

A Heuristic Search Method Unified in Blockchain Expertise for Supply Chain Management

¹J.Jeyabharathi, ²S.Velliangiri, ³N.Nasurudeen Ahamed, ⁴P.Karthikeyan

¹ KPR Institute of Technology, Coimbatore-641 407, india

²CMR Institute of Technology, Hyderabad, India.

^{2,3} Presidency University, Bangalore, India.

Email: ¹shyambharathi2006@gmail.com, ²velliangiris@gmail.com

³nasurmecse@gmail.com, ⁴nrmkarthi@gmail.com

Abstract

Blockchain is a distributed open (Public) ledger that is used to record the transaction across many computers. Blockchain technology can be applied in any domain such as banking, healthcare, real estate, travel, food, and supply chain. In supply chain management, blockchain technology also integrates the Artificial Intelligence (AI). Artificial Intelligence empowers placing that information quickly without quite a bit of human efforts. Blockchain and artificial intelligence advancements, when executed together, might draw out a change that can be named as progressive in the field of innovation. AI, on the other hand, to find the optimal path in the commodities, we present the heuristic search method for the supply chain vehicle.

Keywords – Blockchain, Artificial Intelligence, Heuristic Search, Public Ledger, Supply Chain Management

1. Introduction

Blockchain is an essential innovation for its decentralized foundation. The blockchain contains a square of data. It is preposterous to expect to change square data or predate the data. Blockchain advances ordered into the accompanying kinds: 1. Open Blockchain 2. Private Blockchain 3. Consortium Blockchain. Open Blockchain: All Public Peer can go along with each other, and have equivalent rights (Example: Read, Write, and Execute) in the open hub. Private Blockchain: Only Authorized Private Peer can access in the system. The entrance to the hub in the private companion is just open to the individual hub. Consortium Blockchain: Only Authorized Team can just access and join this blockchain, all activity in the hub must obey to the entrance. Blockchain Technology chiefly centered on the exchange in the business arrange model. Numerous aspects of the present markets are probably going to be affected by an enormous scale selection of the blockchain strategy. In the blockchain, we entered the Supply Chain Management (SCM)[1]. Nowadays, SCM is an essential key factor in logistics. That is, SCM[2][3] is a significant part of an association and is depicted as the supervision and control of everything being equal (Producer to Consumer). A production network is frequently portrayed as an arrangement of organizations, people, actions, info, and assets associated with moving merchandise from the maker to buyer[4][5]. In Artificial Intelligence, we can include several searching techniques that are one integrated searching method is the Heuristic method. The meaning of heuristic is to discover or find a path[6]. Find the correct destination to using the heuristic search model in AI centers in the different changes in the performing frameworks that are related to Artificial Vision. Human-made consciousness.

2. Related Work

In this section, we have discussed a recent literature survey of goods in supply chain integrated with artificial intelligence algorithm optimally to reduce the transportation cost listed as follows:

Khaled Salah et.al.[7]Described how blockchain can be utilized in AI to improve the dependability, security, straightforwardness, trust, and the executives of information and calculations in AI applications.AI calculations can utilize the diagram database to extricate information, group designs, and foresee future solutions.

Annouch et al. [8]proposedthe heuristic can rapidly locate an attainable arrangement when utilizing an underlying that regards all constraints. We create the underlying arrangement utilizing a Greedy Calculation by choosing the most advantageous hubs as far as transportation cost and gas procurement cost. The Greedy Strategy comprises of a scientific procedure that makes the most valuable decision accessible. It permits having a Local Ideal to manage the exploration to discover an Ideal Global Solution.

Dhanvin Mehta et.al.[9]discussed store network the board issue alludes to those issues where the progression of commodities and crude materials should be concluded out how to shift wastage and unnecessary expenses. In a general SCM issue[10], factors like client requests, available stock of crude materials, conveyance times of crude materials, and their expenses are largely stochastic[11]. A methodology for analyzing a comprehensive inventory network the executive's issue into a parameterized endless reported. Incorporation of Artificial Intelligence and Blockchain innovation for transportation costs and production costs in Distribution and Logistics. We examine some existing method as follows:

Tracking and traceability of goods due to some inconsistent data. Bahrudin et al. [12] define food traceability as indispensable to follow through all the stages in the food production network just as guarantee quality food can deliver quality animals. Therefore, this examination suggests that halal person feed through healthful food is significant in the halal food production network.

Due to the food supply chain, distribution, and logistics stage, some contamination also happened without the knowledge of either producer or consumer. Emi Normalina Omar et al. [13]proposed the Halal inventory network is a procedure that the necessity of halal beginning from the cause of supply until it arrives at the client[14]. As right now, the halal inventory network will begin from the farm, the merchant house, to moving and putting away of the chicken items before they arrive at the users. This is to ensure that halal is not useful for things or food. Moreover, for all the activities in the stock system, which consolidate managing and regulating of the things.

Geetanjali Ramesh Chandra et al. [15] discussed how Halal Food Supply Chain would work on a consortium blockchain as far as its application, engineering, and mechanical components. With its one of a kind highlights of a P2P system, accord and information section instrument, and information security enablement, this Distributed Ledger Technology will increment trust among different players all through the stock chain, at last permitting customers to make increasingly educated, confident decisions[16][17].

In supply chain management, the primary concern is Logistics, from producer to consumer to reach the product safely (without any accident) and also without any contamination in the product. Ultimately satisfy the customer that is an original vision in this supply chain. But in this existing method we indicate clearly due to some lagging happens (Example: Transportation Cost Increased, Production Cost Increased, Cross Contamination in the Food) due to this things customer feel unhappy. Regarding this things that appropriate manufacturer or producer see the company loss.

3. Problem Statement

The primary thought is planned to rearrange the preparation procedure of Supply Chain vehicles utilizing a falsely keen blockchain system. For supply chain management to reach the consumer. Take a vehicle very safe to take the goods to reach the appropriate place with a short time.

This Paper proposes vehicles to take the goods from producer to consumer to reach the time properly and reduce the transport path cost while traveling. Because the goods may worthy and also reach the destination in a short time.so, integrated the greedy search for this trained goods vehicle to find the optimal solution.

3.1 Heuristic Search Incorporated in Supply Chain Management Using Blockchain Technology.

The proposed system indicated to reduce the transportation cost and take the short distance to deliver the products in supply chain management. So we integrated the Artificial Intelligence in the Blockchain technology. In this proposed system, exclusively supply chain integrated the heuristic search method. For finding the optimal solution from manufacturer to consumer. Heuristic search is one of the critical sectors in artificial intelligence. Heuristic means to refer to discover. (i.e.) discover destiny with the purpose of information already given that is heuristic, also referred to as information search.in heuristic search method have a variety of types as follows:

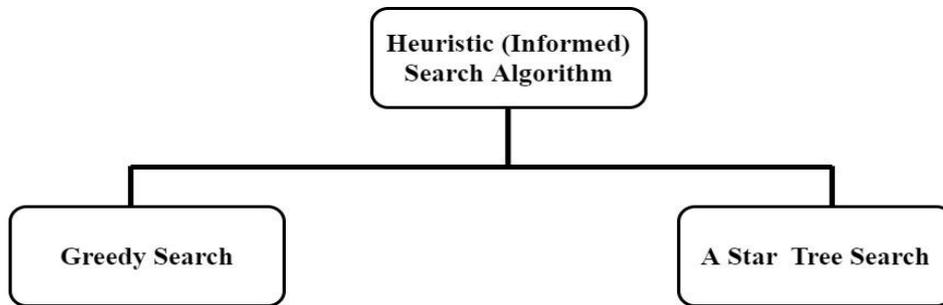


Figure 1. Informed Search Categories

The above figure.1 represents the types of informed search in artificial intelligence to integrate into blockchain technology for supply chain management. Supply chain management distributed, and logistics is a significant task. Also, it is one of the biggest profits for a particular company when the customer feels satisfied. In the informed search means, we informed earlier to start the commodities from producer to destiny with an optimal solution. So, in this above figure illustration, we have to see one by one and give the best optimal path cost for this distribution and logistics (i.e.) we notice the time duration, transport cost, and total cost of this supply chain. In Public ledger, all transaction details are recorded in connected to blockchain technology.

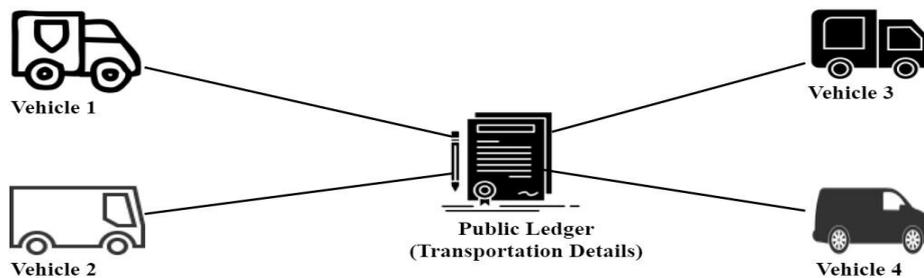


Figure 2. Transaction Details Recorded In Public Ledger.

The above figure 2 shows the distribution and logistics in supply chain management, all transaction are recorded in public ledger. So cannot edit and dynamically updated. The significant advantage to implement the artificial intelligence algorithm (i.e.) searching strategies for the best optimal solution. To reduce the transportation cost for a particular company. That is, each logistics from each state starts the distribution is registered in the blockchain. Each state acts and gets the rewards from the appropriate destinations state. Here, action means vehicle running condition from one state (Example: Producer) to another state (Example: Wholesaler) in the road (Environment) the reward means in driverless supply chain any feedback from destiny (Wholesaler) to the origin (Producer) also we consider the acknowledgment of the goods may reach the proper destination.

A. Greedy Informed Search Strategies in Supply Chain:

Greedy informed strategies follow from the origin and to expand the path very closest to the destination. Here, the path is calculation is represented by the heuristic method. In below, figure 3 represents the initial state of the supply chain from producer to consumer. The vehicle starts for the distribution to reach the correct destination with an optimal solution. Especially in this greedy search method to expand the next path with the minimum cost the same way to expand one another and to reach the correct destination. Moreover, we integrate the blockchain technology in this method, so all transactions are recorded through the public ledger.

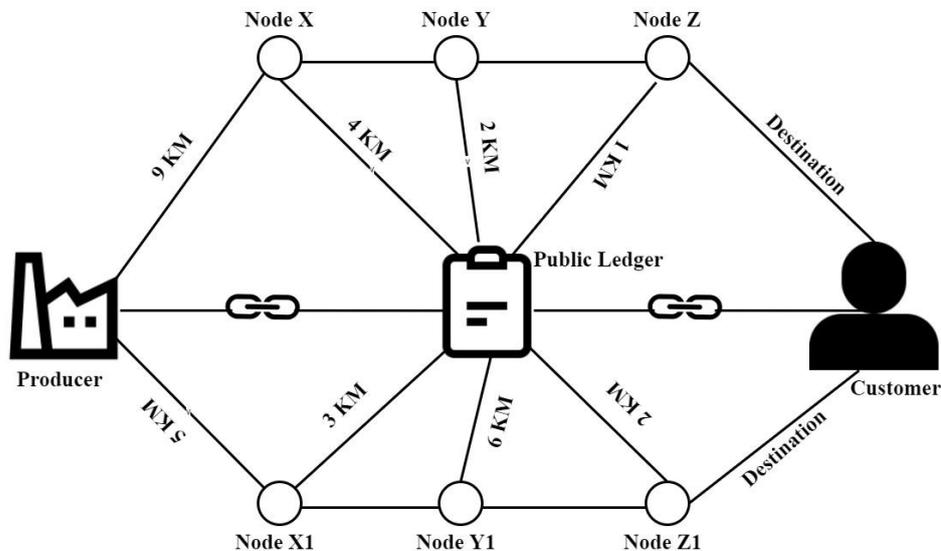


Figure 3. Greedy Search Strategies in Supply Chain.

The above figure 3 illustrates for supply chain find the optimal destiny path (customer) in the below method:

State:{Producer, Node X, Node X1, Node Y, Node Y1, Node Z, Node Z1, Customer}

In Greedy Search start from P (Producer) State to reach the destiny State C (Consumer), in this below Heuristic (Greedy Search Method) expand the node/state which is the lesser value (Example: Traveling Distance, Transportation Cost)

Each node from producer to consumer implement in the blockchain method. During the Distribution and Logistics in the supply chain method, all transactions through the public ledger. So dynamically, all vehicle transportation details recorded in public ledger. At that time, we can operate the vehicle very quickly to find the optimal cost to reach the correct destination without any confusion.

Moreover, we satisfy customer needful. The following Graph has a path and cost specified in the below:

Path and Cost: Two Path and Two Costs have taken in this below sketch, but we take ultimately optimal solutions only.

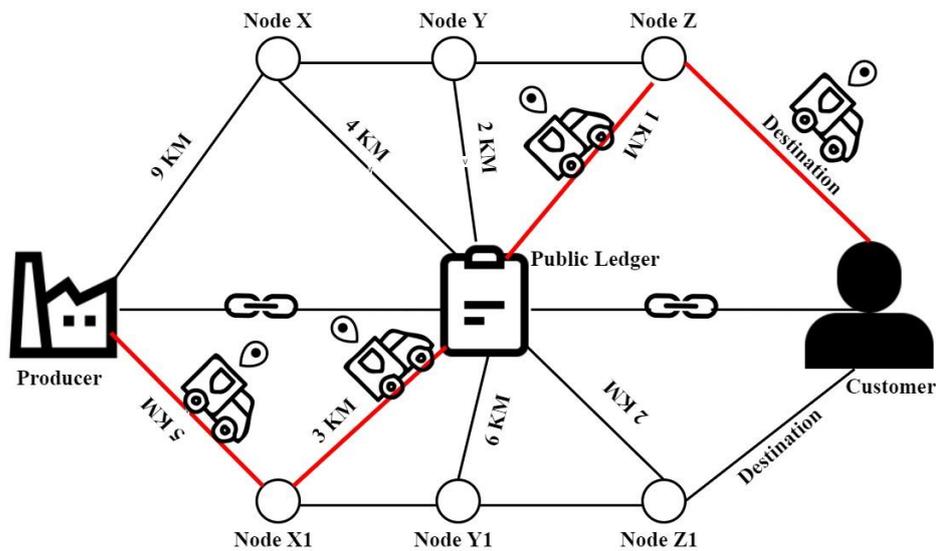


Figure 4. Optimal Path Find Using Greedy Search Method.

The above figure 4 defines the path expanded the minimum cost as per the greedy search method and ultimately finds the optimal solution.

State = {P, X, X1, Y, Y1, Z, Z1, C}

Where, P-Producer, C-Customer

Table 1. Greedy Search Total Path Cost

Vehicle Type	Origin Path	Path Cost	Expand Path
Van	P-X	9 KM	-
	P-X1	5 KM	X1
Van	P-X1-Z	5+3+1 KM	Z
Van	P-X1-Z-C	5+3+1+0 =9 KM	-

(i.e) Path: P-X1-Z-C

Total Travel Path: 5 KM + 3 KM + 1 KM +0 KM = 9 KM

The above graph describes the total path cost is optimal one among another path from producer to consumer.

B. A * Tree Informed Search Strategies in Supply Chain:

A * Tree Informed Search Strategies Take the advantages of Greedy Search, and to expand the detailed structure of informed search principles. In this search, we can take the expand path with the summation of the particular path. (i.e.) $f(x) = g(x) + h(x)$

Where, $f(x)$ describe the summed of greedy ($g(x)$) and heuristic value ($h(x)$)

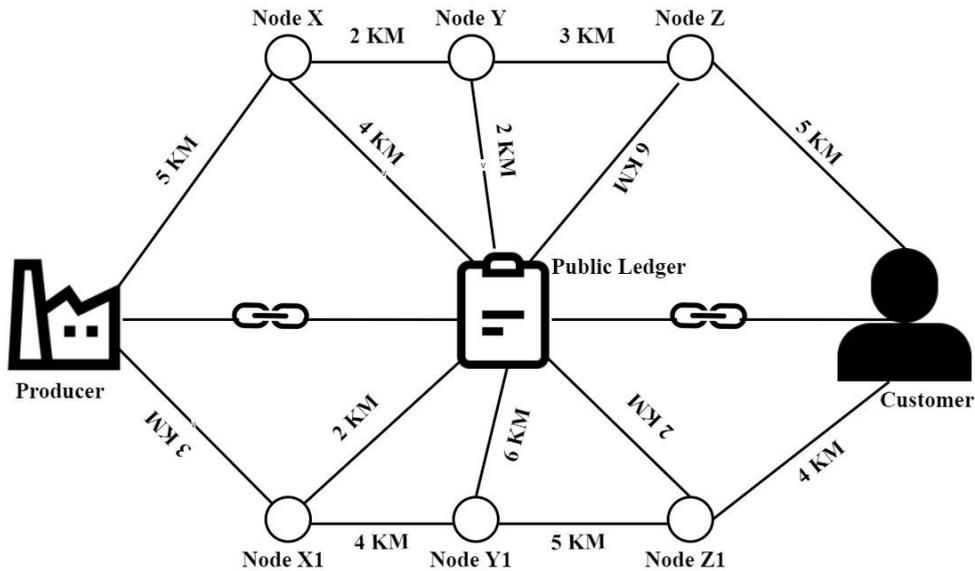


Figure 5. A * Search Method in Supply Chain

In the above figure, 5 represents the start of the distribution and logistics from producer to the consumer as per the heuristic search method expands the node as the minimum value. From origin to start the distribution to expand the path as per the protocol of A * search strategies, we take the summation of heuristic (forward cost), and greedy (backward cost) also consider in this search method. To initialize the goods with the lowest summed cost in the above method. In, below, table 2 represents the total cost of the A * start searching method.

Table 2. A * Search Method Total Path Cost

Vehicle Type	Path	Forward Cost (F)	Backward Cost (B)	Total Cost (F+B)
Van	P- X	5 KM	0	5 KM
	P-X1	3 KM	0	3 KM
To Expand the path from the state X1 (i.e.), X1 has optimal Path Cost				
Van	P-X1	2 KM	3 Km	5 KM
	P-X1-Y1	5 KM	3 KM	8 KM
A * Star Searching Method integrated into the public ledger. So public ledger instructs the vehicle. Which path is closest to the customer? In that way here, we expand the path.				
Van	P-X1-Z	6 KM	5 KM	11 KM
	P-X1-Z1	2 KM	5 KM	7 KM
	P-X1-Z1-C	4 KM	7 KM	11 KM

The Following Graph has a path and cost specified in the below:

Path and Cost: Two Path and Two Cost have taken in this below sketch, but we take ultimately optimal solution only

Path1: {P – X1 – Z1 – C}

Cost1: 3 KM + 2 KM + 2 KM + 4 KM = 11 KM

Path2: {P – X1 – Z – C}

Cost2: 3 KM + 2 KM + 6 KM + 4 KM = 15 KM

In this above two-path and two costs in the heuristic search method, obviously, we can consider, and we train the minimal path cost (i.e.) optimal solution only.

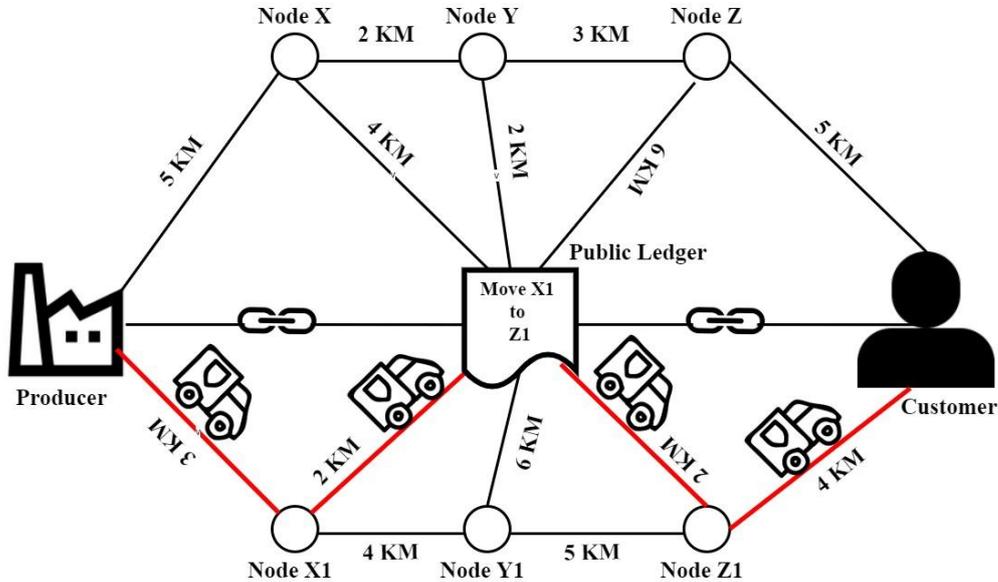


Figure 6. A * Search Method Optimal Path Cost

The above figure, 6 represents the transportation from producer to consumer using in the informed searching method. The use of public ledger gives the instruction to which is the neighbor path of destination. So easily, we can obtain the final path. In this example from Node X1 to we can expand the path two ways **1.**Node X1 to Node Z **2.** Node X1 to Node Z for public ledger intimate the vehicle, which is neighbor to the destination. So ultimately obtained the final path with the lowest cost.

(i.e.) Path: P – X1 –Z1 – C

Cost: 3+2+2+4 = 11 KM.

The above graph describes the total path cost is optimal one among another path from producer to consumer.

5. Conclusion

In this paper, we presented the Informed (Heuristic) Search Method in supply chain management using blockchain technology. In supply chain commodities to connect the people from various locations. So we have to appliance the public ledger in the supply chain for the distribution and logistics. To all transactions in the use of public ledger recorded and any changes in the transaction dynamically updated itself. Moreover, we presented various features in Artificial Intelligence Algorithms are integrated into the blockchain technology. To reduce the Transportation Travel Path Cost in the supply chain. Future of this research, we have to implement the IoT smart sensor and Machine Learning Algorithms to include in the supply chain commodities using blockchain and secure the Products without any contamination.

References

- [1] R. Azzi, R. K. Chamoun, and M. Sokhn, "The power of a blockchain-based supply chain", *Comput. Ind. Eng.*, vol. 135, (2019), pp. 582–592.
- [2] S. Yousuf and D. Svetinovic, "Blockchain Technology in Supply Chain Management: Preliminary Study", 6th Int. Conf. Internet Things Syst. Manag. Secur. IOTSMS, (2019), pp. 537–538.
- [3] M. Montecchi, K. Plangger, and M. Etter, "It's real, trust me! Establishing supply chain provenance using blockchain", *Bus. Horiz.*, vol. 62, no. 3, (2019), pp. 283–293.
- [4] S. Yadav and S. P. Singh, "Blockchain critical success factors for sustainable supply chain", *Resour. Conserv. Recycl.*, vol. 152, (2020), 104505.
- [5] Z. Liu and Z. Li, "A blockchain-based framework of cross-border e-commerce supply chain", *Int. J. Inf. Manage.*, vol. 52, (2020), 102059.
- [6] V. Shalamov, A. Filchenkov, and A. Shalyto, "Heuristic and metaheuristic solutions of pickup and delivery problem for self-driving taxi routing", *Evol. Syst.*, vol. 10, no. 1, (2019), pp. 3–11.
- [7] K. Salah, M. H. U. Rehman, N. Nizamuddin, and A. Al-Fuqaha, "Blockchain for AI: Review and open research challenges", *IEEE Access*, vol. 7, (2019), pp. 10127–10149.
- [8] A. Annouch and A. Bellabdaoui, "Variable neighborhood search heuristic for the full truckload problem in liquefied petroleum gas supply", *Int. Colloq. Logist. Supply Chain Manag. Compet. Innov. Automob. Aeronaut. Ind. LOGISTIQUE*, (2017), pp. 193–198.
- [9] D. Mehta and D. Yamparala, "Policy gradient reinforcement learning for solving supply-chain management problems," *ACM Int. Conf. Proceeding Ser.*, (2014), pp. 1–4.
- [10] G. Perboli, S. Musso, and M. Rosano, "Blockchain in Logistics and Supply Chain: A Lean Approach for Designing Real-World Use Cases", *IEEE Access*, vol. 6, (2018), pp. 62018–62028.
- [11] P. Helo and A. H. M. Shamsuzzoha, "Real-time supply chain—A blockchain architecture for project deliveries", *Robot. Comput. Integr. Manuf.*, vol. 63, (2020), 101909.
- [12] S. S. M. Bahrudin, M. I. Illyas, and M. I. Desa, "Tracking and tracing technology for halal product integrity over the supply chain", *Int. Conf. Electr. Eng. Informatics, ICEEI*, (2011), July.
- [13] E. N. & J. Omar H.S, "Halal transportation in the Food Industry - A Conceptual Model", *IEEE Symp. Business, Eng. Ind. Appl.*, (2011), pp. 384–389.
- [14] J. M. Song, J. Sung, and T. Park, "ScienceDirect Applications of Blockchain to Improve Supply Chain Applications of Blockchain to Improve Supply Chain Traceability Traceability", *Procedia Comput. Sci.*, vol. 162, (2020), pp. 119–122.
- [15] G. R. Chandra, I. A. Liaqat, and B. Sharma, "Blockchain Redefining: The Halal Food Sector", *Proc. - 2019 Amity Int. Conf. Artif. Intell. AICAI*, (2019), pp. 349–354.
- [16] P. Karthikeyan, S. Velliangiri and M. I. T. Joseph. S, "Review of Blockchain based IoT application and its security issues," 2019 2nd International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT), Kannur, Kerala, India, 2019, pp. 6-11. DOI: 10.1109/ICICICT46008.2019.8993124
- [17] S. Velliangiri, G. K. L. Kumar and P. Karthikeyan, "Unsupervised Blockchain for Safeguarding Confidential Information in Vehicle Assets Transfer," 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2020, pp. 44-49. DOI: 10.1109/ICACCS48705.2020.9074285