International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Issue 12, Volume 4 (December 2017) www.ijirae.com

A REVIEW OF MATHEMATICAL MODELS FOR SUPPLY CHAIN NETWORK DESIGN

Anand Jayakumar A*
Department of Mechanical Engineering,
SVS College of Engineering, Coimbatore, India
jay4upeople@gmail.com

Krishnaraj C
Department of Mechanical Engineering,
Karpagam College of Engineering, Coimbatore, India
krishna.kce@gmail.com

Raghunayagan P
Department of Mechanical Engineering,
Nehru Institute of Engineering & Technology, Coimbatore, India
raghunayagan@gmail.com

Manuscript History
Number: **IJIRAE/RS/Vol.04/Issue12/DCAE10083**
DOI: 10.26562/IJIRAE.2017.DCAE10083
Received: 16, November 2017
Final Correction: 09, December 2017
Final Accepted: 17, December 2017
Published: **December 2017**
Citation:

Editor: Dr.A.Arul L.S, Chief Editor, IJIRAE, AM Publications, India

Abstract— Supply chain networks have emerged as the back bones of economic activities in the modern world. The growing number of papers and books on this topic is a further witness of this fact. To foster insight into issues intertwined with supply chain network design problems; this paper is devoted to an extensive review of mathematical programming models in this context. To achieve this, a systematic review approach is followed over the period 2002–2016. As a main goal, the gaps of literature are analyzed to recommend possible research directions. The analysis revealed that reversible supply chain network design and closed loop supply chain network design still require further attention from researchers.

Keywords— Supply chain networks, Supply chain network design, Mathematical programming models, Systematic review, literature

I. INTRODUCTION

With rapid advancements in manufacturing technology the needs of consumers have changed. Manufacturing industries must now think globally. Independent operations are no longer suitable for markets undergoing violent changes. For the survival of manufacturing industries, integration of industries and division of work has become the best solution. For an efficient global supply chain all factories must be tightly integrated. All manufacturing industries must respond to customer requirements, offer high quality products, reduce operating costs and increase customer satisfaction. The supply chain consists of suppliers, manufacturing plants, and distribution centers, warehouses, whose function is to acquire raw materials, convert them to finished products and distribute these products to customers.

The supply chain management can help industries to integrate resulting in various benefits like various reduced costs, production efficiency, marketing and customer service. The greatest advantage is to transmit the information and increase the efficiency. Supply chain networks have emerged as the most important factor of the supply chain in the modern world. Their importance in efficient and timely delivery of products has fuelled an immense interest on researchers and practitioners. Supply chain network design (SCND) involves supply chain networks, their formulation, analysis and solution. Four different aspects are involved in successful supply chains.

1. **Supply Management**
2. **Demand Management**
3. **Product Management**
4. **Information Management**

The SCND problem is associated with the first aspect.

Network design and network flow problems are among the most common problems in supply chain management. Most supply chain network design and network flow problems are undertaken to meet customer requirements and reduce supply chain related costs in organizations. Supply chain cost and customer responsiveness are directly proportional. SCND objectives range from low cost to high responsiveness.

A SCND is the configuration of supply, manufacturing and demand operations network that the cost efficient operation plan while meeting customer needs. This involves three levels of decisions:

1. Strategic decisions deal with supplier network selection, manufacturing networks production process selection and facility location, distribution networks channel selection, warehouses and distribution center locations.
2. Tactical decisions involve inventory of materials i.e. intermediate and finished product.
3. Operational demands involve customer demands.

As most SCND have multiple layers, members, periods and products, a comparative resource constraint exists between different layers. For example a manufacturing plant may have constraints on its productivity and a warehouse may have limited storage capacity. These problems typically increase as the number of supply chain layers increase. This causes the network search space and time required to obtain a solution to increase markedly. The SCND is a NP complete problem. Many studies adopt heuristics algorithm or mathematical programming to solve such problems.

II. RESEARCH METHODOLOGY

A literature review is often aimed to enable the researcher to scan, map, and evaluate the existing intellectual territory. Based on that existing body of knowledge, the key gaps and opportunities of developments can be detected. The underlying principle is to improve and extend the existing body of knowledge further. Analogously, this research presents a systematic literature review on the applications of mathematical models. Given the above research goal, we investigated all articles published in the scientific publishing portals like Elsevier, Emerald and Springer these are selected due to their wide coverage of applied mathematics, management, and engineering journals. The following keyword searches were conducted" supply chain network design". Furthermore, the references of the studied papers and those works, which are cited in the studied papers, have served as a secondary source to search relevant literature. With a time frame of 14 years, a total of 75 references were collected from the mentioned scientific databases.

III. LITERATURE REVIEW

The SCND problem can be classified into three types namely: forward type of supply chain network, reverse type of supply chain network and closed loop type of supply chain network. We have used the following coding method to review the articles.

TABLE I - CODING OF SCND ARTICLES

Aspect	Type	Code
Objectives	Min cost/ max profit	C
	Min environmental impacts	EI
	Max social benefits	S

Modeling	Continuous approximation Stochastic mixed integer programming Fuzzy mixed integer programming Mixed integer non-linear programming Mixed integer linear programming	CA SMIP FMIP MINLP MILP
Network stages	Supply centers Production centers Distribution centers Cross-docks Warehouses Customer zones (retail outlets) Collection/inspection centers Dismantlers Disassembly centers Redistribution centers Recovering centers Remanufacturing centers Recycling centers Disposal / incineration centers	SC PC DC CD WH CZ CIC DSM DAC RDC RCC RMC RYC DPC
Solution method	Solvers Branch and bound Lagrangian relaxation based Genetic algorithm based Simulated annealing based Tabu search based Interactive fuzzy solution approach Other heuristics	E B&B LR GA SA TS F H

IV. FORWARD SCND

In forward type of SCND material flows from supplier to plant and then reaches the customer. There are many stages in this model which may include warehouse and distributors. A typical model of forward type SCND is shown in fig 1.

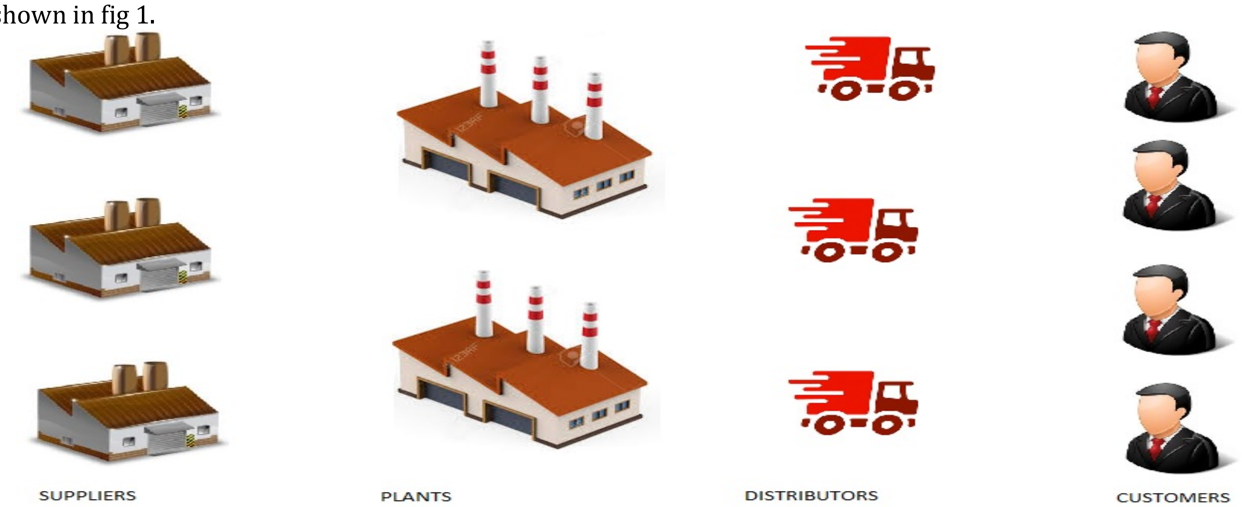

Fig. 1 Forward Supply Chain Network Design

A review of the articles of forward type of network is shown in table 2.

TABLE III - REVIEW OF PREVIOUSLY PUBLISHED LITERATURE ON FORWARD TYPE OF NETWORK

Reference articles	Objectives	Network stages	Modeling	Solution method
(2)	C, EI	SC, PC, CZ	MILP	
(3)	C	SC, PC, CZ, WH	MILP	H
(4)	C	PC, DC, WH	MILP	LR

(5)	C	PC, DC, CZ	MILP	B&B
(6)	C, S	SC, PC, DC, CZ	MILP	H
(7)	C	SC, PC, DC, CZ	MILP	GA
(8)	C	SC, PC, DC, CZ	MILP	GA
(9)	C	SC, PC, DC, CZ	MILP	GA
(10)	C	PC, DC, CZ, WH	MILP	E
(11)	C	PC, DC, CZ	MILP	H
(12)	C	SC, PC, CZ, WH	MILP	H
(15)	C	SC, PC, DC, CZ, WH	MILP	H
(16)	C	PC, DC, CZ, WH	MILP	B&B
(18)	C	PC, DC, CZ	MILP	H
(19)	C	SC, PC, CZ, WH	MILP	E
(20)	C	PC, DC, CZ	MILP	E
(21)	C	SC, PC, CZ, WH	MILP	E
(22)	C	CZ, WH	MILP	E
(23)	C, S	PC, DC, CZ	FMIP	E
(25)	C	PC, DC, CZ	MILP	LR
(27)	C	SC, PC, DC, CZ, WH	MILP	LR
(28)	C	PC, DC, CZ, WH	MINLP	E
(30)	C	SC, PC, CZ, WH	MINLP	H
(32)	C	SC, PC, DC, CZ	FMIP	E
(34)	C	SC, PC, CZ, WH	FMIP	E
(37)	C	DC	MILP	H
(38)	C	SC, PC, DC, CZ	FMIP	E
(42)	C	PC, WH, CZ	MILP	H
(43)	C	SC, PC, WH, CZ	MILP	E
(44)	C	SC, PC	FMIP	E
(45)	C	PC, CZ	MILP	E
(46)	EI	PC, DC, CZ	MILP	H
(48)	C	SC, PC, WH, CZ	MINLP	E
(49)	C	SC, PC, WH, CZ	MILP	E
(50)	C	DC, CZ	MILP	E
(51)	C	SC, PC, WH, CZ	MILP	E
(58)	C	PC, DC, CZ	MILP	E
(59)	C	PC, DC, CZ	MILP	E
(62)	C	SC, PC, WH, CZ	MILP	E
(63)	C	PC, WH, CZ	MILP	E
(65)	C	SC, PC, DC, CZ	MILP	E
(67)	C	SC, PC, WH, CZ	SMIP	E
(68)	C	SC, PC, CZ	MILP	E
(73)	C, SL	PC, DC, CZ	FMIP	F
(74)	C	PC, DC, CZ	MILP	H

A. Hugo, E.N. Pistikopoulos (2) have presented a mathematical programming-based methodology using of life cycle assessment (LCA) for the design and planning of supply chain networks. Tjendera Santoso et al (3) proposed a stochastic programming model and solution algorithm for solving SCND problems. Sherif H. Lashine at al (4) used location, allocation, and routing decisions for the design of a supply chain network. Zuo-Jun Max Shen (5) presented a model in which a company has flexibility in determining which customers to serve .H.S. Wang (6) constructed the optimal model planning the multi-echelon DSC system and proposed the approach TAC based on ant colony algorithm to search the solution. Ming-Jong Yao, Hsin-Wei Hsu (7), proposed a Genetic Algorithm (GA) using determinant encoding for solving this problem. Chang Ying-Hua (8) also used a genetic algorithm to solve this problem .Antonio Costa et al (9) presented a genetic algorithm (GA) to minimize the total logistic cost resulting from the transportation of goods and the location and opening of the facilities in a single product three-stage supply chain network. Michael C. Georgiadis (10) proposed a quantitative model for the problem of SCND comprising multiproduct production facilities with distribution centers, shared production resources, retailers and warehouses and operating under time varying demand uncertainty. Anna Nagurney (11), proposed a framework for SCND and redesign that allows for the determination of the optimal levels of capacity and operational product flows associated with supply chain activities of storage, manufacturing, and distribution at minimal total cost and subject to the satisfaction of product demands.

Nagurney(12), modeled the SCND problem with oligopolistic firms who are involved in the competitive storage, production, and distribution of a homogeneous product to multiple demand markets. Cheng-Chang Lin, Tsai-Hsin Wang (15) studied the SCND under supply and demand uncertainty with embedded supply chain disruption mitigation strategies, postponement with downward substitution, supplier sourcing base and centralized stocking. Pantelis Longinidis, Michael C. Georgiadis (16), introduced a mathematical model that integrates financial considerations with SCND decisions under demand uncertainty. Mir Saman Pishvaee, Masoud Rabbani (18), have used graph theoretic approach to study the structure of the SCND problems and it is proven they could be modeled by a bipartite graph. Raj Singh (19), presented a model of the multi-stage global SCND problem incorporating a set of risk factors (such as: quality problems, logistics, late shipment, exchange rates and transportation breakdown, and production risks), their expected values and probability of their occurrence, and associated additional cost. Reza Babazadeh (20), have proposed a MILP model that is able to consider the key characteristics of agile supply chain such as different transportation modes, discount, alliance (process and information integration) between opened facilities, outsourcing, direct shipments, and maximum waiting time of customers for deliveries. Hossein Badri (21), has presented a new mathematical model for multiple commodity, multiple echel on SCND and considers different time resolutions for tactical and strategic decisions. Stefan Nickel (22) has carried out a work on multi-period SCND.M.S. Pishvaee (23) has researched on problem of socially responsible SCND under uncertain conditions. Jianmai Shi et al (25), has developed a Lagrangian based solution algorithm for the network design problem in a build-to order (BTO) supply chain.

B. Feng Pan, Rakesh Nagi (27) has carried out research on SCND problems in an agile manufacturing scenario with multiple echelons and multiple periods under a situation where multiple customers have heavy demands. Konstantinos Petridis (28), addressed the optimal design of a multiproduct, multi-echelon supply network under uncertainty of demand.A. R. Singh et al (30) proposed, a two stagesto chastic programming model for a capacities based SCND for flexible demands while considering missed opportunity cost and inventory carrying cost. Babak H. Tabrizi, Jafar Razmi (32) has developed aMINLP mathematical model in which the uncertainties are represented by the fuzzy set theory. Guoqing Yang, Yankui Liu (34), developed a new mean-risk fuzzy optimization method for SCND problem, in which the standard semi variance is to gauge the risk resulted from fuzzy uncertainty .Nader Azad et al (37), studied the design problem of a reliable stochastic supply chain network in the presence of random disruptions in the location of distribution centers (DCs) and the transportation modes. Xuejie Bai , Yankui Liu (38), presents a new optimization method for SCND problem by employing variable possibility distributions. Evangelos Grigoroudis et al (42), researched a recursive DEA (RDEA) algorithm, which introduces a different way of designing a supply chain network. Armin Jabbarzadeh et al (43), presented a network design model for the supply of blood during and after disasters. Kaveh Khalili-Damghani et al (44), propose a fuzzy bi-objective mixed-integer linear programming (MILP) model to enhance the material flow in multi-item, dual-channel and multi-objective SCs with multiple echelons under both ambiguous and vague conditions, concurrently. AliReza Madadi et al (45) investigated a supply network design in supply chain with unreliable supply with application in the pharmaceutical industry. Petric˘a C. Pop et al(46), deals with a sustainable supply chain network design problem (SSCNDP) arising in the public sector.

Ali Sabzevari Zadeh (48) studied on tactical and strategic design of steel supply chain (SSC) networks. Mohammad Mohajer TABRIZI, Behrooz KARIMI (49), reconsidered the role of contracts in uncertain environments. Kaike Zhang (50), studied a supply chain network design problem which consists of one external supplier, a set of potential distribution centers, and a set of retailers, each of which is faced with uncertain demands for multiple commodities. Shiva Zokaee et al (51), presented a optimization model for the design of a supply chain facing uncertainty in demand, and major cost data including shortage cost and transportation parameters. Ali Akbar Akbari , Behrooz Karimi (58), have researched a robust design and planning of a multi-echelon, multi-period, multi-product supply chain network considering process uncertainty. Semih Coskun et al (59), proposed a goal-programming model considering three consumer segments, i.e., green, inconsistent and red consumers. Mohammad Fattahi, Kannan Govindan (62), addressed a multi-period , multi-stage SCND problem in which multiple commodities should be produced through different continuous levels of manufacturing processes.Mohammad Fattahi et al (63), addressed a problem in designing and planning a multi-echelon and multi-product supply chain network over a multi-period horizon in which customer zones have price-sensitive demands .Chunxiang Guo et al (65), presented a the robust optimization method to study for constructing and designing the automotive supply chain network, for an integrated supply chain network design that consists of supplier selection problem and facility location– distribution problem. M. Kannegiesser et al (66), addressed the question, if and how fast these long-term sustainability targets can be reached and how the underlying transformation path develops. Ahmad Rezaee et al (67), presented a two-stage stochastic programming model to design a green supply chain in a carbon trading environment.

International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Issue 12, Volume 4 (December 2017) www.ijirae.com

Mahdi Sharifzadeh et al (68), presented a mixed integer (piece-wise) linear program (MILP) to determine the optimal supply chain design and operation, under uncertainty. Juan Yu (73), studied the dual-channel (the traditional channel and the E-commerce channel) supply chain network design (SCND) for fresh agri product (FAP) under information uncertainty. Farnaz Barzinpour, Peyman Taki (74), proposed a mathematical model to identify locations of productions and shipment quantity by exploiting the trade-off between costs, and emissions for a dual channel supply chain network.

V. REVERSE TYPE OF SCND

In reverse type of SCND the material flows back from the customer to the plant. A typical reverse type of SCND is shown in fig 2.

Fig. 2 Reverse Supply Chain Network Design

TABLE IIIII - REVIEW OF PREVIOUSLY PUBLISHED LITERATURE ON REVERSE TYPE OF NETWORK

Reference articles	Objectives	Network stages	Modeling	Solution method
(35)	C	CZ, CIC, RMC, RYC, DPC	MILP	E
(55)	C	CZ, CIC, RMC, DAC, RYC, DPC	MILP	E

Seval Ene, Nursel Öztürk (35), presented a mathematical model for multi stage and multi period reverse supply chain network, which maximizes total profit of the network. Sajan T John R Sridharan (55), has presented a mathematical model for designing a reverse supply chain in a multi-stage environment.

VI. CONCLUSIONS

In closed loop type of SCND the material flows in forward as well as reverse directions. A typical model is shown in fig 3.

Fig. 3 Closed Loop Supply Chain Network Design

A literature review of the articles of closed loop type is shown in table 4.

TABLE IV - REVIEW OF PREVIOUSLY PUBLISHED LITERATURE ON CLOSED LOOP TYPE OF NETWORK

Reference articles	Objectives	Network stages	Modeling	Solution method
(13)	C, S	PC, DC, CZ, CIC, RCC, RYC	MILP	E
(17)	C	CZ, CIC, RCC, RDC, RYC	MILP	E
(24)	C	PC, CZ, CIC, DPC, RYC,	FMIP	E
(26)	C	PC, DC, CZ	MILP	PSO
(29)	C	SC, PC, DC, CZ, CIC, RMC, DPC	MILP	H
(31)	C	SC, PC, DC, CZ, WH, CIC, DPC, RMC	MILP	E
(40)	C	SC, PC, DC, CZ, CIC, RCC, RMC, RYC, DPC	MILP	H
(41)	C, EI	PC, WH, CZ, CIC	MILP	E
(47)	C	SC, PC, DC, CZ, CIC, RMC, DPC	MILP	E
(56)	C	SC, CIC, DAC, RMC	FMIP	E
(57)	C	PC, DC, CZ, CIC, DYP, RYC	MILP	E
(60)	C	PC, DC, CIC, CZ,	FMIP	GA
(61)	C	PC, DC, CZ, CIC, RYC	MILP	E
(64)	C	SC, PC, DC, CZ, CIC, RMC, DPC	MILP	E

M.S. Pishvaee, S.A. Torabi (13) proposed model that integrates the network design decisions in both forward and reverse supply chain networks and also incorporates the strategic network design decisions along with tactical material flow ones to avoid the sub-optimalities led from separated design in both parts .Mir Saman Pishvaee et al (17), proposed a optimization model for handling the inherent uncertainty of input data in a closed-loop supply chain network design problem. Mir Saman Pishvaee, Jafar Razmi (24), proposed a multi-objective fuzzy mathematical programming model for designing an environmental supply chain under inherent uncertainty of input data. ZHOU Xian-cheng et al (26), presented a remanufacture closed-loop supply chain network optimization model based on genetic particle swarm optimization, which can avoid unique and simplified population code mode, meanwhile improve the computation speed. Majid Ramezani et al (29), presented a robust design for a multi-echelon, multiproduct, closed-loop logistic network model in an uncertain environment. Soleimani et al (31), proposed a , multi-product, multi-period closed-loop supply chain network with stochastic demand and price in a MILP structure .K. Devika et al (40), proposed a mixed integer programming model for multi-objective closed-loop supply chain network problem. Nan Gao , Sarah M. Ryan (41), addressed a multi-period capacitated closed-loop supply chain network design problem subject to uncertainties in the demands and returns as well as the potential carbon emission regulations. Majid Ramezani et al (47), presented a financial approach to model a closed-loop supply chain design in which financial aspects are explicitly considered as exogenous variables. Anil Jindal et al (56), proposed a the network design and optimization of a multi-time, multi-product, multi-echelon capacitated closed-loop supply chain in an uncertain environment .M. Fareeduddin et al (57), presented an optimization model based on carbon regulatory policies for a closed-loop supply chain design and logistics operations are presented. Zhuo Dai, Xiaoting Zheng (60), proposed a multi-product, multi-period, multi-echelon closed-loop supply chain network design model under uncertainty. Rameshwar Dubey et al (61), attempted to develop a responsive sustainable supply chain network which can respond to a certain degree of uncertainty due to uncontrollable forces. Kiran Garg et al (64), attempted to deal with the environmental issues presented in the design of CLSC networks.

VII. CONCLUSIONS

Over the last decade supply chain network design has emerged. This paper presented an updated review of scientific literature examining the different dimensions of SCND. We observed that different configurations of supply chains have been studied in the literature: forward SCND, reverse SCND and closed loop SCND. The review revealed that forward SCND has been the most common to be studied by researchers. Closed loop SCND and reverse SCND is a flourishing area. Further research can be developed on this, maybe by adapting some models already developed for simpler structures. Little research is done in the direction of green SCND. The findings of the paper summarize the status of research on applying modeling techniques in SCND and offer insights into directions for future research.

REFERENCES

1. Andi Cakravastia, Isa S. Toha, Nobuto Nakamura, "A two-stage model for the design of supply chain networks", International. Journal of. Production Economics 80 (2002) 231–248.
2. A. Hugo, E.N. Pistikopoulos, "Environmentally conscious long-range planning and design of supply chain networks", Journal of Cleaner Production 13 (2005) 1471-1491

3. Tjendera Santoso, Shabbir Ahmed, Marc Goetschalckx, Alexander Shapiro, "A stochastic programming approach for supply chain network design under uncertainty", European Journal of Operational Research 167 (2005) 96–115
4. Sherif H. Lashine, Mohamed Fattouh and Abeer Issa, " Location / allocation and routing decisions in supply chain network design", Journal of Modelling in Management Vol. 1 No. 2, 2006 pp. 173-183
5. Zuo-Jun Max Shen, "A profit-maximizing supply chain network design model with demand choice flexibility", Operations Research Letters 34 (2006) 673 – 682
6. H.S. Wang, "A two-phase ant colony algorithm for multi-echelon defective supply chain network design", European Journal of Operational Research 192 (2009) 243–252
7. Ming-Jong Yao , Hsin-Wei Hsu, "A new spanning tree-based genetic algorithm for the design of multi-stage supply chain networks with nonlinear transportation costs", Optim Eng (2009) 10: 219–237
8. Chang Ying-Hua, "Adopting co-evolution and constraint-satisfaction concept on genetic algorithms to solve supply chain network design problems", Expert Systems with Applications 37 (2010) 6919–6930
9. Antonio Costa, Giovanni Celano, Sergio Fichera, Enrico Trovato, "A new efficient encoding/decoding procedure for the design of a supply chain network with genetic algorithms", Computers & Industrial Engineering 59 (2010) 986–999
10. Michael C.Georgiadis, PanagiotisTsiakis, PantelisLonginidis, MariaK.Sofioglou, "Optimal design of supply chain networks under uncertain transient demand variations", Omega 39 (2011) 254–272
11. Anna Nagurney, "Optimal supply chain network design and redesign at minimal total cost and with demand satisfaction", Int. J. Production Economics 128 (2010) 200–208
12. Anna Nagurney, "Supply chain network design under profit maximization and oligopolistic competition", Transportation Research Part E 46 (2010) 281–294
13. M.S. Pishvaee, S.A. Torabi, "A possibilistic programming approach for closed-loop supply chain network design under uncertainty", Fuzzy Sets and Systems 161 (2010) 2668–2683
14. Sanjay Kumar Shukla, M.K. Tiwari, Hung-Da Wan, Ravi Shankar, "Optimization of the supply chain network: Simulation, Taguchi, and Psychoclonal algorithm embedded approach", Computers & Industrial Engineering 58 (2010) 29–39
15. Cheng-Chang Lin, Tsai-Hsin Wang, "Build-to-order supply chain network design under supply and demand uncertainties", Transportation Research Part B 45 (2011) 1162–1176
16. Pantelis Longinidis, Michael C. Georgiadis, "Integration of financial statement analysis in the optimal design of supply chain networks under demand uncertainty", Int. J. Production Economics 129 (2011) 262–276
17. Mir Saman Pishvaee, Masoud Rabbani, Seyed Ali Torabi, "A robust optimization approach to closed-loop supply chain network design under uncertainty", Applied Mathematical Modelling 35 (2011) 637–649
18. Mir Saman Pishvaee, Masoud Rabbani, "A graph theoretic-based heuristic algorithm for responsive supply chain network design with direct and indirect shipment", Advances in Engineering Software 42 (2011) 57–63
19. Amit Raj Singh & P. K. Mishra & Rajeev Jain & M. K. Khurana, "Design of global supply chain network with operational risks", Int J Adv Manuf Technol (2012) 60:273–290
20. Reza Babazadeh, Jafar Razmi and Reza Ghodsi, "Supply chain network design problem for a new market opportunity in an agile manufacturing system", Journal of Industrial Engineering International 2012, 8:19
21. Hossein Badri, Mahdi Bashiri, Taha Hossein Hejazi, "Integrated strategic and tactical planning in a supply chain network design with a heuristic solution method", Computers & Operations Research 40 (2013) 1143–1154
22. Stefan Nickel, Francisco Saldanha-da-Gama, Hans-Peter Ziegler, "A multi-stage stochastic supply network design problem with financial decisions and risk management", Omega 40 (2012) 511–524.
23. M.S. Pishvaee, J. Razmi, S.A. Torabi, "Robust possibilistic programming for socially responsible supply chain network design: A new approach", Fuzzy Sets and Systems 206 (2012) 1–20
24. Mir Saman Pishvaee, Jafar Razmi, "Environmental supply chain network design using multi-objective fuzzy mathematical programming", Applied Mathematical Modelling 36 (2012) 3433–3446.
25. Jianmai Shi a,b, Guoqing Zhang, Jichang Sha, "A Lagrangian based solution algorithm for a build-to-order supply chain network design problem", Advances in Engineering Software 49 (2012) 21–28
26. ZHOU Xian-cheng, ZHAO Zhi-xue, ZHOU Kai-jun, HE Cai-hong, "Remanufacturing closed-loop supply chain network design based on genetic particle swarm optimization algorithm", J. Cent. South Univ. (2012) 19: 482–487
27. Feng Pan, Rakesh Nagi, "Multi-echelon supply chain network design in agile manufacturing", Omega 41 (2013) 969–983
28. Konstantinos Petridis, "Optimal design of multi-echelon supply chain networks under normally distributed demand", Ann Oper Res, 2013

29. Majid Ramezani & Mahdi Bashiri & Reza Tavakkoli-Moghaddam, “A robust design for a closed-loop supply chain network under an uncertain environment”, Int J Adv Manuf Technol (2013) 66:825–843
30. A. R. Singh & Rajeev Jain & P. K. Mishra, “Capacities-based supply chain network design considering demand uncertainty using two-stage stochastic programming”, Int J Adv Manuf Technol, 2013
31. Hamed Soleimani • Mirmehdi Seyyed-Esfahani, Mohsen Akbarpour Shirazi, “A new multi-criteria scenario-based solution approach for stochastic forward/reverse supply chain network design”, Ann Oper Res 2013
32. Babak H. Tabrizi, Jafar Razmi, “Introducing a mixed-integer non-linear fuzzy model for risk management in designing supply chain networks”, Journal of Manufacturing Systems 32 (2013) 295– 307
33. Zilin “Elizabeth” Tang, Marc Goetschalckx, Leon McGinnis, “Modeling-based Design of Strategic Supply Chain Networks for Aircraft Manufacturing”, Procedia Computer Science, 16 (2013) 611 – 620
34. Guoqing Yang, Yankui Liu, “Designing fuzzy supply chain network problem by mean-risk optimization method”, J Intell Manuf, 2013
35. Seval Ene, Nursel Öztürk, “Open loop reverse supply chain network design”, Procedia - Social and Behavioral Sciences 109 (2014) 1110 – 1115
36. Florian G. H. Behncke, Florian M. A. Walter, Udo Lindemann, “Procedure to Match the Supply Chain Network Design with a Products’ Architecture”, Procedia CIRP 17 (2014) 272 – 277.
37. Nader Azad , Hamid Davoudpour, Georgios K. D. Saharidis, Morteza Shiripour, “A new model to mitigating random disruption risks of facility and transportation in supply chain network design”, Int J Adv Manuf Technol (2014) 70:1757–1774
38. Xuejie Bai, Yankui Liu, “Robust optimization of supply chain network design in fuzzy decision system”, J Intell Manuf, 2014
39. Sebnem Yılmaz Balaman, Hasan Selim, “A network design model for biomass to energy supply chains with anaerobic digestion systems”, Applied Energy 130 (2014) 289–304
40. K. Devika, A. Jafarian, V. Nourbakhsh, “Designing a sustainable closed-loop supply chain network based on triple bottom line approach: A comparison of metaheuristics hybridization techniques”, European Journal of Operational Research (2014)
41. Nan Gao, Sarah M. Ryan, “Robust design of a closed-loop supply chain network for uncertain carbon regulations and random product flows”, EURO J Transp Logist, 2014
42. Evangelos Grigoroudis, Konstantinos Petridis, Garyfallos Arabatzis, “RDEA: A recursive DEA based algorithm for the optimal design of biomass supply chain networks”, Renewable Energy 71 (2014) 113-122
43. Armin Jabbarzadeh, Behnam Fahimnia, Stefan Seuring, “Dynamic supply chain network design for the supply of blood in disasters: A robust model with real world application”, Transportation Research Part E 70 (2014) 225–244
44. Kaveh Khalili-Damghani, Madjid Tavana, Mohammad Amirkhan, “A fuzzy bi-objective mixed-integer programming method for solving supply chain network design problems under ambiguous and vague conditions”, Int J Adv Manuf Technol, 2014
45. AliReza Madadi, Mary E. Kurz, Kevin M. Taaffe, Julia L. Sharp, Scott J. Mason, “Supply network design: Risk-averse or risk-neutral?”, Computers & Industrial Engineering, 2014
46. Petric˘a C. Pop, Camelia-M. Pintea, Corina Pop Sitar, Mara Hajdu-M˘acelaru, “An Efficient Reverse Distribution System for Solving Sustainable Supply Chain Network Design Problem”, Journal of Applied Logic, 2014
47. Majid Ramezani, Ali Mohammad Kimiagari, Behrooz Karimi, “Closed-loop supply chain network design: A financial approach”, Applied Mathematical Modelling (2014)
48. Ali Sabzevari Zadeh, Rashed Sahraeian, Seyed Mahdi Homayouni, “A dynamic multi-commodity inventory and facility location problem in steel supply chain network design”, Int J Adv Manuf Technol (2014) 70:1267–1282
49. Mohammad Mohajer TABRIZI, Behrooz KARIMI, “Supply chain network design under uncertainty with new insights from contracts”, J Zhejiang Univ-Sci C (Comput & Electron) 2014 15(12):1106-1122
50. Ting Wu, KaikeZhang, “A computational study for common network design in multi-commodity supply chains”, Computers &OperationsResearch44(2014)206–213
51. Shiva Zokaee, Armin Jabbarzadeh, Behnam Fahimnia, Seyed Jafar Sadjadi, “Robust supply chain network design: an optimization model with real world application”, Ann Oper Res, 2014
52. Tomoyuki Urata, Tetsuo Yamada, Norihiro Itsubo, Masato Inoue, “Modeling and Balancing for Costs and CO2 Emissions in Global Supply Chain Network among Asian Countries”, Procedia CIRP 26 (2015) 664 – 669
53. Mariagrazia Dotoli, Nicola Epicoco, Marco Falagario, “A Technique for Supply Chain Network Design under Uncertainty using Cross-Efficiency Fuzzy Data Envelopment Analysis”, IFAC-PapersOnLine 48-3 (2015) 634–639
54. Joana M.ComasMartí, Jean-SébastienTancrez, RalfW.Seifert, “Carbon footprint and responsiveness trade-offs in supply chain network design”, Int. J. Production Economics 166 (2015) 129–142

55. Sajan T John R Sridharan, "Modelling and analysis of network design for a reverse supply chain", Journal of Manufacturing Technology Management , 2015, Vol. 26 Iss 6
56. Anil Jindal, Kuldip Singh Sangwan, and Sachin Saxena, "Network Design and Optimization for Multi-product, Multi-time, Multi-echelon Closed-loop Supply Chain under Uncertainty", Procedia CIRP 29 (2015) 656 – 661
57. M. Fareeduddin, Adnan Hassan, M. N. Syed, S. Z. Selim, "The Impact of Carbon Policies on Closed-Loop Supply Chain Network Design", Procedia CIRP 26 (2015) 335 – 340.
58. Ali Akbar Akbari, Behrooz Karimi, "A new robust optimization approach for integrated multi-echelon, multi-product, multi-period supply chain network design under process uncertainty", Int J Adv Manuf Technol, 2015
59. Semih Coskun, Leyla Ozgur, Olcay Polat, Askiner Gungor, "A Model Proposal for Green Supply Chain Network Design Based On Consumer Segmentation", Journal of Cleaner Production, 2015
60. Zhuo Dai, Xiaoting Zheng, "Design of close-loop supply chain network under uncertainty using hybrid genetic algorithm: a fuzzy and chance-constrained programming model", Computers & Industrial Engineering, 2015
61. Rameshwar Dubey, Angappa Gunasekaran, Stephen J. Childe, "The design of a responsive sustainable supply chain network under uncertainty", Int J Adv Manuf Technol, 2015
62. Mohammad Fattahi, Kannan Govindan, "Investigating risk and robustness measures for supply chain network design under demand uncertainty: A case study of glass supply chain", Intern. Journal of Production Economics, 2015
63. Mohammad Fattahi, Masoud Mahootchi, Kannan Govindan, Seyed Mohammad Moattar Husseini, "Dynamic supply chain network design with capacity planning and multi-period pricing", Transportation Research Part E 81 (2015) 169–202
64. Kiran Garg, Devika Kannan, Ali Diabat, P.C. Jha, "A multi-criteria optimization approach to manage environmental issues in closed loop supply chain network design", Journal of Cleaner Production (2015) 1-18
65. Chunxiang Guo, Xiaoli Liu, Maozhu Jin, Zhihan Lv, "The research on optimization of auto supply chain network robust model under macro economic fluctuations", Chaos, Solitons and Fractals 000 (2015) 1–10
66. M. Kannegiesser, H.-O. Günther, N. Autenrieb, "The time-to-sustainability optimization strategy for sustainable supply network design", Journal of Cleaner Production (2015) 1-13
67. Ahmad Rezaee1, Farzad Dehghanian1, Behnam Fahimnia, Benita Beamon, "Green supply chain network design with stochastic demand and carbon price", Ann Oper Res, 2015
68. Mahdi Sharifzadeh, Marti Cortada Garcia, Nilay Shah, "Supply chain network design and operation: Systematic decision making for centralized, distributed, and mobile biofuel production using mixed integer linear programming (MILP) under uncertainty", Biomass and Bioenergy 81 (2015) 401-414
69. Mosahar Tarimoradi, M. H. Fazel Zarandi, Hosain Zaman, I. B. Turksan, "Evolutionary fuzzy intelligent system for multi-objective supply chain network designs: an agent-based optimization state of the art", J Intell Manuf, 2015
70. Alice Tognetti, Pan Theo Grosse-Ruyken, Stephan M. Wagner, "Green supply chain network optimization and the trade-off between environmental and economic Objectives", Int. J. Production Economics, 2015
71. Yu-Chung Tsao, Vu Thuy Linh, "Supply Chain Network Designs Developed for Deteriorating Items Under Conditions of Trade Credit and Partial Backordering", Netw Spat Econ, 2015
72. Abdolmajid Yolmeh, Najmeh Salehi, "An outer approximation method for an integration of supply chain network designing and assembly line balancing under uncertainty", Computers & Industrial Engineering 83 (2015) 297–306
73. Juan Yu, Mi Gan, Shaoquan Ni, Dingjun Chen, "Multi-objective models and real case study for dual-channel FAP supply chain network design with fuzzy information", J Intell Manuf, 2015
74. Farnaz Barzinpour, Peyman Taki, "A dual-channel network design model in a green supply chain considering pricing and transportation mode choice", J Intell Manuf, 2016
75. Sushil R. Poudel, Mohammad Marufuzzaman, Linkan Bian, "Designing a reliable bio-fuel supply chain network considering link failure probabilities", Computers & Industrial Engineering 91 (2016) 85–99

