ADV MATH SCI JOURNAL
Advances in Mathematics: Scientific Journal **9** (2020), no.8, 6327–6339
ISSN: 1857-8365 (printed); 1857-8438 (electronic)
https://doi.org/10.37418/amsj.9.8.100 Special Issue on ICMA-2020

A REVIEW ON TRANSPORTATION AND SMART LOGISTICS USING GRAPH THEORETICAL APPROACH

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ABSTRACT. Graph is a mathematical concept that is effective for working out many kinds of problems. Finding shortest path plays a prominent role in network based structures. In graph theory number of algorithms can be applied for finding the shortest path in a graph based network structures. It degrades the complication of network paths, cost and time to build and maintain network based systems. The Graph theory is used for finding communities in networks. Graphs are used as a device for modeling and descripting real world network systems such as transport, water, electricity, internet, work operations schemes in the process of production, construction, etc.

1. INTRODUCTION

In the past years, graph theory has covered many researchers. Graph theory has produced a very goodspace for research of proving the technique in Discrete mathematics for researches. Many application in the computation, business, natural and social science are learner using graph theory. It is worth mentioning that all graphs are usually defined when we use a special graph to frame a network in extraordinary situations of real life. The graph theory networks have always been important in transportation and telecommunication. They

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2010 *Mathematics Subject Classification.* 05C85, 94C15, 90C27, 90C35.

Key words and phrases. transportation problem, network, Dijsktra algorithm, Kruskal algorithm, genetic algorithm, shortest path.

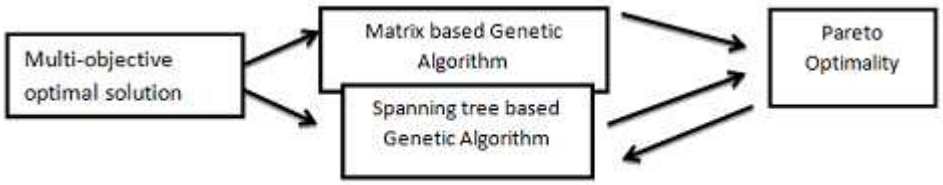

FIGURE 1. Analysis of the paper

have become more important for all business today, especially because of the internet. The internet has connected virtually everything today. It has connected everybody, everything, everywhere into a network.

2. LITERATURE REVIEW

Mistuo Geu et al. [15] proposed a new move towards the spanning tree based genetic algorithm. The multi objective transportation problem has been solved by two algorithms using encoding the transportation problem. The matrix based genetic algorithm and spanning tree based genetic algorithm were used to work out the multi-objective transportation problem. The comparison was made by obtaining the Pareto optimality. Spanning tree based Genetic algorithm gives the exact Pareto optimal solution analysis of the paper shown in Figure 1. International Scientific Research Program, of Japanese government supported the work.

P. Pandian et al. [16] proposed an algorithm called Path labeling algorithm to find a minimum path from a particular node to other nodes in a network and the optimal solution was found and verified by using few numerical examples.

Nasser A. El-Sherbeny [6] presented a review on Vehicle routing problem with time windows (VRPTW). To solve the VRPTW with some limited exacts, heuristics and metaheuristic to approximate algorithms have been proposed. The metaheuristics problems were solved using the method of simulation annealing, Tabu search and genetic algorithm has been proposed. Comparison between the algorithms was made.

H. Afaq et al. [1] gave a novel approach to Discrete Particle swarm optimization technique (DPSO) to solve a Traveling salesman problem which has been considered as a partially connected graph which directs a realistic problem than a completely connected graph, where as in real life paths may not exists between

cities. The confluence of DPSO to the optimal solution for such a graph based traveling salesman problem. It has been verified for small scale transportation problem and it also applicable for large scale transportation problems, model shown in Figure 2.

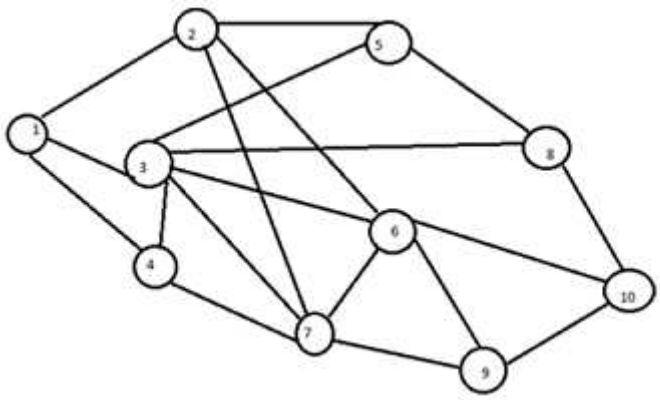

FIGURE 2. Model of Traveling Salesman Problem proposed in the paper

Rame Likej et al. [17] created a network structure for the transportation problem and analysed the model to minimize the shipment cost by finding the minimum spanning tree by Kruskal algorithm and Graph search Dijsktra algorithm, verified by numerical examples.

Y. Zhang et al. [20] addressed a vehicle routing problem experienced in the cold chain organizations of the frozen food delivery industry. Optimization model have been proposed by using the method Heuristic Genetic algorithm to work out the model. As a result the proposed Genetic algorithm method provides the sound solutions with good robustness and confluence characteristics in a sensible time span. The following Figure 3 gives the outline of Genetic Algorithm. This method has been tested in the locations of Carrefour stores in Beijing.

A. Arockiamary et al. [2] both discussed and found the optimal solution for the transportation problem as a network using Dijsktra algorithm in-order to find the shortest path. Comparison were made between Shortest path algorithm and Dijsktra algorithm, finally concluded that Dijsktra algorithm was the best to find the shortest path graphically by using numerical examples.

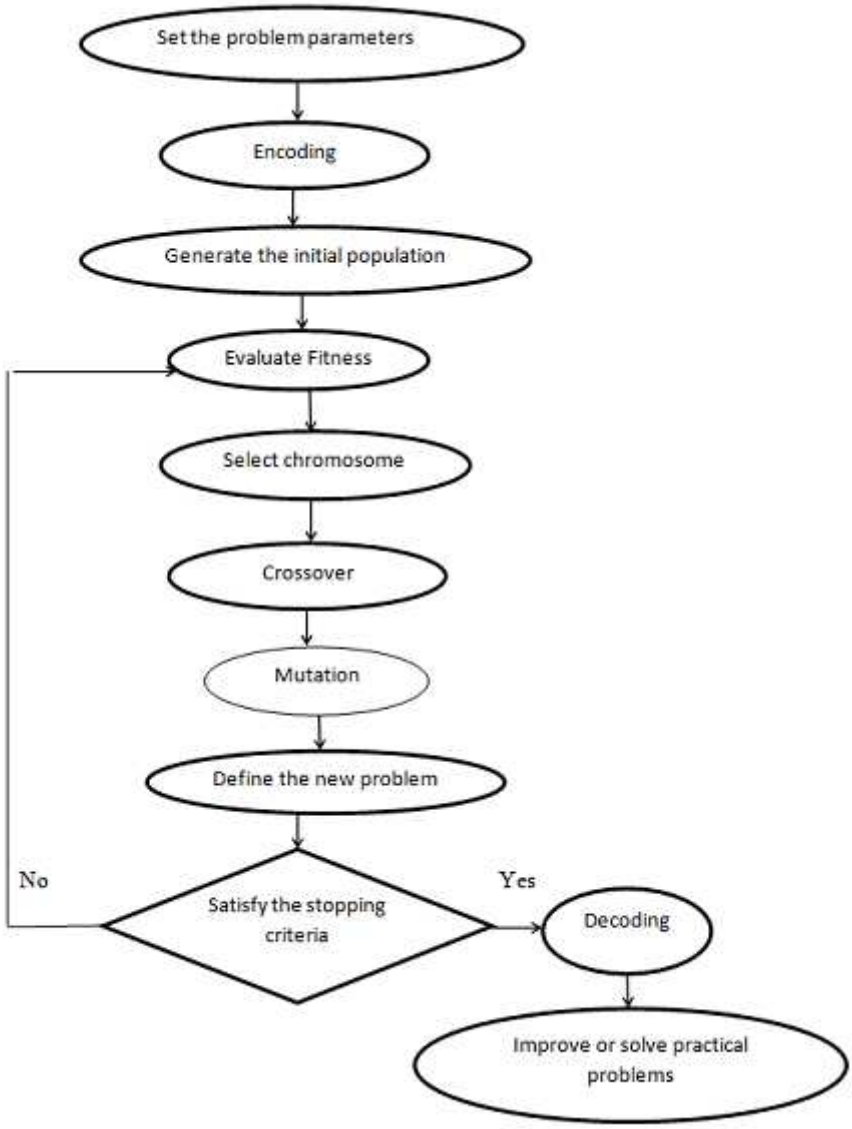

FIGURE 3. Flow chart of Genetic Algorithm

S. C. Li et al. [14] have proposed a Graph theoretic pipe network method (GPNM) to simulate water flow in discrete fracture networks. Using this method few case studies were made and examined with analytical and numerical analysis using Universal Distinct Element code. The proposed GPNM was more efficient and auspicious for more engineering applications and applied for large scales of water reproduction problems.

Hassan Kharazi et al. [8] proposed the new category of graphs namely Distanced balanced graphs and its properties in transportation problem. In order to get the optimality in transportation problem using Dijsktra and Kruskal algorithm, it was examined with the properties of distanced balanced graphs. This method is applicable for the delivery of packages from one place to another with minimum shipment cost, it has been verified using few numerical examples.

Biyuan Yao et al. [5], proposed a feasible approach to deadlock avoidance based on graph theory. The minimum cost and maximum flow result through traditional algorithms based on graph theory, adjacency matrix has been well exerted to express the relationship between transport nodes. A topological sorting transport map has been chosen and verified, model shown in Figure 4 and analysis in Figure 5.

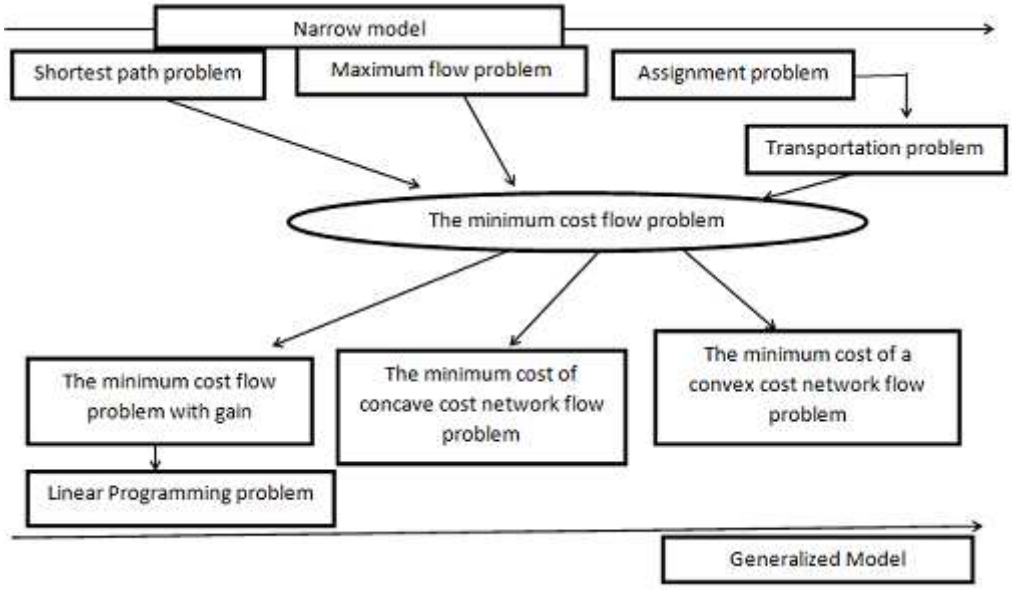

FIGURE 4. The model for minimum and maximum cost flow problem

This method has been applied for the real situation in Hainan Island between high-speed rails and highways to find the shortest path using shortest path search algorithm.

FIGURE 5. Analysis of the paper

Anastasios Drosou et al. [3] have presented an improved Graph Analytics stage for checking of large networks, mainly targeting on the top-down behavioral examination of network components by facilitating the traffic traces and available metadata proposed model shown in Figure 6.

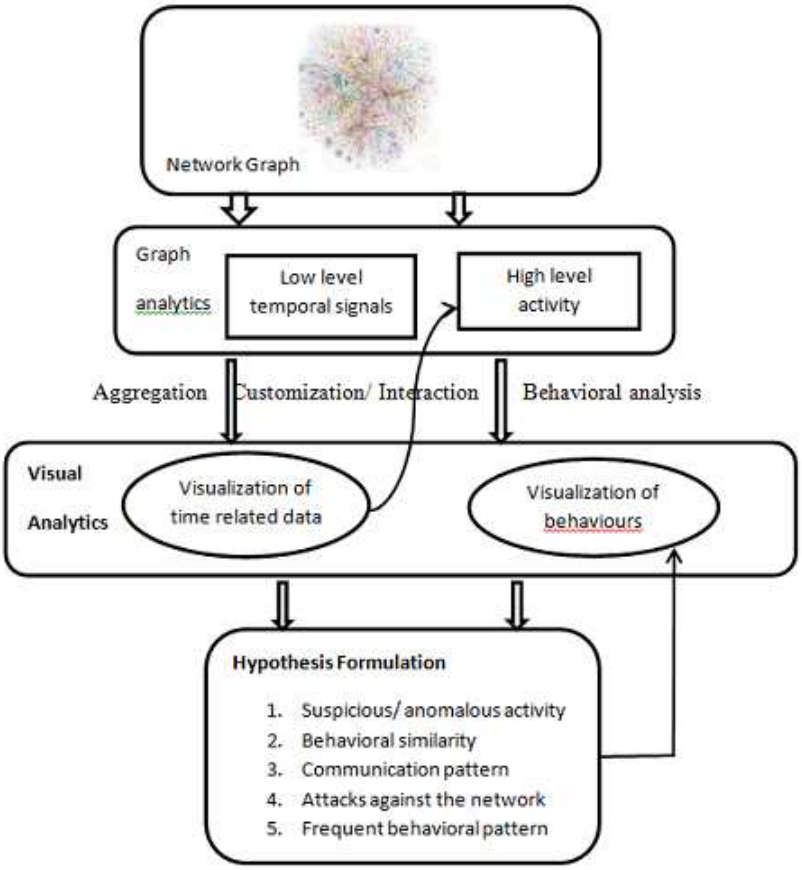

FIGURE 6. Proposed data pipeline

The proposed data pipeline accompanied for the evaluation of the large data

that can be gathered from network systems has been displayed above. This approach has been tested in Twitter related data set.

Jiri Stastny et al. [12] have taken a new approach to recent network-based algorithm for optimisation of planning problems based on Generalized Lifelong Planning A* algorithm which is commonly used for path designing of mobile robots. This approach have been compared with the Genetic algorithm and have got the better results than genetic algorithm.

Amy Babay et al. [4] have given dissemination graphs, on condition that a unified structures specially for routing schemes based on paths, as well as more complicated graphs. Timely dissemination graph-basedon routing approach which retains the marked redundancy to spend supplies in tricky areas of the network have been designed and stated that this move can cost-efficiency over 99 percent of the interpretation between a historical single-path and an optimal scheme.

Huai Su et al. [9] have done a methodical structure and developed a model of vulnerability analysis of a natural gas pipeline network to measure the effect of accidents on gas supply service. The pattern was shown in Figure 7.
This model has been discussed and analyzed in three characteristics: global vulnerability analysis, robustness analysis of demand sites and critical pipeline analysis.

Xue-mei Xiao et al. [19] correlated the heterogeneity and vulnerability of subway networks based on customer flow using the network flow and analyzed this in a real life situation using Beijing subway station. Map is shown in Figure 8.

Eleni Papatzilkou et al. [7] have formulated a Rapid algorithm to find a best mixture of signaling phases and their optimal timings which minimizes the total delay of the whole period based on the multiple-period analysis submitted in highway capacity manual 2010. Two optimal methods Genetic and scatter search algorithm have been used to analyze the optimality.

Spyridon D. Tsolas et al. [18] gave a scalable and structure for the optimisation of complicated water-energy nexus and novel water-energy nexus diagram using the graph theory-based network illustration. They have demonstrated this approach using the case studies on water-energy nexus systems concentrating on the power generations, sea water detoxification, groundwater and surface water at sectional and national scales. They gave a systematical identification

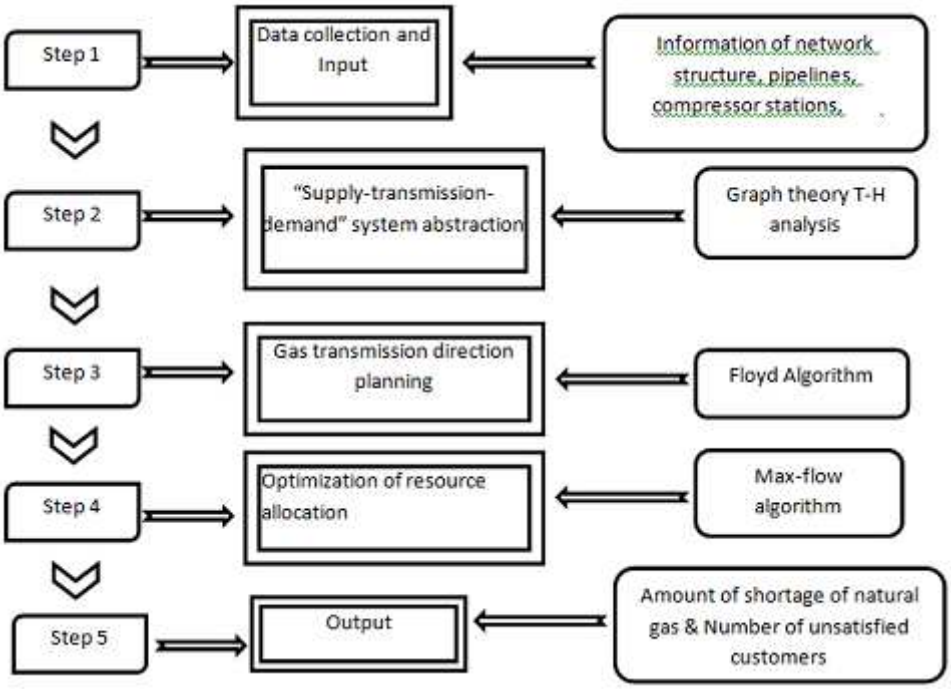

FIGURE 7. Analysis of prposed model

FIGURE 8. Map

and removed superfluous cycles, flows and things within a nexus for survivability and designed a nexus with least eradication of water and energy supplies from the exactness of the input data given, rather than the dimensions of the nexus structures.

Huai Su et al. [10] have developed a structure to assess the dependency of natural gas pipeline networks. Uncertainty and complexity have been accounted by the performance of the integration of stochastic process, graph theory and thermal-hydraulic simulation. The analysis covers three characteriztion: global vulnerability analysis, robustness analysis of demand sites and critical pipelines analysis. This method has been implemented in china. The proposed model has been given in Figure 9.

Limei lin et al. [13] have applied a new topological model priority relation graph to evaluate the data delivery routing in Mobile Social Network. Priority relation graph-based social feature routing algorithm had been determined to find the disjoined multi-paths in mobile social networks. The efficiency of the algorithm has been tested and compared with the certain state of the art. In Figure 10 it is illustrated.

Javier Ferrer et al. [11] decided to simulate the control of real-time traffic lights issue in urban areas. For this simulation process they made a thorough analysis with the evolutionary algorithms like IRACE, a Genetic algorithm, a Differential algorithm, a Particle swarm Optimization and a Random Search by the datas collected from the sensors. Traffic jam and overcrowding are one of the most important sources of greenhouse gas emissions, therefore grantors to global climate change. Finally they gave the promising directions with these algorithms. It has been tested in the mobility department of the city council of Malaga (Spain).

Zsolt Magyari-Saska [21] gave the affirmation that road network topology was seriously related but not determinative in forming local or regional communities based on mother tongue, and have presented a methodology for comparing two types of clustering results and applied it in a study region. One result is to create a homogenous network based on routes and settlements even if the two type of objects were vectorized independently with no initial spatial connection between them. The other result was a cluster analysis based on edge attached similarity values and it is shown in Figure 11.

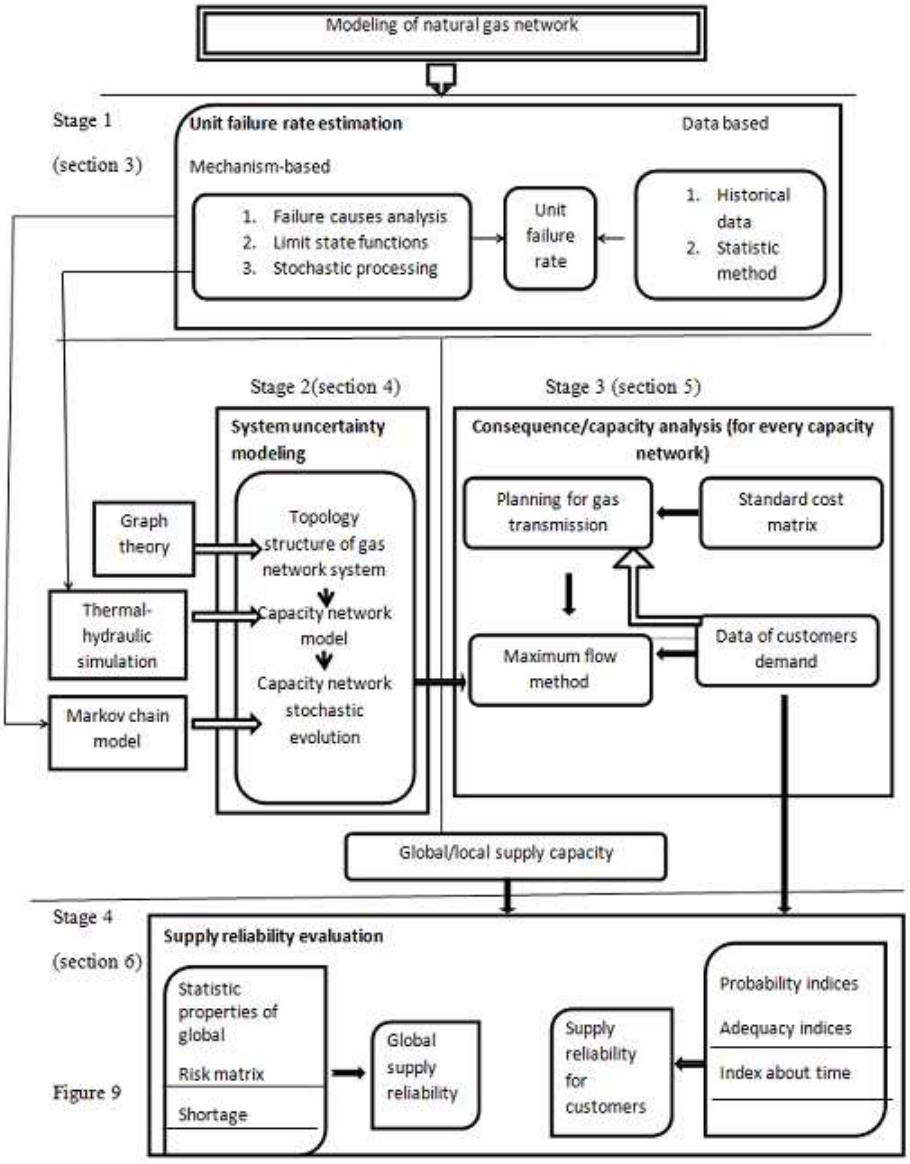

Figure 9

FIGURE 9. Evaluation process

3. CONCLUSION

This paper provides the literature report of transportation problem such as cost minimizing transportation problem, reducing the cost of the transportation problem with mixed constraints and multi-objective transportation problem especially finding the shortest path using graph theory algorithms and also

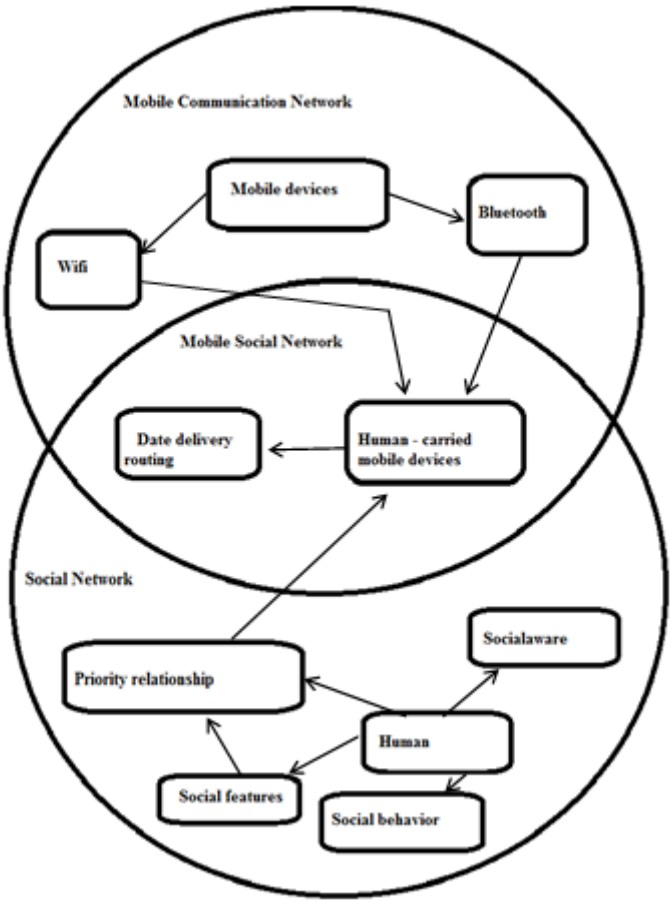

FIGURE 10. Topological model

FIGURE 11. Example-Austro-hungarian monarchy road network model

analyzed few papers which involves the smart logistics using graph theoretical approach.

REFERENCES

[1] H. AFAQ, S. SAINI: *A novel approach to solve graph based travelling salesman problem using particle swarm optimization technique*, IEEE International Conference on Computational Intelligence and Computing Research, 2012.

[2] A. A. MARY, G. PRAVINA: *Application of Graph theory to find shortest path of Transportation problem*, International Journal of Computing Algorithm, **3**(2014), 883–837.

[3] A. DROSOU, I. KALAMARAS, S. PAPADOPOULOS, D. TZOVARAS: *An enhanced Graph Analytics Platform(GAP) providing insight in Big Network Data*, Journal of Innovation in Digital Ecosystems, **3**(2016), 83–97.

[4] A. BABAY, E. WAGNER, M. DINITZ, Y. AMIR: *Timely, Reliable and Cost-Effective internet Transport servise using Dissemination Graphs*, IEEE 37th International Conference on Distributed Computing Systems, 2017.

[5] B. YAO, J. YIN, H. ZHOU, W. WEIWU: *Path Optimization Algorithms based on Graph theory*, International Journal of Grid and Distributed Computing, **9**(6) (2016), 137–148.

[6] N. A. EL-SHERBENY: *Vehicle routing with time windows: An overview of exact, Heuristic and Meta-heuristic methods*, Journal of king saud university (Science), **22**(3) (2010), 123–131.

[7] E. PAPATZILKOU, A. STATHOPOULOS: *Rapid Algorithm for finding the best combination of signaling phases using optimization methods*, International Journal of Transportation Science and Technology, **7**(2018), 229–240.

[8] H. KHARAZI, E. POURHADI: *Graph theory in Distribution and Transportation problems and the Connection to Distance-Balanced graphs*, International Journal series in Multidisciplinary Research, **1**(3) (2015), 2455–2461.

[9] H. SU, J. ZHANG, E. ZIO, X. LI: *A Systematic Framework of Vulnerability of a Gas Pipeline Network.*, Reliability Engineering and System Safety, **175**(2018), 79–91.

[10] H. SU, J. ZHANG, E. ZIO, N. YANG, X. LI, Z. ZHANG: *An Integrated Systematic method for supply reliability assessment of natural gas pipeline networks*, Applied Energy, **209**(2018), 489–501.

[11] J. FERRER, M. L. IBANEZ, E. ALBA: *Reliable simulation-optimization of traffic lights in a real-world city*, Applied soft computation Journal, **78**(2019), 697–711.

[12] J. STASTNY, V. SKORPIL, L. CIZEK: *Traveling Salesman Problem Optimization by means of Graph-based Algorithm*, IEEE Travelling Salesman problem, 2016.

[13] L. LIN, L. XU, Y. HUANG, X. HE: *On Exploiting priority relation graph for reliable multipath communication in mobile social networks*, Information Sciences, **477**(2018), 490–507.

[14] S. C. LI, Z. H. XU, G. W. MA: *A Graph-Theoretic pipe network method for water flow simulation in discrete fracture networks: GPNM*, Tunnellinf and Underground Space Technology, **42**(2014), 247–263.

[15] M. GEN, K. IDA, Y. LI: *Solving Multi-objective transportation problem by spanning tree-based genetic algorithm*, **E82-A**(12) (1999), 2802–2810.

[16] P.PANDIAN, P. RAJENDRAN: *A new algorithm for minimum path in a Network*, Applied Mathematics Sciences, **4**(54) (2010), 2697–2710.

[17] R. LIKEJ, A. SHALA, M. MEHMETAJ, P. HYSENI, X. BAJRAMI: *Application of Graph theory to find the optimal paths for the transportation problem*, 15th Workshop on International stability, Technology and Culture, The International Federation of Automatic control, 2013.

[18] S. D. TSOLAS, M. N. KARIM, M. M. F. HASAN: *Optimization of water-energy nexus: A Network Representation-based Graphical Approach.*, Applied Energy, **224**(2018), 230–250.

[19] X. XIAO, L. JIA, Y. WANG: *Correlation between Heterogeneity and Vulnerability of subway networks based on Passenger flow*, Journal of Rail Transport Planning and Management, **8**(2018), 145–157.

[20] Y. ZHANG, X. D. CHAN: *An Optimization model for the Vehicle Routing problem in Multi-product frozen food delivery*, Journal of Applied Research and Technology, **12**(2014), 239–250.

[21] Z. M. SASKA: *Road Network based community dtection. Case study for as Eastern Region of Austro-Hungarion monarchy.*, Geographia Technica, **14**(1) (2019), 82–91.

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