithm and Challenges**.** *Researchgate and accepted paper in Elsevier Jornal pf Computers & Electrical Engineering. Access to: https://www.researchgate.net/publication/344150047.*
11. Sadeep N Kugali, Basaveshar Karnataka (2020). Venicular Ad Hoc Network (VANET), A brief knowledge. *International Journal of Engineering Research & Technology (IJERT)***.** DOI: 10.17577/IJERTV9IS060784. *Access to: https://www.researchgate.net/publication/342529669.*
12. Saroj Kumar, Saho Apu Kumar, Absalom, Jefrey O, Anath (2022). Moths Flame Optimization: Theory, Modification, Hybridzation and Application. Archives of Computational Methods in Engineering (2023) 30-391-426. https://doi.org/10.1007/s11831-022-09801-z.
13. Sanaz Khakpour, Richard W. Pazzi, Khalil El-Khatib (2016). Using Clustering for Target in Vehicular Ad-Hoc Network. *Accepted Manuscript. DOI: https://dx.doi.org/10.1016/j.vehcom.2017.02.002. Reference: VEHCOM 78*
14. Yaser.A., Aaadil, F., Khalil, A.,Assam, M., Abunadi, I, Alluhaidan, & A.S., & Al-Wesabi F.N (2022). An Evolutionary Algorithm Based Vehicular Clustering Technique for VANET. DOI 10.1109/ACCESS.2022.3145905. *IEEE Access.*
15. Sham Rizal, Sazlina and Shamala K.Subramaniam (Prof.Dato'Dr). Cluster Optimization in VANET using MFO Algorithm and K-Means Clustering. 2023 13th International Conference on Information Technology in Asia (CITA).DOI: 10.1109/CITA58204.2023.10262579.