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# Implementation Of Optimised Manet For Waste Management System With Real-Time Data

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**ABSTRACT**

In recent years, Waste Management System (WMS) is processing in smart cities with a support by the Internet of Things (IoT). WMS involves several responsibilities namely collection, disposal and waste usages in relevant facilities. Efficient waste management has a considerable impact on the quality of citizen's life in cities. The interaction between wireless sensor networks (WSN) and Mobile Ad-hoc NETworks (MANETs) with IoT provides excellent mobility for users and reduces the networks deployment. Data transfer via the intermediate connected devices must be maintained to shorten the distance between the devices. An intelligent routing algorithm of RUN optimizer is applied in MANET to find efficient paths that comply with the WMS constraints and avoid invalid paths that cause increased computation time. The RUN optimiser includes a Runge-Kutta technique to solve an ordinary differential equation that added a new parameter that depends on the step length of each individual while revising the individual location. The proposed work used to improve the balance between exploration and exploitation and enhance the routing table and distance. It attains higher efficiency than all other traditional methods.

**Keywords:** Waste management, MANET, sensor data collection, RUN optimiser, metrics

## 1. Introduction

The universe is moving to a smart environment and smart society with a numerous technology [1]. In smart technologies, an Effective WMS is a crucial factor for an urban development to enhance their infrastructure and services. This Waste treatment involves a several tasks such as collection, transportation, processing, recycling and disposal of waste materials [2]. The complexity of waste management systems increases day by day that leads to environmental degradation, poorly maintained infrastructure, health hazards, reduced human's life span, overflowing waste bins, unsanitary wastes, contributes to environmental pollution, harming ecosystems, spreading diseases and posing health risks to residents and so on [3].

Considering these issues, Effective WMS is to be developed by maintaining a clean, healthy and sustainable urban environment. An emerging technology if an IoT offered a promising support to integrate an advanced technologies for better waste collection, processing, and disposal [4]. In an IoT enabled WMS, there are various sensors are deployed across the city to monitor waste levels, environmental conditions and the waste bins status. The data collection is done in real-time which is essential for WMS. This real-time monitoring allows city authorities for ensuring waste management issues.

Though to attain a highly effective management system in real time dynamically, the MANET is integrated with an IoT system. MANET consist of mobile nodes that communicate with each other without depend on a fixed infrastructure for flexibility and scalability. In the WMS, the MANET played a vital role to enhance its mobility and allowed seamless movement of data between mobile nodes such as waste collection vehicles and static nodes like waste bins [5]. Furthermore, it has a self-configuring behaviour to ensure a continuous task even in dynamic conditions and various node positions which attains a robust and reliable communication for WMS applications.

In a traditional MANET based WMS have several limitations such as High computation time where an optimal route can be computationally intensive. Also, it leads to delays and inefficiencies in data transmission and inaccurate path selection that results an increased energy consumption and latency [6]. Some cases lead to bottlenecks, lower reliability and Limited adaptability that may not adapt well to the dynamic nature. Therefore, advanced routing algorithms in MANET is to addressed and enhanced the efficiency of WMS [7].

To overcome the limitations of traditional methods, the RUN optimiser based MANET is proposed. The RUN optimiser is designed to improve routing efficiency and also optimizing the balance between exploration and exploitation [8]. It also has a dynamic adjustment to ensure more efficient path selection and minimise computation time. By updating routing tables dynamically, it achieved the most efficient paths and also improved performance metrics such as energy consumption, Accuracy, packet delivery ratio and delay than the traditional methods.

The rest of the work contributes as related work discussed in section 2, section 3 presented a materials and methods of proposed work with its explanation. The section 4 described the result and discussion of proposed and traditional work performances and section 5 summarise the conclusion.

## 2. Related Works

Abdullah et al. [9] discussed a genetic optimization method to find efficient paths that meet WMS constraints and avoid paths that increase computation time. It includes a chromosome intersection operation, activation functions and node tables to achieve a redundancy and ensure path validity.

Saha et al. [10] explored various WMS like animal feeding, recycling, composting, fermentation, burning, landfills and land application. It integrated an IoT to iprove WMS processes at every stage from reduction to reuse and reduce a disposable materials.

Ijemaru et al. [11] developed an IoV-based model for smart city WMS strategies. It used a vehicles as opportunistic mobile data collectors and ant colony optimisation methods to optimize energy efficiency and data collection. It achieved an energy-efficient routing applications with an analytical approach to determine network energy consumption.

Kumar et al. [12] designed a WMS method for waste disposal with vehicular ad-hoc networks (VANETs). It provided an IEEE 802.11p and multicast routing in garbage collecting vehicle’s (GCV) on-board units (OBU), road-side units (RSU) and sensors for effective communication and data collections.

Nabou et al. [13] described a MANET based detect congestion normality test. It analysed throughput and end-to-end delay that can be affected by congestion to attain detection without modifying routing protocols or adding control messages.

Alslaim et al. [14] discussed a MANET routing protocols to establish efficient routes with minimal overhead and bandwidth consumption. It categorized routing protocols into proactive and reactive types due to the mobility and dynamic nature.

Sugumaran et al. [15] optimized routing in MANETs using a Token Economy Management method that assigned a token based on relative velocity, time delay, route cost and energy usage effectively.

Abdullah et al. [16] applied IoT in containers and trucks to manage waste overflow and separation by using a genetic method to attain an effective WMS. It considered waste source locations and population density in waste generation to attain a truck size based on waste type and optimizing routes accurately.

Singh et al. [17] examined data transmission challenges in MANETs such as taxi sharing and emergency services. It discussed the importance of node collaboration and trust for ideal network performance and reviewed MANET routing topology.

Rahman et al. [18] investigated the LoRa technology to collect a waste and focus on fairness in actuating truck agents. It presented a vehicle routing issues with an objective function considering both total distance and distance dispersion to improve fairness in WMS.

AM, A. B et al. [19] explored a self-configurable cluster using the k-means protocol to effectively select cluster heads and reduce power and energy loss. It operates on periodic rotations of cluster heads to enhances the better performance than transmission and direct communication protocols.

Janani et al. [20] presented an Aggregation-based Archive Population Optimization (AAPO) as routing protocol to minimise an energy usage. It prioritizes both local and global optimal routes and estimates route quality using multiple paths to minimize network disruptions.

Burduk et al. [21] utilized IMPACT IoT platform for WMS that has a waste container filling and route inconveniences. It considers a real-time container status to enhance a waste collection efficiency and avoid overfilling or frequent emptying.

## 3. Materials and Methods

To attain an efficient WMS for smart cities, an enhanced data collection, transmission and processing is to be carried out. The proposed architecture is shown in figure 1 that Initially process a sensor based data collection is done which is given in the following.

### 1.1. Sensor Deployment and Data Collection

Initially, sensors are strategically deployed across the city to ensure waste level monitoring, environmental conditions and bin locations. These IoT based sensors continuously collect data and transmit it to the central management system via wireless sensor networks (WSNs) and MANET. Some of the deployed sensors are mentioned in figure that are explained below.

**Level Sensors**: it is installed in waste bins to monitor fill levels in real-time. It provides helps schedule optimal data collection schedules and prevents overflow to assure timely waste collection.

**Gas Sensors**: it is used to detect gas such sd methane and carbon dioxide emitted from decomposing waste. It helps to identify potential hazards and provide decomposition processes.

**Temperature and Humidity Sensors**: These sensors used to track environmental conditions such as temperature and humidity that influence waste decomposition rates and odor generation in WMS.

**GPS Sensors**: Installed on both mobile waste collection units and static bins, it provides precise location data. This data optimized a collection route and efficiently coordinates a waste collection activity.

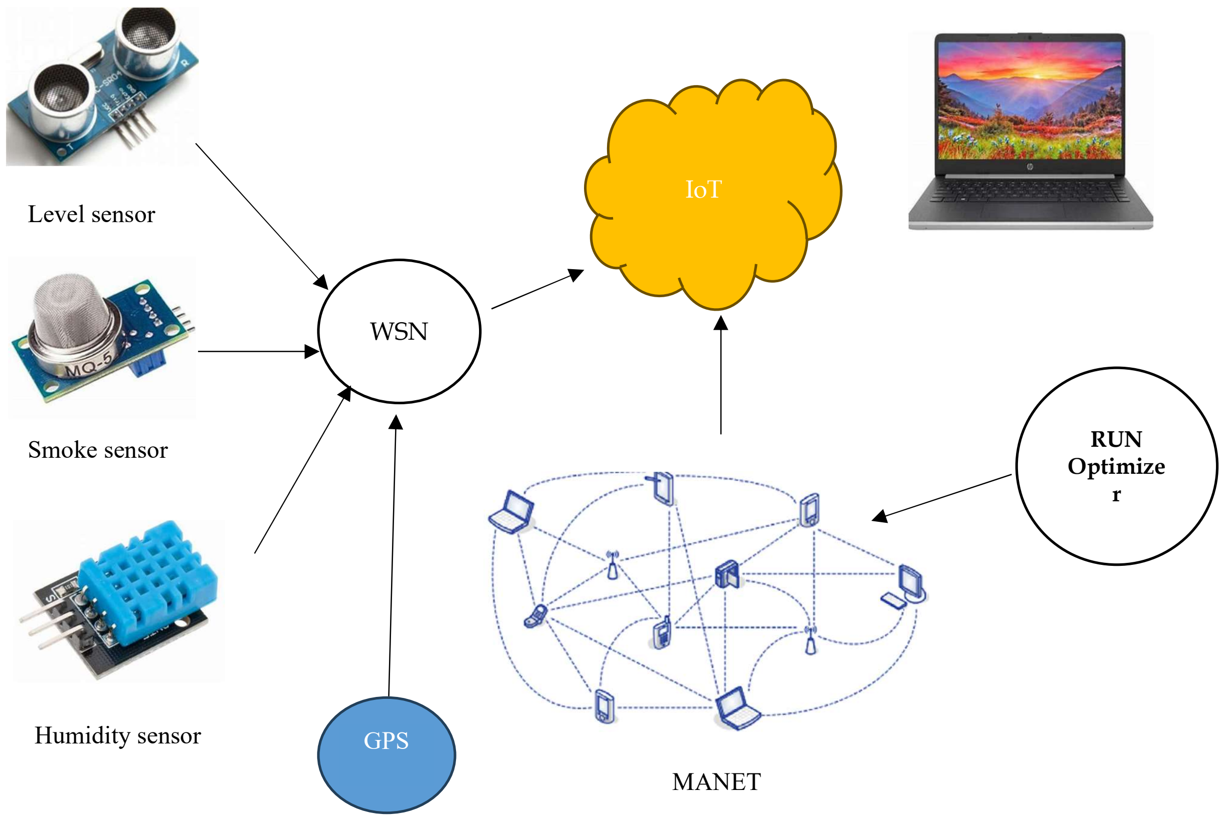



**Figure 1: proposed Architecture**

**Data Transmission and Network Communication**:

After the Data collection each sensor node communicates with its neighbors to relay information through WNS. The MANETs facilitate data transfer between mobile nodes (e.g., waste collection vehicles) and static nodes (e.g., waste bins).

WSN: It consists of numerous sensor nodes distributed throughout the city. These networks enable real-time data collection from the various sensors deployed. Each sensor node communicates with others to transmit collected data to a central system to process and analysis.

MANET: It is used to facilitate communication between mobile and static nodes without requiring a fixed infrastructure. It provides a flexibility required for dynamic urban environments and help reduce deployment costs. It supports seamless data transfer and ensure continuous network operation even when node positions and network conditions change.

**Methods**

In modern WMS, an optimal routing based on resource utilization and operational effectiveness in MANET is presented. The proposed work has MANET based RUN optimiser to attain an efficient routing path. The RUN optimiser is based on swarm optimization model that has stochastic components and the Runge-Kutta technique into it. It majorly focuses on mathematical principles and adaptive rules avoiding metaphors and clichéd to attain a robust solution for complex optimization issues.

**RUN Optimization**

The metaheuristic optimization algorithm are used to solve real world engineering problems [22][23]. The RUN method utilizes the Runge Kutta (RK) technique to calculate slopes and solve ordinary differential equations that serves as search logic foundation. By initializing a population randomly within specified bounds, the RUN optimiser process both global and local searches to find optimal solutions.

Exploration phase

During the exploration phase, the acceleration of each individual in the population is updated to encourage the exploration of new areas in the search space. This equation calculates the acceleration based on the current position, random coefficients, and the best-known positions.

$$a_i = x_i + \alpha(x_{best} - x_i) + \beta(x_j - x_k) \quad \textbf{(1)}$$

Where $a_i$ indicates an Acceleration of individual i, $x_i$ denotes current position of individual i, α and β indicates Random coefficients between 0 and 1, $x_{best}$ presents Best position and $x_i$ and $x_k$ are Randomly selected positions from the population.

Thus, an acceleration is updated to refine solutions around the best position to ensure a convergence to optimal solutions.

$$a_i = x_i + \gamma(x_{best} - x_i) + \delta(x_{best} - x_i) \quad (2)$$

Where γ and δ indicates a Random coefficient between 0 and 1.

The Normalization of the acceleration ensures that the updated acceleration values remain within a specific range that preventing extreme values that could destabilize the search process that is expressed in below equation.

$$a_{norm} = a_i - \; min(a_i)/max(a_i) - min(a_i) \quad (3)$$

Where $a_{norm}$ indicates Normalized acceleration, $min(a_i) and$ max $(a_i)$ represents as Minimum and maximum acceleration values.

Based on the normalized acceleration, the position of each individual is updated to assure that the search process incorporates both exploration and exploitation effectively. (equation 10)

$$x_i^{t+1} = x_i^t + a_{norm} \cdot \Delta_t \quad (4)$$

Where $x_i^{t+1}$ as Updated position of individual i at time t+1, $x_i^t$as Current position of individual i at time t and $\Delta_t$ Time step

The ESQ mechanism provides a new solutions by averaging random solutions and incorporating the best-known position that refining these solutions iteratively which is expressed in equation 11.

$$x_{new1} = x_{avg} + \epsilon(x_{best} - x_{avg}) \quad (5)$$

Where $x_{new1}$represents New solution generated, $x_{avg}$ as Average of three random solutions, ϵ indicates Random coefficient between 0 and 1 respectively.

Further refinement steps:

$$x_{new2} = x_{new1} + \zeta(x_{best} - x_{new1}) \qquad (6)$$

Where $x_{new}$ denotes as Further refined new solution and ζ indicates Random coefficient between 0 and 1.

These equations collectively ensure that the RUN method balances the exploration of new areas in the search space with the exploitation of known good solutions that facilitating efficient and effective optimization for MANET routing and the pseudocode of RUN optimiser is given in Algorithm 1.

**Algorithm 1: Pseudocode of RUN optimizer**

Procedure RUN_Optimizer(N, t_max, Con1, Con2, Con3, Con4, lli, uli)

Initialize parameters a, b and other constants (Con1, Con2, Con3, Con4)

Initialize population Xn (n = 1, 2, ..., N) with random positions within bounds (lli, uli)

Estimate an objective function

Evaluate $x_{best}$ solutions

t = 1

while (t <= $t_{max}$)

for each individual i in population

Calculate transfer (TO) and density declining factors (df) //Exploration phase

if (TO <= Con3)

Update acceleration using Equation (1) with Con1 and Con2

Normalize acceleration using Equation (3) with Con4

Update position using Equation (4)

else // Exploitation phase

Update acceleration using Equation (2) with Con1 and Con2

Normalize acceleration using Equation (3) with Con4

Update position using Equation (4)

end if

Determine objective function

If rand < 0.5 then

Calculate $x_{new2}$ using Equation (5) with Con1, Con2

If f($x_i$) < f($x_{new2}$) then

Further refine $x_{new2}$ to $x_{new}$ using Con1, Con2

end if

end if

end for

Update best and worst solutions

t = t + 1

end while

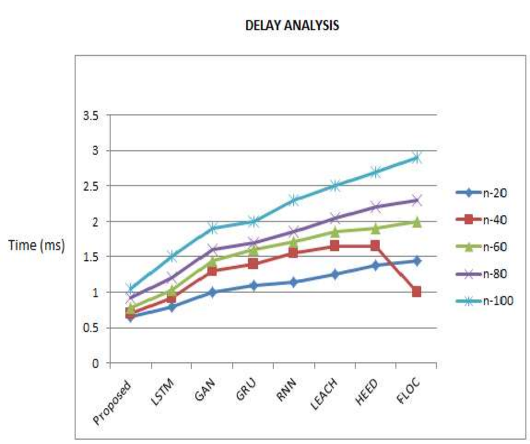
Return individual with the best fitness value

End Procedure

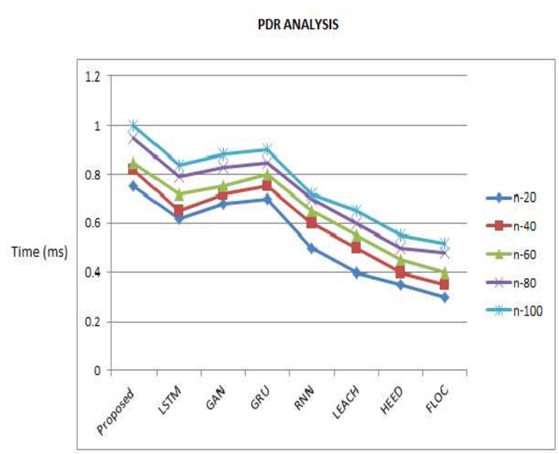
To optimize the routing model for a MANET based WMS, the RUN method is applied to handle routing efficiency, minimize energy consumption and improve data transmission reliability. Sensors data is transmitted via MANET where the RUN method optimizes routing paths by balancing exploration and exploitation phases to assure robust and adaptive routing.

## 4. Performance Evaluation

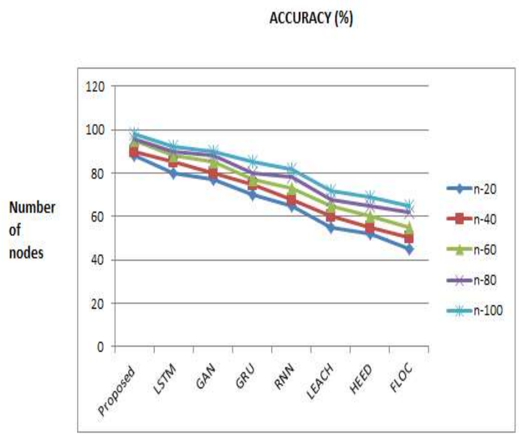
The proposed methodology is collected the real time data of sensor and provided an efficient routing mechanism using RUN optimiser. The performance of proposed and prior techniques are evaluated and compared with several metrics such as delay, packet delivery ratio (PDR), Accuracy and energy consumption. These metrics help in assessing the effectiveness of proposed RUN optimizer with traditional methods

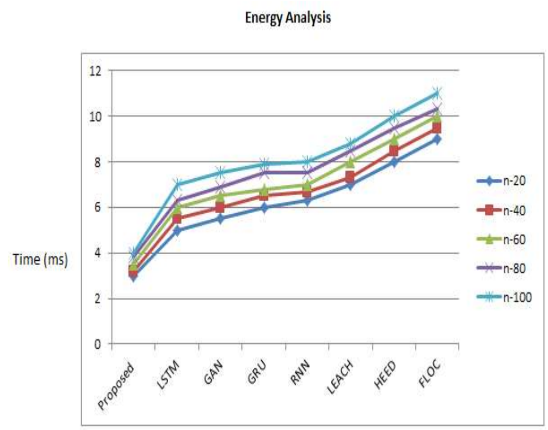



(a)




(b)




**(c)** **(d)**

**Figure 2: performance metrics analysis (a) delay analysis, (b) PDR analysis, (c) Accuracy and (d) Energy consumption analysis**

The proposed method outperforms LSTM, GAN, GRU, RNN, LEACH, HEED and FLOC significantly in various metrics. For delay analysis (figure 2a), the proposed model maintains the lowest delay across all node counts with values ranging from 0.65 to 1.05 while other methods show higher delays (e.g., LSTM at 1.5 and HEED at 2.7 for 100 nodes). In PDR analysis (figure 2b), the proposed method achieves the highest PDR that peaking at 1 for 100 nodes, compared to lower PDRs in other methods (e.g., RNN at 0.72 and FLOC at 0.52). The accuracy of the proposed model (Figure 2c) is superior that reaches 98% for 100 nodes effectively higher than the other methods (e.g., GAN at 90% and FLOC at 65%). Additionally, the proposed model demonstrates the best energy efficiency with energy consumption (figure 2d) increasing gradually from 3 to 4 as the number of nodes increases while other methods show higher energy usage (e.g., LSTM at 7 and FLOC at 11 for 100 nodes).

## 5. Conclusion

By integrating IoT with advanced method like RUN optimiser in WMS which can significantly enhance waste management in smart cities. By addressing the issues, the proposed systems ensure more efficient, reliable and scalable waste treatment solutions. This work includes a sensor for data collection that enables a real-time monitoring and decision-making. The proposed work improves routing efficiency of MANET by introducing new parameters and optimizing the balance between exploration and exploitation that resulting in superior performance in delay, accuracy, PDR and energy consumption. Whereas the proposed model maintains the lowest delay across all node counts with values ranging from 0.65 to 1.05, highest PDR, accuracy reaches 98% for 100 nodes and best energy efficiency with energy consumption. Therefore, the proposed method contributes to cleaner, healthier and more sustainable urban environments by improving the overall quality of life for residents.

## References

[1] Olusanya, M. O., & Vincent, O. R. (2020, March). A manet-based emergency communication system for environmental hazards using opportunistic routing. In 2020 International Conference in Mathematics, Computer Engineering and Computer Science (ICMCECS) (pp. 1-6). IEEE.

[2] Veeraiah, N., Khalaf, O. I., Prasad, C. V. P. R., Alotaibi, Y., Alsufyani, A., Alghamdi, S. A., & Alsufyani, N. (2021). Trust aware secure energy efficient hybrid protocol for manet. IEEe Access, 9, 120996-121005.

[3] Ramya, P., Ramya, V., & Babu Rao, M. (2023). Optimized deep learning-based e-waste management in IoT application via energy-aware routing. Cybernetics and Systems, 1-30.

[4] Srilakshmi, U., Veeraiah, N., Alotaibi, Y., Alghamdi, S. A., Khalaf, O. I., & Subbayamma, B. V. (2021). An improved hybrid secure multipath routing protocol for MANET. IEEE Access, 9, 163043-163053.
[5] Gopala Krishnan, C., Nishan, A. H., Gomathi, S., & Aravind Swaminathan, G. (2022). Energy and trust management framework for MANET using clustering algorithm. Wireless Personal Communications, 122(2), 1267-1281.
[6] Kumar, S. Aanjan, P. Karthikeyan, S. Aanjana Devi, S. Poonkuntran, V. Palanisamy, and V. Navatharani. "Protecting Medical Images Using Deep Learning Fuzzy Extractor Model." In Deep Learning for Smart Healthcare, pp. 183-203. Auerbach Publications, 2024.
[7] Rajeshkumar, G., Kumar, M. V., Kumar, K. S., Bhatia, S., Mashat, A., & Dadheech, P. (2023). An Improved Multi-Objective Particle Swarm Optimization Routing on MANET. Computer Systems Science & Engineering, 44(2).
[8] Ahmadianfar, I., Heidari, A. A., Gandomi, A. H., Chu, X., & Chen, H. (2021). RUN beyond the metaphor: An efficient optimization algorithm based on Runge Kutta method. Expert Systems with Applications, 181, 115079.
[9] Singhai, A., Aanjankumar, S., & Poonkuntran, S. (2023, May). A Novel Methodology for Credit Card Fraud Detection using KNN Dependent Machine Learning Methodology. In 2023 2nd International Conference on Applied Artificial Intelligence and Computing (ICAAIC) (pp. 878-884). IEEE.

[10] Kalphana, K. R., S. Aanjankumar, M. Surya, M. S. Ramadevi, K. R. Ramela, T. Anitha, N. Nagaprasad, and Ramaswamy Krishnaraj. "Prediction of android ransomware with deep learning model using hybrid cryptography." Scientific Reports 14, no. 1 (2024): 22351.

[11] Ijemaru, G. K., Ang, L. M., & Seng, K. P. (2022). Transformation from IoT to IoV for waste management in smart cities. Journal of Network and Computer Applications, 204, 103393.

[12] Kumar, N., Swamy, C., & Nagadarshini, K. N. (2014). Efficient garbage disposal management in metropolitan cities using VANETs. Journal of Clean Energy Technologies, 2(3), 258-262.

[13] Nabou, A., Laanaoui, M. D., Ouzzif, M., & El Houssaini, M. A. (2021). New method to detect the congestion for green networking in MANET. In Emerging Trends in ICT for Sustainable Development: The Proceedings of NICE2020 International Conference (pp. 161-169). Springer International Publishing.

[14] Kumar, S. Aanjan, Monoj Kumar Muchahari, S. Poonkuntran, L. Sathish Kumar, Rajesh Kumar Dhanaraj, and P. Karthikeyan. "Application of hybrid capsule network model for malaria parasite detection on microscopic blood smear images." Multimedia Tools and Applications (2024): 1-27.

[15] Sugumaran, S., Sivasankaran, V., Chitra, M. G., Sivasakthiselvan, S., & Jayarajan, P. (2022, January). Best optimized route in MANET using token economy management system. In 2022 IEEE Fourth International Conference on Advances in Electronics, Computers and Communications (ICAECC) (pp. 1-6). IEEE.

[16] Abdullah, N., Al-Wesabi, O. A., Mohammed, B. A., Al-Mekhlafi, Z. G., Alazmi, M., Alsaffar, M., ... & Sumari, P. (2022). IoT-Based waste management system in formal and informal public areas in Mecca. International Journal of Environmental Research and Public Health, 19(20), 13066.

[17] Singh, S., Pise, A., Alfarraj, O., Tolba, A., & Yoon, B. (2022). A cryptographic approach to prevent network incursion for enhancement of QoS in sustainable smart city using MANET. Sustainable Cities and Society, 79, 103483.

[18] Rahman, M. A., Tan, S. W., Asyhari, A. T., Kurniawan, I. F., Alenazi, M. J., & Uddin, M. (2024). IoT-enabled Intelligent Garbage Management System for Smart City: A Fairness Perspective. IEEE Access.

[19] AM, A. B. (2021). High energy efficient lifetime management system and trust management framework for

manet using self-configurable cluster mechanism. Peer-to-Peer Networking and Applications, 14, 1229-1241.

[20] Janani, R. S., & Asokan, R. (2024). Deployment of efficient MANET testbed using aggregation based archive population optimization. Biomedical Signal Processing and Control, 96, 106556.

[21] Burduk, A., Łapczyńska, D., Kochańska, J., Musiał, K., Więcek, D., & Kuric, I. (2022). Waste management with the use of heuristic algorithms and Internet of Things technology. Sensors, 22(22), 8786.

[22] V. P Kavitha, B. Sakthivel, S. Deivasigamani, K. Jayaram, R. Badlishah Ahmad & Ibrahima Sory Keita (04 Aug 2024): An Efficient Modified Black Widow Optimized Node Localization in Wireless Sensor Network, IETE Journal of Research, DOI: 10.1080/03772063.2024.2384486.

[23] Narmadha Ganesamoorthy, B. Sakthivel, Deivasigamani Subbramania, K. Balasubadra "Hen maternal care inspired optimization framework for attack detection in wireless smart grid network", International Journal of Informatics and Communication Technology, Vol. 13, No. 1, April 2024, pp. 123~130,