MAHISHADAL RAJ COLLEGE

SESSION: 2019-2020

Total number of PUBLICATIONS in Journals: 22

(SCI/SCIE/SCOPUS/UGC-indexed: 17)

Faculty of Science

Journals (SCI/SCIE/SCOPUS/UGC-indexed)

1. Nilesh Pakhira, **Manas Kumar Maiti**, and Manoranjan Maiti. "Two-level supply chain for a deteriorating item with stock and promotional cost dependent demand under shortages." *Iranian Journal of Fuzzy Systems* 17, no. 1 (2020): 29-52, https://doi.org/10.22111/ijfs.2020.5109, Print ISSN: 1735-0654, Online ISSN: 2676-4334.
2. Mostafijur Rahaman, Sankar Prasad Mondal, Ali Akbar Shaikh, Prasenjit Pramanik, Samarjit Roy, **Manas Kumar Maiti**, Rituparna Mondal, and Debashis De. "Artificial bee colony optimization-inspired synergetic study of fractional-order economic production quantity model." *Soft Computing* 24 (2020): 15341-15359, https://doi.org/10.1007/s00500-020-04867-y, Electronic ISSN: 1433-7479, Print ISSN: 1432-7643.
3. Nilesh Pakhira, **Manas Kumar Maiti**, and Manoranjan Maiti. "A two-warehouse multi-item supply chain with stock dependent promotional demand under joint replenishment policy: a mixed-mode ABC approach." *International Journal of Systems Science: Operations & Logistics* 8, no. 3 (2020): 262-282, https://doi.org/10.1080/23302674.2020.1753127, Print ISSN: 2330-2674, Online ISSN: 2330-2682.
4. Nilesh Pakhira, **Manas Kumar Maiti**, and Manoranjan Maiti. "A supply chain of deteriorating items with variable demand." *Journal of Intelligent & Fuzzy Systems* 37, no. 1 (2019): 565-581, DOI: 10.3233/JIFS-16913, ISSN online: 1875-8967.
5. Prasenjit Pramanik, Sarama Malik Das, and **Manas Kumar Maiti**. "Note on: Supply chain inventory model for deteriorating items with maximum lifetime and partial trade credit to credit risk customers." *Journal of Industrial & Management Optimization* 15, no. 3 (2019), DOI: 10.3934/jimo.2018096, ISSN: 1547-5816, eISSN: 1553-166X.
6. Prasenjit Pramanik, and **Manas Kumar Maiti**. "An inventory model for deteriorating items with inflation induced variable demand under two level partial trade credit: A hybrid ABC-GA approach." *Engineering Applications of Artificial Intelligence* 85 (2019): 194-207, https://doi.org/10.1016/j.engappai.2019.06.013, Online ISSN: 1873-6769, Print ISSN: 0952-1976.
7. Prasenjit Pramanik and **Manas Kumar Maiti**. "Trade credit policy of an inventory model with imprecise variable demand: an ABC-GA approach." *Soft Computing* 24, no. 13 (2019): 9857-9874, https://doi.org/10.1007/s00500-019-04502-5, Electronic ISSN: 1433-7479, Print ISSN: 1432-7643.
8. Indadul Khan, Sova Pal, and **Manas Kumar Maiti**. "A hybrid PSO-GA algorithm for traveling salesman problems in different environments." *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems* 27, no. 05 (2019): 693-717, https://doi.org/10.1142/S0218488519500314, ISSN (print): 0218-4885 | ISSN (online): 1793-6411.
9. Barun Khara, **Jayanta Kumar Dey**, and Shyamal Kumar Mondal. "An integrated imperfect production system with advertisement dependent demand using branch and bound technique." *Flexible Services and Manufacturing Journal 33* (2020): 508-546, https://doi.org/10.1007/s10696-020-09377-5, Electronic ISSN: 1936-6590, Print ISSN: 1936-6582.
10. Prasanta Kumar Ghosh and **Jayanta Kumar Dey**. "Imperfect production inventory model with uncertain elapsed time." *Decision Making: Applications in Management and Engineering* 3, no. 2 (2020): 1-18, https://doi.org/10.31181/dmame2003102g, Print ISSN: 2560-6018, Online ISSN: 2620-0104.

11. Barun Khara, **Jayanta Kumar Dey**, and Shyamal Kumar Mondal. "Sustainable recycling in an imperfect production system with acceptance quality level dependent development cost and demand." *Computers & Industrial Engineering* 142 (2020): 106300, https://doi.org/10.1016/j.cie.2020.106300, Online ISSN: 1879-0550, Print ISSN: 0360-8352.
12. Barun Khara, **Jayanta Kumar Dey**, and Shyamal Kumar Mondal. "Effects of product reliability dependent demand in an EPQ model considering partially imperfect production." *International Journal of Mathematics in Operational Research* 15, no. 2 (2019): 242-264, https://doi.org/10.1504/IJMOR.2019.101621, ISSN online: 1757-5869, ISSN print: 1757-5850.
13. **Samiran Kumar** and Dilip Kumar Giri. "Realization of Nonclassical Effects of Light and Total Noise in Coherent Anti-Stokes Raman and Hyper-Raman Scatterings Up to the First-Order Hamiltonian Interaction." *Journal of Russian Laser Research* 41 (2020): 235-245, https://doi.org/10.1007/s10946-020-09870-0, Electronic ISSN: 1573-8760, Print ISSN: 1071-2836.
14. **Anwesha Mukherjee**, Shreya Ghosh, Aabhas Behere, Soumya K. Ghosh, and Rajkumar Buyya. "Internet of Health Things (IoHT) for personalized health care using integrated edge-fog-cloud network." Journal of Ambient Intelligence and Humanized Computing 12, no. 1 (2020): 943-959, https://doi.org/10.1007/s12652-020-02113-9, Electronic ISSN: 1868-5145, Print ISSN: 1868-5137.
15. Jaydeep Das, **Anwesha Mukherjee**, Soumya K. Ghosh, and Rajkumar Buyya. "Spatio-Fog: A green and timeliness-oriented fog computing model for geospatial query resolution." Simulation Modelling Practice and Theory 100, (2020): 102043, https://doi.org/10.1016/j.simpat.2019.102043, Print ISSN: 1569-190X, Online ISSN: 1878-1462.
16. Debashis De, **Anwesha Mukherjee**, and Deepsubhra Guha Roy. "Power and Delay Efficient Multilevel Offloading Strategies for Mobile Cloud Computing." Wireless Personal Communications 112, (2020): 2159–2186, https://doi.org/10.1007/s11277-020-07144-1, Electronic ISSN: 1572-834X, Print ISSN: 0929-6212.
17. Ankit Chatterjee, **Rajkumar Guchhait**, Sukhendu Maity, Dilip Mukherjee, and Kousik Pramanick. "Functions of interleukin-6 in ovulation of female climbing perch, Anabas testudineus." *Animal reproduction science* 219 (2020): 106528.

Journal (Others)

18. **Soma Chanda** and Bhaskar Bhowmik. "An assessment of macrophyte and water characteristics of Pahar Dighi, Purba Medinipur, West Bengal." Journal of Environment and Sociobiology 17, no. 1 (2020): 39-42, Online ISSN: 2454-2601, Print ISSN: 0973-0834.

Humanities & Social Science

Journals (Peer-reviewed/ UGC care listed)

19. **Asis De**. 'The Lost Years of a Nomad: Exploring Indian Experience in Nuruddin Farah's Literary Oeuvre' in ***Tydskrif Vir Letterkunde***, 57 (1) 2020, **ISSN**: 0041-476X; **E-SSN**: 2309-9070, pp. 37-44. DOI: dx.doi.org/10.17159/2309-9070/tvl.v.57i1.8059
20. **Asis De**. "Transnationality, Multiculturalism and 'New' Cosmopolitanism: Indo-Australian Interface in ***Of Sadhus and Spinners: Australian Encounters with India*****" in *Indian Journal of Australian Studies***, Vol. 10 (Special Issue on Multiculturalism), Ed. Neelima Kanwar, Centre for Australian and New Zealand Studies, Himachal Pradesh University, Shimla, 2019, pp. 63-77.
21. **Asis De**. "Cultural Ecotone and Transformation of the Human Geography in Mahasweta Devi's *Chotti Munda and His Arrow*" in **Sambalpur Studies in Literatures and Cultures** (Journal ISSN: 2231-5616) of the Department of English, Sambalpur University, Odisha, Series 5, 2019, pp.133-144.
22. **Swati Basak**. "Food, Festivals and Sweets, Creating Cultural Identity of Bengal in the 21st Century", *Modern Historical Studies*, Rabindra Bharati University, Vol, 13-14, Print, ISSN 0972-6756, pp. 149-161.

Iranian Journal of Fuzzy Systems

Volume 17, Number 1, (2020), pp. 29-52

University of Sistan and Baluchestan

Two-level supply chain for a deteriorating item with stock and promotional cost dependent demand under shortages

N. Pakhira[1], M. K. Maiti[2] and M. Maiti[3]

[1,3] *Department of Applied Mathematics with Oceanology and Computer Programming, Vidyasagar University, Midnapore, Paschim Medinipur, West Bengal, 721102, India*

[2] *Department of Mathematics, Mahishadal Raj College, Mahishadal, Purba Medinipur, West Bengal, 721628, India*

npakhira1@yahoo.com, manasmaiti@yahoo.co.in, mmaiti2005@yahoo.co.in

Abstract

In this research work, a wholesaler-retailer-customer supply chain model for a deteriorating item is considered, where the retailer's warehouse in the market place has a limited capacity. The retailer can rent an additional warehouse (rented warehouse) if needed, with a higher rent compared to the existing warehouse (own warehouse). The customers' demand of the item is linearly influenced by the stock level and in case of shortages the base demand is partially backlogged. Being the leader of the supply chain, the retailer introduces some promotional cost to boost the base demand of the item. To participate in joint marketing decision, the wholesaler shares a compromise part of this promotional cost. Goal of this research work is to maximize the individual profits (when the retailer is the leader and the wholesaler is the follower) as well as the channel profit (when the retailer and the wholesaler jointly make marketing decision) of the system. It is established that if the wholesaler shares a part of the promotional cost, then the channel profit as well as the individual profits increase. The supply chain model is also considered in imprecise environment, where different inventory parameters are fuzzy/rough in nature. In this case, the individual profits as well as the channel profit become fuzzy/rough in nature. As optimization of fuzzy/rough objective is not well defined, following credibility/trust measure of fuzzy/rough event, an approach is followed for comparison of fuzzy/rough objectives and a Particle Swarm Optimization algorithm is implemented to find the marketing decisions. Efficiency of the algorithm in solving the problem is statistically established. The existence of the joint marketing decision is established analytically and numerically (with illustration) in crisp as well as in imprecise environments.

Keywords: Deteriorating inventory, two-warehouse model, promotional cost, credibility measure, trust measure, particle swarm optimization.

1 Introduction

The classical inventory models on deteriorating items are normally developed with the common assumption that the capacity of the retailer's outlet is sufficient, i.e., the outlet has sufficient space to store the order quantity [2, 5, 30, 37, 43, 44]. However, in several real-life problems, this assumption may not appropriate. There are a number of factors which influence the marketing decisions in different ways. Sometimes these factors may force the retailer to buy more than his/her own warehouse (OW) capacity. The retailer may overcome the situation using an additional rented warehouse (RW), having sufficient capacity, normally with higher rent relative to the OW [8, 24].

Influence of displayed inventory level on the demand of any item is a well established phenomenon [12, 11]. Due to this reason, a retailer normally uses a decorated outlet at the market place to attract the customers and uses another storehouse near the outlet to stock the excess order quantity [23, 24, 29, 35]. Also inventory modelings of the deteriorating items draw significant attention by the researchers [2, 3, 5, 21, 26, 30, 41, 44]. During last two decades, several researchers on inventory control problems developed their models incorporating the above mentioned

Corresponding Author: N. Pakhira
Received: September 2017; Revised: October 2018; Accepted: April 2019.

[35] D. Panda, M. K. Maiti, M. Maiti, *Two warehouse inventory models for single vendor multiple retailers with price and stock dependent demand*, Applied Mathematical Modelling, **34** (2010), 3571-3585.

[36] P. Pramanik, M. K. Maiti, M. Maiti, *Three level partial trade credit with promotional cost sharing*, Applied Soft Computing, **58** (2017), 553-575.

[37] K. Prasad, B. Mukherjee, *Optimal inventory model under stock and time dependent demand for time varying deterioration rate with shortages*, Annals of Operations Research, **243**(1-2) (2014), 323-334.

[38] B. Sarkar, S. Sarkar, *An improved inventory model with partial backlogging, time varying deterioration and stock-dependent demand*, Economic Modelling, **30** (2013), 924-932.

[39] S. Tiwari, C. K. Jaggi, A. K. Bhunia, A. A. Shaikh, M. Goh, *Two-warehouse inventory model for non-instantaneous deteriorating items with stock-dependent demand and inflation using particle swarm optimization*, Annals of Operations Research, **254**(1-2) (2017), 401-423.

[40] D. D. Wu, *Bargaining in supply chain with price and promotional effort dependent demand*, Mathematical and Computer Modelling, **58** (2013), 1659-1669.

[41] H. L. Yang, *Two-warehouse partial backlogging inventory models for deteriorating items under inflation*, International Journal of Production Economics, **103** (2006), 362-370.

[42] W. H. Yang, Y. S. Tarng, *Design optimization of cutting parameters for turning operations based on the Taguchi method*, Journal of Materials Processing Technology, **84** (1998), 122-129.

[43] H. L. Yang, J. T. Teng, M. S. Chern, *An inventory model under inflation for deteriorating items with stock-dependent consumption rate and partial backlogging shortages*, International Journal of Production Economics, **123** (2010), 8-19.

[44] Y. Yu, Z. Wang, L. Liang, *A vendor managed inventory supply chain with deteriorating raw materials and products*, International Journal of Production Economics, **136** (2012), 266-274.

Soft Computing
https://doi.org/10.1007/s00500-020-04867-y

METHODOLOGIES AND APPLICATION

Artificial bee colony optimization-inspired synergetic study of fractional-order economic production quantity model

Mostafijur Rahaman[1] · Sankar Prasad Mondal[2] · Ali Akbar Shaikh[3] · Prasenjit Pramanik[4] · Samarjit Roy[5] · Manas Kumar Maiti[6] · Rituparna Mondal[7] · Debashis De[5]

Abstract
Inventory control is one of the most widely recognized issues in the reality. This investigation manages the utilization of fractional derivatives and integration on an inventory control problem. The memory of a dynamical model is a highly concerned issue which is commonly neglected by the models described in terms of integer-order differential equation. The memory capturing the power of fractional derivative (in Caputo's sense) is utilized here to describe an economic production quantity model with deterioration when the demand depends on price and stock and production is stock dependent. Also, this study covers the integer-order model with the same assumptions as a memoryless model and a particular case of the fractional model. Due to the complex nature of the model, numerical optimization with the help of a modified artificial bee colony algorithm is done instead of the analytical approach of optimization. Finally, we have performed a sensitivity analysis in order to make a fruitful conclusion.

Keywords Fractional-order differential equation · EPQ model · Laplace transformation · ABC algorithm

1 Introduction

Fractional calculus (FC) is a branch of mathematics which old enough as the traditional integer-order calculus. In the late seventeenth century, the foundation stone for the establishment of FC was laid by the conversation between two famous mathematicians L'Hospital and Liebnitz. Liebnitz's response to the question of L'Hospital on the existence of derivative of $\frac{1}{2}$ the order was "an apparent paradox from which 1-day useful consequences will be drawn". Surprisingly, the application of FC in the practical field of science and technology is neglected for decades and centuries looking at the concept of FC as an abstract and absurd almost. But, it is proved through recent progress of the subject that the concept is not abstract. Rather, it can describe more accurately the dynamical behaviour of processes in nature and real world in comparison to integer-order calculus. So, these days, global excitement for FC as well as fractional-order system (FOS) has been seemingly exponential. Due to the different nice results of fractional derivatives, FC has attained much attention for modelling of the image processes, various fields of mathematics, economics, physics and engineering (Diethelm et al. 2012;

Communicated by V. Loia.

✉ Sankar Prasad Mondal
sankar.res07@gmail.com

[1] Department of Mathematics, Indian Institute of Engineering Science and Technology, Shibpur, Howrah 711103, India

[2] Department of Applied Science, Maulana Abul Kalam Azad University of Technology, West Bengal, Haringhata, Nadia, West Bengal 741249, India

[3] Department of Mathematics, University of Burdwan, Golapbag, Burdwan, West Bengal, India

[4] Department of Applied Mathematics with Oceanology and Computer Programming, Vidyasagar University, Midnapore, Paschim Medinipur, West Bengal, India

[5] Department of Computer Science and Engineering, Maulana Abul Kalam Azad University of Technology, West Bengal, Haringhata, Nadia, West Bengal 741249, India

[6] Department of Mathematics, Mahishadal Raj College, Mahishadal, Purba-Medinipur, West Bengal 721628, India

[7] Applied Mathematics and Humanities Department, Sardar Vallabhbhai National Institute of Technology, Surat, Gujrat, India

Published online: 31 March 2020

Pramanik P, Maity MK (2019b) An inventory model for deterioration items with inflation induced variable demand under two level partial trade credit: a hybrid ABC-GA approach. Eng Appl Artif Intell 85:194–207. https://doi.org/10.1016/j.engappai.2019.06.013

Rahaman M, Mondal SP, Shaikh AA et al (2020) Arbitrary-order economic production quantity model with and without deterioration: generalized point of view. Adv Differ Equ 2020:16. https://doi.org/10.1186/s13662-019-2465-x

Singh J (2019) A new analysis for fractional rumor spreading dynamical model in a social network with Mittag–Leffler law. Chaos 29:013–137

Singh J, Kumar D, Hammouch Z, Atangana A (2018a) A fractional epidemiological model for computer viruses pertaining to a new fractional derivative. Appl Math Comput 316:504–515

Singh J, Kumar D, Baleanu D, Rathore S (2018b) An efficient numerical algorithm for the fractional Drinfeld–Sokolov–Wilson equation. Appl Math Comput 335:12–24

Singh J, Kumar J, Baleanu D (2018c) On the analysis of fractional diabetes model with exponential law. Adv Differ Equ. https://doi.org/10.1186/s13662-018-1680-1

Singh J, Secer A, Swroop R, Kumar D (2018d) A reliable analytical approach for a fractional model of advection–dispersion equation. Nonlinear Eng. https://doi.org/10.1515/nleng-2018-0027

Singh J, Kumar D, Baleanu D (2019) New aspects of fractional Biswas–Milovic model with Mittag–Leffler law. Math Model Nat Phenom 14(3):303

Zhu G, Kwong S (2010) Gbest-guided artificial bee colony algorithm for numerical function optimization. Appl Math Comput 217 (7):3166–3173

INTERNATIONAL JOURNAL OF SYSTEMS SCIENCE: OPERATIONS & LOGISTICS
https://doi.org/10.1080/23302674.2020.1753127

A two-warehouse multi-item supply chain with stock dependent promotional demand under joint replenishment policy: a mixed-mode ABC approach

Nilesh Pakhira[a], Manas Kumar Maiti[b] and Manoranjan Maiti[a]

[a]Department of Applied Mathematics with Oceanology and Computer Programming, Vidyasagar University, Paschim-Medinipur, West Bengal, India; [b]Department of Mathematics, Mahishadal Raj College, Purba-Medinipur, West Bengal, India

ABSTRACT

A multi-item two-level supply chain model under promotional cost sharing is proposed and analysed in this investigation. Here, it is assumed that a retailer purchases different items from a wholesaler under joint replenishment policy and sells the items to its customers. Due to the scarcity of the market place, the retailer uses two rented warehouses to run the business – one with moderate capacity situated at the heart of the market place, namely RW_1 and another with sufficiently large capacity, a little away from the market place, namely RW_2. Items are ordered jointly using basic period (BP) policy, initially stored at RW_2 and transferred jointly to RW_1 for sale following another BP policy. Demands of the items depend on displayed inventory levels, selling prices as well as the frequencies of the advertisements. Total cost due to the reduced selling prices and the advertisements is considered as the promotional cost. The problem is formulated as a mixed-integer optimisation problem in crisp as well in imprecise environments. To solve such real-life problems, here artificial bee colony algorithm is modified, tested and used. Model is illustrated with some hypothetical test problems and some managerial insights are outlined.

ARTICLE HISTORY
Received 22 May 2019
Accepted 31 March 2020

KEYWORDS
Two-warehouse; joint replenishment; promotional cost sharing; mixed-mode ABC algorithm

1. Introduction

In any supply chain, profit of each party mostly depends on the market demand of the items involved in the chain. Though every item has some base demand in the market, goal of every supply chain is to improve this base demand to survive in the market. Displayed inventory level always influences the customers and accordingly retailers normally hire a showroom in the market place to attracts the customers. This investment is mainly done at the retailer level. Two other factors which highly influence the demand are – advertisement (Maiti & Maiti, 2006a; Manna et al., 2017) and selling price (Maiti & Maiti, 2006a; Pakhira et al., 2017; Paul et al., 2014; Wee, 1997). An item is supposed to be sold in the maximum retail price printed on the packet, but in reality it is observed that different retailers give different discounts to attract their customers. Sometimes packaging is made with some extra amount which basically decreases the unit price. Free gift/extra amount with a purchase is another approach of reducing the selling price. Again different multinationals, as well as small companies, use frequent advertisements to boost the demand of their products to the customers. Though this type of investment reduces the profit from per unit sale, the resultant profit of each party increases, as total demand improves significantly. But if only one party invests this promotional cost, then, he/she will be the sole decision maker (DM) of the system (Haseli et al., 2019), which may not satisfy the other party's interest. So a coordination is highly required among all the parties in such a manner that all the parties will share the promotional cost and take part in the marketing decision. Some research articles have already been published incorporating promotional cost sharing in supply chain (Cárdenas-Barrón & Sana, 2015; Pakhira et al., 2018a, 2018b, 2019; Pramanik et al., 2017a). In all these studies, it is assumed that a promotional effort influences the demand of an item and promotional cost is a function of this promotional effort. Thus, a research gap from these studies can be identified as follows:

It is neither clear how promotional effort actually improves the demand nor how the promotional cost function is estimated. Moreover, none of these studies considered the influence of displayed inventory on the demand, specially for a supply chain management (SCM) system under retailer's two-warehouse facility.

It has already been mentioned that the displayed inventory has significant role in drawing attention to the

CONTACT Nilesh Pakhira npakhira1@yahoo.com Department of Applied Mathematics with Oceanology and Computer Programming, Vidyasagar University, Midnapore, Paschim-Medinipur, West Bengal 721102, India

Production Planning & Control, *8*(5), 494–499. https://doi.org/10.1080/095372897235073

Yang, H.-L. (2004). Two-warehouse inventory models for deteriorating items with shortages under inflation. *European Journal of Operational Research*, *157*(2), 344–356. https://doi.org/10.1016/S0377-2217(03)00221-2

Zhou, Y.-W., & Yang, S.-L. (2005). A two-warehouse inventory model for items with stock-level-dependent demand rate. *International Journal of Production Economics*, *95*(2), 215–228. https://doi.org/10.1016/j.ijpe.2003.12.007

Zimmermann, H.-J. (1996). *Fuzzy set theory and its applications*. Springer Science+Business Media.

Journal of Intelligent & Fuzzy Systems 37 (2019) 565–581
DOI:10.3233/JIFS-16913
IOS Press

A supply chain of deteriorating items with variable demand

Nilesh Pakhira[a,*], Manas Kumar Maiti[b] and Manoranjan Maiti[a]
[a]*Department of Applied Mathematics with Oceanology and Computer Programming, Vidyasagar University, Midnapore, Paschim-Medinipur, West Bengal, India*
[b]*Department of Mathematics, Mahishadal Raj College, Mahishadal, Purba-Medinipur, West Bengal, India*

Abstract. Here two-level supply chain model is considered for a deteriorating item where the retailer's warehouse in the market place has a limited capacity. Therefore the retailer can rent a warehouse (RW) if needed with a higher cost compared to own warehouse (OW). This model includes one wholesaler and one retailer and our aim is to maximize the total profit. The demand rate in retailer is stock-dependent and in case of any shortages, the demand is partially backlogged. Retailer also introduces some promotional cost to boost the base demand of the item. It is established that if the wholesaler shares a part of promotional cost then channel profit as well as individual profit increase. The supply chain model is also considered for imprecise environment when different inventory parameters are fuzzy/rough in nature. In this case individual profits as well as channel profit become fuzzy/rough in nature. As optimization of fuzzy/rough objective is not well defined, following credibility/trust measure of fuzzy/rough event, an approach is proposed for comparison of fuzzy/rough objectives and a Particle Swarm Optimization (PSO) algorithm is used to find marketing decisions. Models are illustrated with numerical examples.

Keywords: Deterioration, Two-warehouse model, Promotional Cost, Credibility/Trust measure, Particle Swarm Optimization

1. Introduction

In the classical inventory model for deteriorating products, it is usually assumed that the warehouse has no limits in the capacity. However, in the real-life problem the situation is different. There are a number of factors which influence the optimum solution in different ways. Sometimes these factors may suggest retailers to buy more than their own warehouse (OW) capacity. In these situations, the retailers can benefit from a rented warehouse (RW).

Today's globalized and competitive markets drive companies to become more efficient and cost-effective. Usually, supply chain (SC) members optimize local decisions without considering the impact of their decision on the other member's performance and on the overall performance of SC [33]. Thus, a coordination mechanism may be necessary to motivate the members. SC members are dependent on each other and these members need to be coordinated efficiently by managing dependencies between each other. Jaber and Osman [15] considered a two-level supply chain with delay in payments and profit sharing. The ordering and advertising policies for a single-period commodity was presented by Chen [3] in a two-level supply chain. Wang [32] considered a two-level supply chain with multiple retailers and stochastic demand. Dong et al. [6] developed a model on multi-level supply chain.

Many researchers have discussed on inventory models for deteriorating items. Bhunia and Maiti [2] proposed a deterministic inventory model for

*Corresponding author. Nilesh Pakhira, Department of Applied Mathematics with Oceanology and Computer Programming, Vidyasagar University, Midnapore, Paschim-Medinipur, West Bengal, 721102, India. E-mail: npakhira1@yahoo.com.

[21] M.K. Maiti and M. Maiti, Fuzzy inventory model with two warehouses under possibility constraints, *Fuzzy Sets and Systems* **157**(1) (2006), 52–73.

[22] Y. Marinakis and M. Marinaki, A hybrid genetic – Particle Swarm Optimization Algorithm for the vehicle routing problem, *Expert Systems with Applications* **37**(2) (2010), 1446–1455.

[23] V.K. Mishra, Deteriorating inventory model with controllable deterioration rate for time-dependent demand and time-varying holding cost, *Yugoslav Journal of Operations Research* **24**(1) (2014), 87–98.

[24] S. Mukhopadhyay, R.N. Mukherjee and K.S. Chaudhuri, Joint pricing and ordering policy for a deteriorating inventory, *Computers & Industrial Engineering* **47**(4) (2004), 339–349.

[25] N. Pakhira, M.K. Maiti and M. Maiti, Uncertain multi-item supply chain with two level trade credit under promotional cost sharing, *Computers & Industrial Engineering* **118** (2018), 451–463.

[26] B. Pal, S.S. Sana and K. Chaudhuri, Coordination contracts for competitive two-echelon supply chain with price and promotional effort sensitive non-linear demand, *International Journal of Systems Science: Operations & Logistics* **2**(2) (2015), 113–124.

[27] K. Prasad and B. Mukherjee, Optimal inventory model under stock and time dependent demand for time varying deterioration rate with shortages, *Annals of Operations Research* **243**(1-2) (2016), 323–334.

[28] B. Sarkar and S. Sarkar, An improved inventory model with partial backlogging, time varying deterioration and stock-dependent demand, *Economic Modelling* **30** (2013), 924–932.

[29] Q.Wang, A periodic-review inventory control policy for a two-level supply chain with multiple retailers and stochastic demand, *European Journal of Operational Research* **230**(1) (2013), 53–62.

[30] S. Whang, Coordination in operations: A taxonomy, *Journal of Operations Management* **12**(3-4) (1995), 413–422.

[31] D.D. Wu, Bargaining in supply chain with price and promotional effort dependent demand, *Mathematical and Computer Modelling* **58**(9-10) (2013), 1659–1669.

[32] J. Xu and L. Yao, A class of expected value multi-objective programming problems with random rough coefficients, *Mathematical and Computer Modelling* **50**(1-2) (2009), 141–158.

[33] H.-L. Yang, Two-warehouse partial backlogging inventory models for deteriorating items under inflation, *International Journal of Production Economics* **103**(1) (2006), 362–370.

[34] H.-L. Yang, J.-T. Teng and M.-S. Chern, An inventory model under inflation for deteriorating items with stock-dependent consumption rate and partial backlogging shortages, *International Journal of Production Economics* **123**(1) (2010), 8–19.

[35] Y. Yu, Z.Wang and L. Liang, A vendor managed inventory supply chain with deteriorating raw materials and products, International Journal of Production Economics, **136**(2)(2012), 266-274.

[36] L.A. Zadeh, Fuzzy sets, *Information and Control* **8** (1965), 338–353.

[37] L.A. Zadeh, The concept of linguistic variable and its application to approximate reasoning, *Memorandum ERL-M 411*, Berkeley, 1973.

JOURNAL OF INDUSTRIAL AND
MANAGEMENT OPTIMIZATION
Volume **15**, Number **3**, July **2019**

doi:10.3934/jimo.2018096

pp. **1289–1315**

NOTE ON: SUPPLY CHAIN INVENTORY MODEL FOR DETERIORATING ITEMS WITH MAXIMUM LIFETIME AND PARTIAL TRADE CREDIT TO CREDIT RISK CUSTOMERS

Prasenjit Pramanik*

Department of Applied Mathematics with Oceanology and Computer Programming
Vidyasagar University, Midnapore, Paschim Medinipur, West Bengal 721102, India

Sarama Malik Das

Department of Mathematics, Calcutta Institute of Technology
Uluberia, Howrah, West Bengal 711316, India

Manas Kumar Maiti

Department of Mathematics, Mahishadal Raj College
Mahishadal, Purba Medinipur, West Bengal 721628, India

(Communicated by Changzhi Wu)

Abstract. In the recently published paper [Gour Chandra Mahata and Sujit Kumar De, Supply chain inventory model for deteriorating items with maximum lifetime and partial trade credit to credit-risk customers, International Journal of Management Science and Engineering Management, 2017, DOI:10.1080/17509653.2015.1109482], a supplier-retailer supply chain model of a deteriorating item with maximum lifetime and partial trade credit to credit risk customers is studied. In their study, unfortunately the amount of the payable bank interest due to the deteriorated units is omitted in the retailer's profit function for making the marketing decision. Some other unrealistic studies are also found in the numerical section of the paper. In this study those non-trivial flaws are identified and technically corrected. After correction, the theoretical existence of the optimal solutions of different scenarios are established and the solutions are derived using a soft computing technique.

1. **Introduction.** In a real life business environment there are several products such as fruits, vegetables, medicines, volatile liquids, blood in blood bank, high-tech products etc., which deteriorate continuously due to evaporation, spoilage, obsolescence, etc. In reality, it is not possible to prevent the deterioration of any deteriorating item fully in any business sector. Due to this reason the maintenance of inventory system of a deteriorating item is a crucial issue for the decision maker of the system. To overcome this difficulty in 1963, Ghare and Schrader[10] first explored an economic order quantity (EOQ) model for deteriorating items. After the novel invention of Ghare and Schrader[10], the researchers and the practitioners of inventory control system/ supply chain management developed various realistic models for deteriorating items considering constant deterioration rate[1, 3, 6, 8, 11,

2010 *Mathematics Subject Classification.* Primary: 90B05; Secondary 91B60.

Key words and phrases. Supply chain, EOQ model, deterioration, partial trade credit, maximum lifetime.

* Corresponding author.

[34] T. Singh and H. Pattanayak, An EOQ model for deteriorating items with linear demand, variable deterioration and partial backlogging, *Journal of Service Science and Management*, **6** (2013), 186–190.
[35] S. Tayal, S. R. Singh and R. Sharma, Multi Item Inventory Model for Deteriorating Items with Expiration Date and Allowable Shortages, *Indian Journal of Science and Technology*, **7** (2014), 463–471.
[36] J. T. Teng, Optimal ordering policies for a retailer who offers distinct trade credits to its good and bad customers, *International Journal of Production Economics*, **119** (2009), 415–423.
[37] J. T. Teng, H. J. Chang, C. Y. Dye and C. H. Hung, An optimal replenishment policy for deteriorating items with time-varying demand and partial backlogging, *Operation Research Letters*, **30** (2002), 387–393.
[38] J. T. Teng, M. S. Chern, H. L. Yang and Y. J. Wang, Deterministic lot-size inventory models with shortages and deterioration for fluctuating demand, *Operation Research Letters*, **24** (1999), 65–72.
[39] J. T. Teng and S. K. Goyal, Optimal ordering policies for a retailer in a supply chain with up-stream and down-stream trade credits, *Journal of the Operational Research Society*, **58** (2007), 1252–1255.
[40] Y. C. Tsao, Managing multi-echelon multi-item channels with trade allowances under credit period, *International Journal Production Economics*, **127** (2010), 226–237.

Received August 2017; revised February 2018.

E-mail address: pramanik.prasenjit72@gmail.com
E-mail address: srijanmyson@gmail.com
E-mail address: manasmaiti@yahoo.co.in

Engineering Applications of Artificial Intelligence 85 (2019) 194–207

Contents lists available at ScienceDirect

Engineering Applications of Artificial Intelligence

journal homepage: www.elsevier.com/locate/engappai

An inventory model for deteriorating items with inflation induced variable demand under two level partial trade credit : A hybrid ABC-GA approach☆

Prasenjit Pramanik [a,*], Manas Kumar Maiti [b]

[a] Department of Applied Mathematics with Oceanology and Computer Programming, Vidyasagar University, Midnapore, Paschim-Medinipur, West Bengal 721102, India

[b] Department of Mathematics, Mahishadal Raj College, Mahishadal, Purba-Medinipur, West Bengal 721628, India

ARTICLE INFO

Keywords:
Inventory
Partial trade credit
Promotional effort
Inflation
Time value of money
Artificial bee Genetic algorithm (ABGA)

ABSTRACT

In this research work an inventory model of a deteriorating item is considered under two level partial trade credit policy incorporating inflation and time value of money in a finite planning horizon. Here it is assumed that a wholesaler offers a partial trade credit to a retailer i.e., trade credit period is offered on an portion of the total purchase amount. In turn the retailer also offers a partial trade credit to its customers. Demand of the item linearly decreases with time and influenced by unit selling price of the item. As selling price is influenced by the inflation and time value of money, so the base demand depends on inflation and bank interest rate also. The retailer also introduces some promotional cost to boost the demand of the item. Under this circumstances, marketing decisions are made to maximize the present value of the total profit. On the other hand combining the features of artificial bee colony (ABC) and genetic algorithm (GA), a hybrid algorithm, artificial bee genetic algorithm (ABGA) has been developed to find the most appropriate business strategies for the proposed model. Efficiency of this algorithm is tested and compared with some ABC variants using a set of benchmark test functions. The model has been illustrated with several numerical examples and some managerial insights are outlined.

1. Introduction and literature review

Due to huge and stiff competition among the business enterprises in the local as well as in the global market, the business enterprises adopt various tolls to sell their products efficiently. Trade credit policy is one of the most effective promotional tools to push a product, which indirectly reduce the selling price of the product. With the novel invention of Goyal (1985), trade credit policy is heavily used in inventory control systems. In Goyal (1985), it is assumed that a supplier offers some delay period in payment to a retailer. From this point of view the researchers and the practitioners of inventory control systems developed various models (Aggarwal and Jaggi, 1995; Chung and Liao, 2004; Huang, 2007a; Ouyang et al., 2009; Pramanik et al., 2017c). From these studies it is seen that a supplier/wholesaler offers a credit period to a retailer but in turn the retailer does not offer any credit opportunity to his/her customers, which is an unrealistic phenomenon. (Huang, 2003) first explore an inventory model under two level trade credit policy, where a supplier offers a credit period for payment to a retailer and in turn the retailer also offers a credit period to the customers. From this point of view there are several research works developed with different circumstances to make the models more realistic (Chung, 2011, 2013; Guchhait et al., 2014; Huang, 2006, 2007b; Lashgari and Taleizadeh, 2016; Maiti, 2011; Maiti and Maiti, 2007; Taleizadeh et al., 2016; Teng et al., 2013). Also to reduce the default credit risk the researchers of inventory control system develop their models (Huang and Hsu, 2008; Mahata, 2012; Ouyang et al., 2009) with partial credit policy under two level credit policy, where the supplier/wholesaler offers a full credit to the retailer but in turn the retailer offers a credit period to the customers on some portion of the total purchase amount and the remaining portion of the purchase amount has to pay as collateral deposit at the time of receiving the units of the item. Recently Pramanik et al. (2017a) have developed an economic order quantity (EOQ) model under three level trade credit policy with retailer's partial credit policy. Now-a-days, there are so many fake orders are made to the supplier in case of e-business. To mitigate the order cancellation risk, the researchers are devoted in the direction of advance payment scheme (full or partial) for the retailers and offers some credit period on some portion of the total purchase amount (Diabat et al., 2017; Lashgaria et al., 2016, 2018; Taleizadeh et al., 2018; Tavakoli and Taleizadeh; Zia and Taleizadeh, 2015). In

☆ No author associated with this paper has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to https://doi.org/10.1016/j.engappai.2019.06.013.

* Corresponding author.
E-mail addresses: pramanik.prasenjit72@gmail.com (P. Pramanik), manasmaiti@yahoo.co.in (M.K. Maiti).

https://doi.org/10.1016/j.engappai.2019.06.013
Received 23 March 2018; Received in revised form 10 November 2018; Accepted 19 June 2019
Available online xxxx
0952-1976/

Maihami, R., Karimi, B., 2014. Optimizing the pricing and replenishment policy for non-instantaneous deteriorating items with stochastic demand and promotional efforts. Comput. Oper. Res. 51, 302–312.

Maiti, M.K., 2011. A fuzzy genetic algorithm with varying population size to solve an inventory model with credit-linked promotional demand in an imprecise planning horizon. European J. Oper. Res. 213, 96–106.

Maiti, M.K., Maiti, M., 2007. Two-storage inventory model with lot-size dependent fuzzy lead-time under possibility constraints via genetic algorithm. European J. Oper. Res. 179, 352–371.

Michalewicz, Z., 1992. Genetic Algorithms + Data Structures = Evolution Programs. Springer, Berlin.

Min, J., Zhou, Y.W., Zhao, J., 2010. An inventory model for deteriorating items under stock dependent demand and two-level trade credit. Appl. Math. Model. 34, 3273–3285.

Ouyang, L.Y., Ho, C.H., Su, C.H., 2008. Optimal strategy for an integrated system with variable production rate when the freight rate and trade credit are both linked to order quantity. Int. J. Prod. Econ. 115, 151–162.

Ouyang, L.Y., Teng, J.T., Goyal, S.K., Yang, C.T., 2009. An economic order quantity model for deteriorating items with partially permissible delay in payments to order quantity. European J. Oper. Res. 194, 418–431.

Pal, B., Sana, S.S., Chaudhuri, K., 2015. Coordination contracts for competitive two-echelon supply chain with price and promotional effort sensitive non-linear demand. Int. J. Syst. Sci. Oper. Logist. 2 (2), 113–124.

Pramanik, P., Maiti, M.K., Maiti, M., 2017a. A supply chain with variable demand under three level trade credit policy. Comput. Ind. Eng. 106, 205–221.

Pramanik, P., Maiti, M.K., Maiti, M., 2017b. Three level partial trade credit with promotional cost sharing. Appl. Soft Comput. 58, 553–575.

Pramanik, P., Maiti, M.K., Maiti, M., 2017c. An appropriate business strategy for a sale item. OPSEARCH http://dx.doi.org/10.1007/s12597-017-0310-0.

Sarkar, B., Mandal, P., Sarkar, S., 2014. An EMQ model with price and time dependent demand under the effect of reliability and inflation. Appl. Math. Comput. 231, 414–421.

Sarkar, B., Saren, S., Wee, H.M., 2013. An inventory model with variable demand, component cost and selling price for deteriorating items. Econ. Model. 30, 306–310.

Sarker, B.R., Jamal, A.M.M., Wang, S., 2000. Supply chain models for perishable products under inflation and permissible delay in payment. Comput. Oper. Res. 27, 59–75.

Shah, N.H., Vaghela, C.R., 2016. Economic order quantity for deteriorating items under inflation with time and advertisement dependent demand. OPSEARCH 54, 168–180.

Taleizadeh, A.A., Lashgari, M., Akram, R., Heydari, J., 2016. An imperfect EPQ model with up-stream trade credit periods linked to raw material order quantity and down-stream trade credit periods. Appl. Math. Model. 40, 8777–8793.

Taleizadeh, A.A., Tavakoli, S., San-José, L.A., 2018. A lot sizing model with advance payment and planned backordering. Ann. Oper. Res. http://dx.doi.org/10.1007/s10479-018-2753-y.

Tavakoli, S., Taleizadeh, A.A., An EOQ model for decaying item with full advanced payment and conditional discount, 259 (2017) 415–436.

Tayal, S., Singh, S.R., Sharma, R., 2014. Multi item inventory model for deteriorating items with expiration date and allowable shortages. Indian J. Sci. Technol. 7, 463–471.

Teng, J.T., Yang, H.L., Chern, M.S., 2013. An inventory model for increasing demand under two levels of trade credit linked to order quantity. Appl. Math. Model. 37, 7624–7632.

Tsao, Y.C., 2010. Managing multi-echelon multi-item channels with trade allowances under credit period. Int. J. Prod. Econ. 127, 226–237.

Wang, S.D., Zhou, Y.W., Min, J., Zhong, Y.G., 2011. Coordination of cooperative advertising models in a one-manufacturer two-retailer supply chain system. Comput. Ind. Eng. 61, 1053–1071.

Wee, H.M., 1999. Deteriorating inventory model with quantity discount pricing and partial backordering. Int. J. Prod. Econ. 59, 511–518.

Yelghi, A., köse, C., 2018. A modified firefly algorithm for global minimum optimization. Appl. Soft Comput. 62, 29–44.

Zhu, G., Kwong, S., 2010. Gbest-guided artificial bee colony algorithm for numerical function optimization. Appl. Math. Comput. 217, 3166–3173.

Zia, N.P., Taleizadeh, A.A., 2015. A lot-sizing model with backordering under hybrid linked-to-order multiple advance payments and delayed payment. Trans. Res. E. 82, 19–37.

Soft Computing
https://doi.org/10.1007/s00500-019-04502-5

METHODOLOGIES AND APPLICATION

Trade credit policy of an inventory model with imprecise variable demand: an ABC-GA approach

Prasenjit Pramanik[1] · **Manas Kumar Maiti**[2]

Abstract
In this research work, an inventory model with fuzzy promotional effort induced dynamic demand under two level partial trade credit policy has been developed in an imprecise planning horizon. Here, it is assumed that in the planning horizon a retailer completed a finite number full cycles. In each of the retailer's cycle, a wholesaler offers a credit period to the retailer on the full purchased amount and in turn the retailer offers a credit period to its customers on a part of his/her purchased amount. The imprecise marketing demand is influenced by the retailer's fuzzy promotional effort, customers' credit period, customers' credit amount and retail selling price. Goal of this study is to find the optimal business strategy for the retailer with respect to his/her total fuzzy financial gain from the system. Due to imprecise nature of the demand, the problem is mathematically represented following fuzzy differential equation and fuzzy Riemann integration and alpha-cut of the entire fuzzy gain from the system is derived. Its graded mean integration representation is computed and optimized with respect to customer's credit amount credit period, and retailer's order quantity for most appropriate marketing decision. Hence, the problem reduced to a multivariate crisp optimization problem and a heuristic, multichoice artificial bee genetic algorithm (MCABGA) has been proposed for it. The efficiency of MCABGA is tested against some other existing artificial bee colony variants using a list of benchmark test functions available in the literature. The model is illustrated with some hypothetical test problems and some managerial insights are outlined. Finally, a conclusion is drawn and some future research directions are proposed.

Keywords Inventory · Imprecise variable demand · Fuzzy differential equation · Artificial bee colony (ABC) · Genetic algorithm (GA)

1 Introduction

Trade credit policy is an important and effective promotional tool to push a product efficiently. Initiative work on the modelling of inventory problems incorporating trade credit option was made by Goyal(1985) and then the researchers and the practitioners of inventory problems proposed various models (economic order quantity (EOQ)/economic production quantity(EPQ)) incorporating trade credit options in different levels (customers' level, retailer level, wholesaler level, etc.) of a business chain. Since last two decade, several inventory models are developed by various researchers to maintain the inventory most appropriately in various circumstances under different trade credit policies, like, single level (wholesaler to retailer) credit opportunity (Aggarwal and Jaggi 1995; Chung and Liao 2004; Huang 2007; Ouyang et al. 2009; Pramanik et al. 2017c), two levels of trade option (wholesaler to retailer and retailer to customers) (Chung 2011, 2013; Guchhait et al. 2015; Huang 2003, 2006; Huang and Hsu 2008; Pramanik and Maiti 2019b; Pramanik et al. 2019; Teng 2009) and three levels of trade credit where credit opportunity exists for the wholesaler also from the supplier(Pal et al. 2015; Pramanik et al. 2017a, b). It is a real practice that in a business chain under two level credit opportunity wholesaler offers a credit period on full purchased amount to the retailer (named as

Communicated by V. Loia.

✉ Prasenjit Pramanik
pramanik.prasenjit72@gmail.com

Manas Kumar Maiti
manasmaiti@yahoo.co.in

[1] Department of Applied Mathematics with Oceanology and Computer Programming, Vidyasagar University, Midnapore,Paschim-Medinipur, West Bengal 721102, India

[2] Department of Mathematics, Mahishadal Raj College, Mahishadal, Purba-Medinipur, West Bengal 721628, India

Published online: 15 November 2019

Ishii H, Konno T (1998) A stochastic inventory problem with fuzzy shortage cost. Eur J Oper Res 106:90–94
Kandal A, Bytt WJ (1978) Fuzzy differential equation. In: Proceedings of international conference on cybernetics society, Tokyo, pp 1213–1216
Kandal A, Bytt WJ (1980) Fuzzy processes. Fuzzy Sets Syst 4:117–152
Kao C, Hsu WK (2002) A single-period inventory model with fuzzy demand. Comput Math Appl 43(6–7):841–848
Karaboga D (2015) An idea based on honey bee swarm for numerical optimization. Technical report-TR06, Erciyes University, Kayseri, Turkey
Karaboga D, Akay B (2009) A comparative study of artificial bee colony algorithm. Appl Math Comput 214:108–132
Karaboga D, Basturk B (2007) A powerful and efficient algorithm for numerical function optimization: artificial bee colony (ABC) algorithm. J Glob Optim 39:459–471
Karaboga D, Basturk B (2008) On the performance of artificial bee colony (ABC) algorithm. Appl Soft Comput 8:687–697
Katagiri H, Ishii H (2000) Some inventory problems with fuzzy shortage cost. Fuzzy Sets Syst 111:87–97
Katagiri H, Ishii H (2002) Fuzzy inventory problems for perishable commodities. Eur J Oper Res 138:545–553
Kiran MS, Hakli H, Gundaz M, Uguz H (2015) Artificial bee colony algorithm with variable search strategy for continuous optimization. Inf Sci 300:140–157
Kundu A, Guchhait P, Pramanik P, Maiti MK, Maiti M (2017) A production inventory model with price discounted fuzzy demand using an interval compared hybrid algorithm. Swarm Evol Comput 34:1–17
Liu B (2002) Theory and practice of uncertain programming. Physica, Heidelberg
Liu B, Iwamura K (1998) Chance constrained programming with fuzzy parameters. Fuzzy Sets Syst 94:227–237
Mahata GC (2012) An EPQ-based inventory model for exponentially deteriorating items under retailer partial trade credit policy in supply chain. Expert Syst Appl 39:3537–3550
Mahata GC, De SK (2016) An EOQ inventory system of ameliorating items for price dependent demand rate under retailer partial trade credit policy. OPSEARCH. https://doi.org/10.1007/s12597-016-0252-y
Maiti MK (2008) Fuzzy inventory model with two warehouses under possibility measure on fuzzy goal. Eur J Oper Res 188(3):746–774
Maiti MK (2011) A fuzzy genetic algorithm with varying population size to solve an inventory model with credit-linked promotional demand in an imprecise planning horizon. Eur J Oper Res 213:96–106
Maiti MK, Maiti M (2006) Fuzzy inventory model with two warehouses under possibility constraints. Fuzzy Sets Syst 157(1):52–73
Maiti MK, Maiti M (2007) Two-storage inventory model with lot-size dependent fuzzy lead-time under possibility constraints via genetic algorithm. Eur J Oper Res 179:352–371
Mandal NK, Roy TK, Maiti M (2005) Multi-objective fuzzy inventory model with three constraints: a geometric programming approach. Fuzzy Sets Syst 150(1):87–106
Michalewicz Z (1992) Genetic algorithms + data structures = evolution programs. Springer, Berlin
Ouyang LY, Ho CH, Su CH (2008) Optimal strategy for an integrated system with variable production rate when the freight rate and trade credit are both linked to order quantity. Int J Prod Econ 115:151–162
Ouyang LY, Teng JT, Goyal SK, Yang CT (2009) An economic order quantity model for deteriorating items with partially permissible delay in payments to order quantity. Eur J Oper Res 194:418–431
Pal B, Sana SS, Chaudhuri K (2015) Coordination contracts for competitive two-echelon supply chain with price and promotional effort sensitive non-linear demand. Int J Syst Sci Oper Logist 2(2):113–124
Pramanik P, Maiti MK (2019a) An inventory model for deteriorating items with inflation induced variable demand under two level partial trade credit: a hybrid ABC-GA approach. Eng Appl Artif Intell 85:194–207
Pramanik P, Maiti MK (2019b) An inventory model with variable demand incorporating unfaithfulness of customers under two-level trade credit. Eur J Ind Eng 13(4):461–488. https://doi.org/10.1504/EJIE.2019.100957
Pramanik P, Maiti MK, Maiti M (2017a) An appropriate business strategy for a sale item. OPSEARCH. https://doi.org/10.1007/s12597-017-0310-0
Pramanik P, Maiti MK, Maiti M (2017b) A supply chain with variable demand under three level trade credit policy. Comput Ind Eng 106:205–221
Pramanik P, Maiti MK, Maiti M (2017c) Three level partial trade credit with promotional cost sharing. Appl Soft Comput 58:553–575
Pramanik P, Malik Das S, Maiti MK (2019) Note on: supply chain inventory model for deteriorating items with maximum lifetime and partial trade credit to credit risk customers. J Ind Manag Optim 15(3):1289–1315
Raula P, Indrajitsingha SK, Samanta PN, Misra UK (2016) A fuzzy inventory model for constant deteriorating item by using GMIR method in which inventory parameters treated as HFN. Open J Appl Theor Math (OJATM) 2(1):13–20
Roman-Flores H, Barros L, Bassanezi R (2001) A note on the Zadeh's extensions. Fuzzy Sets Syst 117:327–331
Roy A, Maiti MK, Kar S, Maiti M (2007) Two-storage inventory model with fuzzy deterioration over a random time horizon. Math Comput Model 46:1419–1433
Sarkar S, Chakrabarti T (2012) An EPQ model with two-component demand under fuzzy environment and Weibull distribution deterioration with shortages. Adv Oper Res. https://doi.org/10.1155/2012/264182
Teng JT (2009) Optimal ordering policies for a retailer who offers distinct trade credits to its good and bad customers. Int J Prod Econ 119:415–423
Vorobiev D, Seikkala S (2002) Towards the fuzzy differential equations. Fuzzy Sets Syst 125:231–237
Wee HM (1999) Deteriorating inventory model with quantity discount, pricing and partial backordering. Int J Prod Econ 59:511–518
Wee HM, Lo CC, Hsu PH (2009) A multi-objective joint replenishment inventory model of deteriorated items in a fuzzy environment. Eur J Oper Res 197:620–631
Wu HC (2000) The fuzzy Riemann integral and its numerical integration. Fuzzy Sets Syst 110:1–25
Zadeh LA (1965) Fuzzy sets. Inf. Control 8:338–356
Zadeh LA (1978) Fuzzy sets as a basis for a theory of possibility. Fuzzy Sets Syst 1:3–28
Zhu G, Kwong S (2010) Gbest-guided artificial bee colony algorithm for numerical function optimization. Appl Math Comput 217:3166–3173

International Journal of Uncertainty,
Fuzziness and Knowledge-Based Systems
Vol. 27, No. 5 (2019) 693–717

DOI: 10.1142/S0218488519500314

A Hybrid PSO-GA Algorithm for Traveling Salesman Problems in Different Environments

Indadul Khan
Department of Computer Science, Chandrakona Vidyasagar Mahavidyalaya, Paschim-Medinipur, West Bengal 721201, India
indadulkhan@gmail.com.

Sova Pal
Department of Computer Science, Y.S. Palpara Mahavidyalaya, Palpara, Purba-Medinipur, West Bengal 721458, India
sova_pal10@rediffmail.com

Manas Kumar Maiti
Department of Mathematics, Mahishadal Raj College, Mahishadal, Purba-Medinipur, West Bengal 721628, India
manasmaiti@yahoo.co.in

Received 17 November 2017
Revised 2 June 2018

In this study particle swarm optimization (PSO) is modified and hybridised with genetic algorithm (GA) using one's output as the other's input to solve Traveling Salesman Problem(TSP). Here multiple velocity update rules are introduced to modify the PSO and at the time of the movement of a solution, one rule is selected depending on its performances using roulette wheel selection process. Each velocity update rule and the corresponding solution update rule are defined using swap sequence (SS) and swap operation (SO). K-Opt operation is applied in a regular interval of iterations for the movement of any stagnant solution. GA is applied on the final output swarm of the PSO to search the optimal path of the large size TSPs. Roulette wheel selection process, multi-point cyclic crossover and the K-opt operation for the mutation are used in the GA phase. The algorithm is tested in crisp environment using different size benchmark test problems available in the TSPLIB. In the crisp environment the algorithm gives approximately 100% success rate for the test problems up to considerably large sizes. Efficiency of the algorithm is tested with some other existing algorithms in the literature using Friedman test. Some approaches are incorporated with this algorithm for finding solutions of the TSPs in imprecise (fuzzy/rough) environment. Imprecise problems are generated from the crisp problems randomly, solved and obtained results are discussed. It is observed that the performance of the proposed algorithm is better compared to the some other algorithms in the existing literature with respect to the accuracy and the consistency for the symmetric TSPs as well as the Asymmetric TSPs.

Keywords: Traveling Salesmen Problem; particle swarm optimization; multiple velocity update rules; genetic algorithm; K-Opt operation.

55. X. Yan, C. Zhang, W. Luo, W. Li, W. Chen and H. Liu, Solve traveling salesman problem using particle swarm optimization algorithm, *Int. J. Computer Science Issues* **9**(6) (2012) 264–271.
56. C. Yuan, X. Sun, and R. Lv, Fingerprint liveness detection based on multi-scale LPQ and PCA, *China Communications* **13**(7) (2016) 60–65.
57. L. Zadeh, Fuzzy sets, *Information and Control* **8** (1965) 338–356.
58. S. H. Zhan, J. Lin, Z. J. Zhang and Y. W. Zhong, List-based simulated annealing algorithm for traveling salesman problem, *Computational Intelligence and Neuroscience* **2016** (2016) 1-12.

Flexible Services and Manufacturing Journal
https://doi.org/10.1007/s10696-020-09377-5

An integrated imperfect production system with advertisement dependent demand using branch and bound technique

Barun Khara[1] · Jayanta Kumar Dey[2] · Shyamal Kumar Mondal[1]

Abstract
This paper develops an integrated imperfect production-inventory system consisting of a retailer and a manufacturer who produces breakable items. As breakable items are very sensitive to transport, in this paper, to stimulate the retailer, the manufacturer offers (1) free transportation subject to the condition that the retailer must have to order a minimum replenishment quantity specified by the manufacturer and (2) a credit period depending on the replenishment quantity. Moreover, malfunctioning of the production system increases due to several kinds of problem and consequently it produces a mixture of perfect and imperfect quality items. So, to maintain the reliability of the production system, development cost has been incorporated. Also to aware the customer about the reliability of the production system, the manufacturer has paid attention to give a constant amount of advertisement regularly during his/her production period. Henceforth, the advertisement dependent demand has been considered here. Under such circumstances, an integrated profit function has been developed and solved by branch and bound technique to obtain the optimum values of the system. From numerical studies, it is revealed that in case of incorporation of the advertisement, the retailer's average profit, the manufacturer's average profit and the average integrated profit are higher than that in the case without advertisement.

Keywords Branch and bound technique · System reliability parameter · Replenishment quantity · Breakable rate · Credit period

✉ Barun Khara
barunkhara1710@gmail.com

Jayanta Kumar Dey
dey_jaykum@yahoo.com

Shyamal Kumar Mondal
shyamal_260180@yahoo.com

[1] Department of Applied Mathematics with Oceanology and Computer Programming, Vidyasagar University, Midnapore, W.B. 721102, India

[2] Department of Mathematics, Mahishadal Raj College, Purba Medinipur, W.B., India

Published online: 05 March 2020

Sarkar B, Moon I (2014) Improved quality, set up cost reduction, and variable backorder costs in an imperfect production process. Int J Prod Econ 155:204–213
Sarkar B, Saren S (2016) Product inspection policy for an imperfect production system with inspection errors and warranty cost. Eur J Oper Res 248(1):263–271
Sarkar B, Saren S (2017) Ordering and transfer policy and variable deterioration for a warehouse model. Hacet J Math Stat 46(5):985–1014
Sarkar M, Sarkar B (2013a) An economic manufacturing quantity model with probabilistic deterioration in a production system. Econ Model 31:245–252
Sarkar B, Sarkar S (2013b) Variable deterioration and demand-An inventory model. Econ Model 31:548–556
Sarkar B, Sana SS, Chaudhuri KS (2011) An imperfect production process for time varying demand with inflation and time value of money—an EMQ model. Expert Sys with Appl 38(11):13543–13548
Sarkar B, Cardenas-Barron LE, Sarkar M, Singgih ML (2014a) An economic production quantity model with random defective rate, rework process and backorders for a single stage production system. J Manuf Syst 33(3):423–435
Sarkar B, Gupta H, Chaudhuri KS, Goyal SK (2014b) An integrated inventory model with variable lead time, defective units and delay in payments. Appl Math Comput 237:650–658
Sarkar B, Mandal B, Sarkar S (2015a) Quality improvement and backorder price discount under controllable lead time in an inventory model. J Manuf Syst 35:26–36
Sarkar B, Chaudhuri KS, Moon I (2015b) Manufacturing setup cost reduction and quality improvement for the distribution free continuous-review inventory model with a service level constraint. J Manuf Syst 34:74–82
Sarkar B, Sett BK, Sarkar S (2018a) Optimal production run time and inspection errors in an imperfect production system with warranty. J Ind Manag Opt 14(1):267–282
Sarkar B, Majumder A, Sarkar M, Kim N, Ullah M (2018b) Effects of variable production rate on quality of products in a single-vendor multi-buyer supply chain management. Int J Adv Manuf Technol 99:567–581
Sett BK, Sarkar S, Sarkar B (2017) Optimal buffer inventory and inspection errors in an imperfect production system with preventive maintenance. Int J Adv Manuf Technol 90:545–560
Tayyab M, Sarkar B (2016) Optimal batch quantity in a cleaner multi-stage lean production system with random defective rate. J Cleaner Prod 139:922–934
Teng JT, Chang CT (2005) Economic production quantity models for deteriorating items with price- and stock-dependent demand. Comput Oper Res 32(2):297–308
Tiwari S, Cardenas-Barron LE, Goh M, Shaikh AA (2018) Joint pricing and inventory model for deteriorating items with expiration dates and partial backlogging under two-level partial trade credits in supply chain. Int J Prod Econ 200:16–36

Barun Khara is a Research Scholar at the Department of Applied Mathematics with Oceanology and Computer Programming in Vidyasagar University, Midnapore. He obtained M.Sc. in Applied Mathematics from the Jadavpur University. His fields of interest are operations research and fuzzy mathematics. He has already published articles in reputed journals like Computers & Industrial Engineering, IJMOR etc.

Jayanta Kumar Dey is an Associate Professor at the Department of Mathematics in Mahishadal Raj College, Purba Medinipur, India. He obtained Ph.D. from Vidyasagar University. He has more than 30 publications in international journals like Applied soft computing, Computers and Industrial engineering, Applied Mathematical Modelling, EJOR, IJPE, Information systems etc in mathematics and operations research. His fields of interest are operations research, fuzzy mathematics, fuzzy and rough sets etc.

Shyamal Kumar Mondal is a Professor at the Department of Applied Mathematics with Oceanology and Computer Programming in Vidyasagar University. He did his Ph.D. in Applied Mathematics in 2004 from Vidyasagar University. Previously he worked as an lecturer in Rabindra Satabarshiki Mahavidyalaya, Ghatal, Midnapore, India. 13 students already got Ph.D. in under his supervision. He has more than 90 publications in international journals like Journal of Cleaner Production, Applied soft computing, Computers and Industrial engineering, Applied Mathematical Modelling, EJOR, IJPE, Information sciences, Engineering Applications of Artificial Intelligence, Chaos, Solitons & Fractals, Non-linear Dynamics etc in mathematics and operations research. His fields of interest are operations research, fuzzy mathematics, fuzzy and rough sets, Bio-Mathematics etc.

Decision Making: Applications in Management and Engineering
Vol. 3, Issue 2, 2020, pp. 1-18.
ISSN: 2560-6018
eISSN: 2620-0104
DOI: https://doi.org/10.31181/dmame2003102g

IMPERFECT PRODUCTION INVENTORY MODEL WITH UNCERTAIN ELAPSED TIME

Prasanta Kumar Ghosh [1] and Jayanta Kumar Dey [2*]

[1] Yogoda Satsanga Palpara Mahavidyalaya, Purba Medinipur, West Bengal, India
[1] Mahishadal Raj College,Mahishadal, PurbaMedinipur, West Bengal, India

Received: 25 January 2019;
Accepted: 15 July 2019;
Available online: 23 August 2019.

Original scientific paper

***Abstract**: Most of the classical inventory control model assumes that all items received conform to quality characteristics. However, in practice, items may be damaged due to production conditions, transportation and environmental conditions. Modelling such real world problems involve various indeterminate phenomena which can be estimated through human beliefs. The uncertainty theory proposed by Liu (2015) is extensively regarded as an appropriate tool to deal with such uncertainty. This paper investigates the optimum production run time and optimum cost in an imperfect production process, where the rate of imperfect items are different in different states of the process. The process may be shifting from 'in-control' state to the 'out-of-control' state is an uncertain variable with certain uncertainty distribution. Some propositions are derived for the optimal production run time and optimized the expected total cost function per unit time. Finally, numerical examples have been illustrated to study the practical feasibility of the model.*

***Keywords:** Inventory, Imperfect production, Uncertain variables, Uncertain distribution, Expected value model.*

1. Introduction

In some real uncertain situation, we have to depend on domain experts to represent the belief degree when no samples are available to estimate a probability distribution. To deal with uncertainty in human belief, which is neither random nor fuzzy, Liu (2009), (2015), (2016) introduced uncertainty theory. It deals with modeling of uncertainty, based on normality, monotonicity, self-duality, countable sub-additivityand product measure axioms. Uncertain variable, uncertain set and uncertain measure are the basic tools to describe the uncertain phenomenon.

* Corresponding author.
E-mail addresses: prasantakumarghosh43@gmail.com (P.K. Ghosh), jkdey1971@gmail.com (J.K. Dey)

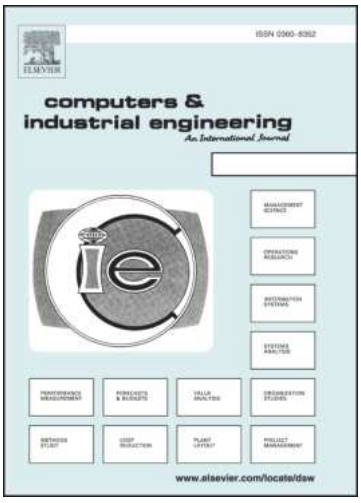
Yeh, R. H., Chen, M. Y., & Lin, C. Y. (2007). Optimal periodic replacement policy for repairable products under free-repair warranty. European Journal of Operational Research, 176, 1678-1686.

Yeo, W. M., & Yuan, XueMing. (2009). Optimal warranty policies for systems with imperfect repair. European Journal of Operational Research, 199, 187-197.

Yun, Won Young., Murthy, D. N. P. & Jack, N. (2008). Warranty servicing with imperfect repair. International Journal of Production Economics, 111, 159-169.

Zhou, C., Tang, W., & Zhao, R. (2014). An uncertain search model for recruitment problem with enterprise performance. Journal of Intelligent Manufacturing, 28(3), 695-704.

Journal Pre-proofs



Sustainable recycling in an imperfect production system with acceptance quality level dependent development cost and demand

Barun Khara, Jayanta Kumar Dey, Shyamal Kumar Mondal

PII: S0360-8352(20)30034-6
DOI: https://doi.org/10.1016/j.cie.2020.106300
Reference: CAIE 106300

To appear in: *Computers & Industrial Engineering*

Received Date: 11 July 2019
Revised Date: 16 December 2019
Accepted Date: 20 January 2020

Please cite this article as: Khara, B., Dey, J.K., Mondal, S.K., Sustainable recycling in an imperfect production system with acceptance quality level dependent development cost and demand, *Computers & Industrial Engineering* (2020), doi: https://doi.org/10.1016/j.cie.2020.106300

Sustainable recycling in an imperfect production system with acceptance quality level dependent development cost and demand.

Barun Khara[1]*, Jayanta Kumar Dey[2], Shyamal Kumar Mondal[1]

[1]Department of Applied Mathematics with Oceanology and Computer Programming,

Vidyasagar University, Midnapore -721 102,W.B., India,

[2]Mahishadal Raj College, Purba Medinipur, W.B, India,

E-mail: barunkhara1710@gmail.com, dey_jaykum@yahoo.com, shyamal_260180@yahoo.com

*Corresponding author: E-mail: barunkhara1710@gmail.com

Sustainable recycling in an imperfect production system with acceptance quality level dependent development cost and demand.

Abstract: This paper considers a closed-loop supply chain production inventory model consisting of a virgin raw material supplier, a manufacturer, a retailer and a collector who collects the used product from consumers at a return rate depending on acceptance quality level of the used product. Here, two types of products are produced : manufactured product using virgin raw materials and remanufactured product using used manufactured product. So, to make the model more realistic, here, the manufacturer incorporates two separate remanufacturing and manufacturing infrastructures to process simultaneously to produce remanufactured and manufactured items due to overcome the lost sale situation arisen in several published model. Again, since the quality of a product from a remanufacturing process mostly depends upon the acceptance quality level of the used product, hence an acceptance quality level dependent development cost has been considered in remanufacturing process. Also, both demand of the remanufactured products and procurement cost of the used products from collector to manufacturer have been considered as a function of acceptance quality level of returned items. Moreover, remanufacturing and manufacturing processes produce some defective items which are reworked within the same cycle. With these considerations, a mathematical model has been developed (i) to find out optimum acceptance quality level of the used manufactured product for recycling, (ii) to overcome the lost sale situation due to unsatisfied demand of remanufactured (manufactured) product at the time of manufacturing (remanufacturing) process and (iii) to obtain optimum number of deliveries from supplier to manufacturer, from manufacturer to retailer and from collector to manufacturer that maximize total integrated profit. To get the optimum solutions of the proposed model, sequential and global optimizations methods have been used. Finally, the

Taleizadeh, A. A., Noori-daryan, M. (2016). Pricing, inventory and production policies in a supply chain of pharmacological products with rework process: a game theoretic approach. *Operational Research, An International Journal* , 16, 89-115.

Taleizadeh, A. A., Moshtagh, M. S., & Moon, I. (2017). Optimal decisions of price, quality, effort level and return policy in a three-level closed-loop supply chain based on different game theory approaches. *European Journal of Industrial Engineering*, 11(4), 486-525.

Taleizadeh, A. A., Pourreza, P., & Moon, I. (2018a). Hybrid for an imperfect production system considering product quality and returns under two warranty policies. *Applied Soft Computing*, 75, 333-348.

Taleizadeh, A. A., & Moshtagh, M. S. (2019). A consignment stock scheme for closed loop supply chain with imperfect manufacturing processes, lost sales, and quality dependent return: Multi Levels Structure. 217, 298-316

Taleizadeh, A. A., Hazarkhani, B., & Moon, I. (2018b). Joint pricing and inventory decisions with carbon emission considerations, partial backordering and planned discounts. *Annals of Operations Research*, https://doi.org/10.1007/s10479-018-2968-y.

Taleizadeh, A. A., Alizadeh-Basban, N., Niaki, S.T.A (2019a). A closed-loop supply chain considering carbon reduction, quality improvement effort, and return policy under two remanufacturing scenarios. *Journal of Cleaner Production*, 232, 1230-1250.

Taleizadeh, A. A., Haghighi, F., & Niaki, S. T. A. (2019b). Modeling and solving a sustainable closed loop supply chain problem with pricing decisions and discounts on returned products. *Journal of Cleaner Production*, 207, 163-181.

Yang, P. C., Wee, H. M., Chung, S. L., & Ho, P. C. (2010). Sequential and global optimization for a closed loop deteriorating inventory supply chain. *Mathematical and Computer Modelling*, 52, 161-176.

Zerang, E.S., Taleizadeh, A. A., Razmi, J. (2018). Analytical comparisons in a three-echelon closed-loop supply chain with price and marketing effort-dependent demand: game theory approaches. *Environ Dev Sustain*, 20, 451-478.

Highlights:

- **An integrated closed-loop supply chain production inventory model has been developed.**
- **The remanufacturing and manufacturing processes have been considered simultaneously to overcome the lost sale situation.**
- **Acceptance quality level dependent development cost and demand has been constructed**.

Effects of product reliability dependent demand in an EPQ model considering partially imperfect production

Barun Khara

Department of Applied Mathematics with Oceanology and Computer Programming,
Vidyasagar University,
Midnapore-721102, W.B., India
Email: barunkhara1710@gmail.com

Jayanta Kumar Dey*

Mahishadal Raj College,
Mahishadal-721628, W.B., India
Email: dey_jaykum@yahoo.com
*Corresponding author

Shyamal Kumar Mondal

Department of Applied Mathematics with Oceanology and Computer Programming,
Vidyasagar University,
Midnapore-721102, W.B., India
Email: shyamal_260180@yahoo.com

Abstract: In this article, an economic production quantity (EPQ) model with partially imperfect production system has been considered where both perfect and imperfect quality items are produced and demand of the product has been assumed as a function of selling price, reliability of the product and advertisement. Perfect quality items are ready for sale but imperfect quality items are reworked at a cost to become perfect one. Reworking cost, reliability of the product and reliability parameter of the manufacturing system can be improved by introducing the time dependent development cost and also by improving the quality of the raw material used in the production system. Under such circumstances, a profit function has been developed and maximised by optimising the reliability parameter of the manufacturing system, reliability of the product and duration of production. Finally, the model has been illustrated with some numerical examples.

Keywords: inventory; imperfect production; production time; reliability parameter; product reliability; development cost; rework; screening cost; raw material cost; advertisement; selling price.

Taleizadeh, A.A., Khanbaglo, M.P.S. and Cardenas-Barron, L.E. (2016) 'An EOQ inventory model with partial backordering and reparation of imperfect products', *International Journal of Production Economics*, Vol. 182, pp.418–434.

Taleizadeh, A.A., Kalantari, S.S. and Cardenas-Barron, L.E. (2016) 'Pricing and lot sizing for an EPQ inventory model with rework and multiple shipments', *TOP*, Vol. 24, pp.143–155.

Teng, J.T. and Chang, C.T. (2005) 'Economic production quantity models for deteriorating items with price- and stock-dependent demand', *Computers & Operations Research*, Vol. 32, pp.297–308.

Trevino-Garza, G., Castillo-Villar, K.K. and Cardenas-Barron, L.E. (2015) 'Joint determination of the lot size and number of shipments for a family of integrated vendor-buyer systems considering defective products', *International Journal of Systems Science*, Vol. 46, No. 9, pp.1705–1716.

Yoo, S.H., Kim, D. and Park, M.S. (2009) 'Economic production quantity model with imperfect-quality items, two-way imperfect inspection and sales return', *International Journal of Production Economics*, Vol. 121, pp.255–265.

Wang, W.T., Wee, H.M. Cheng, Y.L., Wen, C.L. and Cardenas-Barron, L.E. (2015) 'EOQ model for imperfect quality items with partial backorders and screening constraint', *European Journal of Industrial Engineering*, Vol. 9, No. 6, pp.744–773.

DOI 10.1007/s10946-020-09870-0
Journal of Russian Laser Research, Volume 41, Number 3, May, 2020

REALIZATION OF NONCLASSICAL EFFECTS OF LIGHT AND TOTAL NOISE IN COHERENT ANTI-STOKES RAMAN AND HYPER-RAMAN SCATTERINGS UP TO THE FIRST-ORDER HAMILTONIAN INTERACTION

Samiran Kumar[1,2*] **and Dilip Kumar Giri**[3]

[1] *Department of Physics*
Mahishadal Raj College
Mahishadal 721628, India

[2] *University Department of Physics*
Vinoba Bhave University
Hazaribag 825301, India

[3] *University Department of Physics*
Binod Bihari Mahto Koyalanchal University
Dhanbad 828130, India

*Corresponding author e-mail: samiran892008@gmail.com
e-mail: dilipkumargiri@gmail.com

Abstract

In this paper, we give an overview of nonclassical effects, such as squeezing and sub-Poissonian states, of an optical field in coherent anti-Stokes Raman scattering and coherent anti-Stokes hyper-Raman scattering under the short time scale. We establish the coupled Heisenberg equations of motion of quadrature operators in terms of real and imaginary parts. We investigate the photon statistics of the pump mode in these processes and find that they are sub-Poissonian in nature. We demonstrate that squeezing and sub-Poissonian photon statistics are greater in coherent anti-Stokes hyper-Raman scattering (CAHRS) than in coherent anti-Stokes Raman scattering (CARS). The effect of the sub-Poissonian nature of an optical field in terms of total noise is also incorporated. We show that the depth of nonclassicality directly depends on the amount of total noise present in the system. This suggests that the more squeezed the state, the greater its total noise in the system.

Keywords: nonclassical light, queezing of radiation, sub-Poissonian photon statistics, coherent anti-Stokes Raman scattering, coherent anti-Stokes hyper-Raman scattering, photon number operator, total noise.

1. Introduction

Squeezing [1–3] and sub-Poissonian [4–6] behavior of light has recently attracted considerable attention owing to its low-noise property [7–9] with applications in high-quality telecommunication [9, 10] and cryptography [11, 12]. Squeezing means that the fluctuation in one of the two conjugate components (amplitude or phase) is suppressed while it is enhanced in the other. It is a purely quantum-mechanical

Manuscript submitted by the authors in English on February 24, 2020.

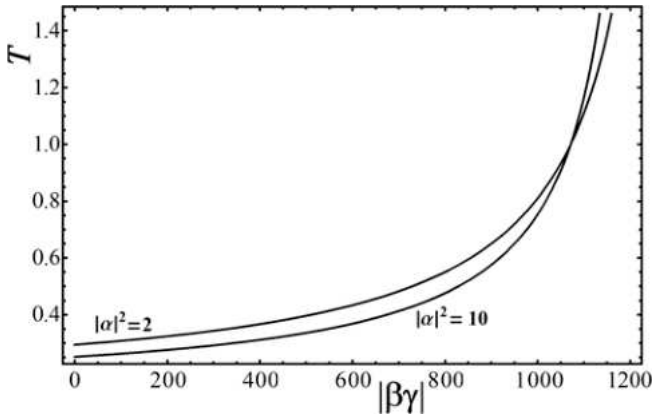


Fig. 7. Variation of total noise T in the quantum state with $|\beta\gamma|$ and $|\alpha|^2 = 2$, 10 in CARS process at $\theta_1 = \pi/4$, $\theta_2 + \theta_3 = \pi/2$, and $|gt| = 10^{-4}$.

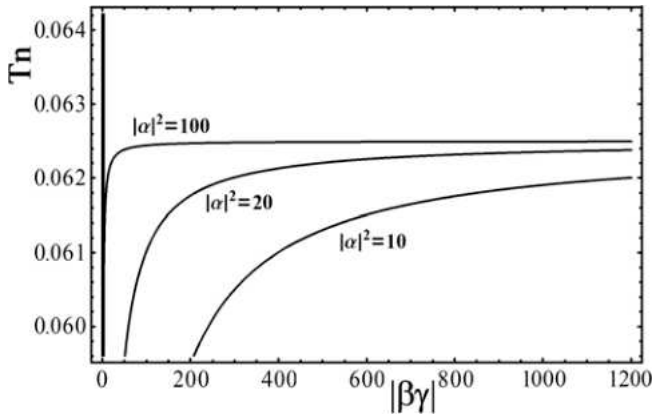


Fig. 8. Variation of total noise Tn in the quantum state with $|\beta\gamma|$ and $|\alpha|^2 = 10$, 20, 100 in the CAHRS process at $\theta_1 = \pi/4$, $\theta_2 + \theta_3 = \pi/2$, and $|gt| = 10^{-4}$.

statistics of light increase with increasing $|\alpha|^2$ and $|\beta\gamma|$, i.e., the increase is directly proportional to the number of photons.

Comparing Figs. 5 and 6, we found that the depth of nonclassicality is greater in the CAHRS than in the CARS. Thus, the degree of nonclassicality of light increases with the photon numbers in the Stokes and anti-Stokes modes. This also confirms that the sub-Poissonian statistics are associated with a large number of photons and with a higher degree of nonlinearity.

To study the variation of first-order squeezing in terms of the total noise with $|\alpha|^2$, we plot a graph of Eqs. (32) and (59) versus T and Tn in Figs. 7 and 8 for CARS and CAHRS, respectively.

The steady increase in the curves shows that the total noise increases with increase in the number of photons $|\alpha|^2$ and $|\beta\gamma|$. This infers that the depth of nonclassicality directly depends on the large number of photons. This also suggests that the more squeezed the state, the greater its total noise. From Eqs. (33) and (60), it is obvious that, for fixed $\langle N\rangle$, as $[\Delta N(t)]^2$ decreases, the total noise must increase; therefore, as the state becomes more sub-Poissonian with decreasing $(\Delta N(t)/\langle N\rangle)$, its total noise increases.

A comparison of Figs. 7 and 8 shows that the greater the total noise, the greater the squeezing having the same number of photons in CAHRS than CARS processes. The results of the present study agree with the result of Hillery [26] that a maximum total noise is available in higher-order squeezing.

5. Conclusions

In this study, we showed that the presence of squeezing is greater in the CAHRS due to higher nonlinearity than the corresponding squeezing in the CARS. We observed that, when the value of the Stokes and anti-Stokes modes is higher, the squeezing increases in the pump mode and lowers the depth of classicality of the field amplitude. This fact confirmed that the degree of normal squeezing directly depends upon the photon number in the pump, Stokes, and anti-Stokes modes. Also we found that the sub-Poissonian statistics are associated with a large number of photons.

We conclude that the total noise increases with increase in the number of pump photons and with the value of the Stokes and anti-Stokes modes. We show that the more squeezed the state, the greater its total noise. Therefore, as the state becomes more sub-Poissonian, its total noise increases.

Also we observed that a maximum total noise is available in higher-order squeezing. Hence it is inferred that a higher photon absorption process is suitable for generating optimum squeezed light.

Our results suggest that the desired degree of squeezing, sub-Poissonian statistics, and total noise are obtained using a short interaction time and having a number of photons present in the field before initiating the interaction in the system. Hence, the total noise of a quantum state can be considered as a measure of the depth of nonclassicality, i.e., a more nonclassical state (squeezing and the sub-Poissonian condition) of the field in any system is observed. Finally, we conclude that the CARS and CAHRS processes can be used for high-quality telecommunications and quantum cryptography owing to the multiphoton version of the sub-Poissonian state.

References

1. D. F. Walls, *Nature*, **306**, 141 (1983).
2. R. Loudon and P. L. Knight, *J. Mod. Opt.*, **34**, 709 (1987).
3. M. C. Teich and B. E. A. Saleh, *Quantum Opt.*, **1**, 153 (1989).
4. J. Perina, *Quantum Statistics of Linear and Nonlinear Optical Phenomena*, Kluwer, Dordrecht (1991), Chs. 9 & 10.
5. V. V. Dodonov, *J. Opt. B: Quantum Semiclass. Opt.*, **4**, R1 (2002).
6. J. Perina, V. Perinova, and J. Kodousek, *Opt. Commun.*, **49**, 210 (1984).
7. B. E. A. Saleh and M. C. Teich, *Phys. Rev. Lett.*, **58**, 2656 (1987).
8. H. J. Kimble and D. F. Walls, *J. Opt. Soc. Am.*, **B 4**, 1450 (1987).
9. H. P. Yuen and J. H. Shapiro, *IEEE Trans. Inf. Theor.*, **24**, 657 (1978).
10. L. Mandel, *Phys. Scr. T*, **12**, 34 (1986).
11. C. H. Bennett, G. Brassard, and N. D. Mermin, *Phys. Rev. Lett.*, **68**, 557 (1992).
12. J. Kempe, *Phys. Rev. A.*, **60**, 910 (1999).
13. J. Perina, V. Perinova, C. Sibilia, and M. Bertolotti, *Opt. Commun.*, **49**, 285 (1984).
14. M. S. K. Razmi and J. H. Eberly, *Opt. Commun.*, **76**, 265, (1990).
15. C. K. Hong and L. Mandel, *Phys. Rev. Lett.*, **54** 323-325 (1985);
16. C. K. Hong and L. Mandel, *Phys. Rev. A*, **32**, 974 (1985).
17. D. K. Giri and P. S. Gupta, *J. Opt. B: Quantum Semiclass. Opt.*, **6**, 91 (2004);
18. D. K. Giri and P. S. Gupta, *Opt. Commun.*, **221**, 135 (2003).
19. L. Mandel, *Opt. Commun.*, **42**, 437 (1982).
20. M. Hillery, *Opt. Commun.*, **62**, 135 (1987).
21. M. Hillery, *Phys. Rev. A*, **36**, 3796 (1987).
22. S. Rani, J. Lal, and N. Singh, *Opt. Commun.*, **281**, 341 (2008).
23. R. Pratap, D. K. Giri, and A. Prasad, *Optik*, **125**, 1065 (2014).
24. You-bang Zhan, *Phys. Lett. A*, **160**, 498 (1991).
25. D. K. Giri and P. S. Gupta, *J. Mod. Opt.*, **51**, 1705 (2004).
26. M. Hillery, *Phys. Rev. A*, **39**, 2994 (1989).
27. P. Gupta and A. Pathak, *Optik: Int. J. Light Electron Opt.*, **121**, 1507 (2010).
28. S. Gill, S. Rani, and N. Singh, *Int. J. Opt.*, **2012**, 1 (2012).
29. B. K. Choudhary and D. K. Giri, *Acta Phys. Pol. A*, **134**, 1108 (2018).

Journal of Ambient Intelligence and Humanized Computing
https://doi.org/10.1007/s12652-020-02113-9

ORIGINAL RESEARCH

Internet of Health Things (IoHT) for personalized health care using integrated edge-fog-cloud network

Anwesha Mukherjee[1] · Shreya Ghosh[2] · Aabhas Behere[2] · Soumya K. Ghosh[2] · Rajkumar Buyya[3]

Received: 31 December 2019 / Accepted: 11 May 2020

Abstract
This paper proposes a mobile healthcare framework based on edge-fog-cloud collaborative network. It uses edge and fog devices for parameterized health monitoring, and cloud for further health data analysis in case of abnormal health status. The continuous location change of users is a critical issue, and the connection interruption and delay in delivering health related data may be fatal in case of emergency. In this direction, in the proposed framework, mobility information of the users is considered and the users' mobility pattern detection is performed inside the cloud for advising the user regarding nearby health centre. From the theoretical analysis, it is observed that the proposed framework reduces the delay and energy consumption of user device by $\sim 28\%$ and $\sim 27\%$ respectively than the cloud only health care model. The proposed healthcare framework has been implemented in the laboratory and health data of few student volunteers are analyzed to predict their health status. The experimental analysis also shows that the proposed mobility prediction model has better precision, recall value and time-efficiency than the existing models.

Keywords Health monitoring · Edge-fog-cloud network · Mobility prediction · Internet of Health Things (IoHT)

1 Introduction

The rapid advances in sensor-based systems and Internet technologies have enabled a new dimension of health care technology namely Internet of Health Things (IoHT). IoHT is the exchange and processing of the data for health status monitoring of individuals by integrating sensor or IoT devices with advanced mobile technologies (da Costa et al. 2018). IoHT can become a demanding application for personalized health care leveraging on fog, edge and cloud computing. In a cloud based health care system, the health data are collected using body area network (BAN) or body sensor network (BSN) and then stored and processed inside the cloud servers. In BAN, there are several sensors attached with human body and varied health data e.g. body temperature, blood pressure etc are collected by these sensors.

With availability of several body sensors, it is possible to design and develop a low-cost wearable system to capture values of various health parameters of human body (e.g. blood pressure, heart/pulse rate, oxygen level, body temperature etc.) and to predict the health status of individuals based on the collected data and contextual information (e.g. atmospheric condition, user's location, activity etc.). These sensor nodes collect health parameter values and transmit to the connected smart phone. Next, the data is processed and health status is predited by the smartphones. But smart phones are resource hungry. Therefore, the computationally complex applications are difficult to execute in the resource-limited smart phones.

✉ Shreya Ghosh
shreya.cst@gmail.com

Anwesha Mukherjee
anweshamukherjee2011@gmail.com

Aabhas Behere
aabhas.bhr@gmail.com

Soumya K. Ghosh
skg@cse.iitkgp.ac.in

Rajkumar Buyya
rbuyya@unimelb.edu.au

[1] Department of Computer Science, Mahishadal Raj College, Mahishadal, West Bengal, India

[2] Department of Computer Science and Engineering, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal, India

[3] Cloud Computing and Distributed Systems (CLOUDS) Lab, School of Computing and Information Systems, The University of Melbourne, Melbourne, Australia

Published online: 08 June 2020

Ghosh S, Mukherjee A, Ghosh SK, Buyya R (2019b) Mobi-iost: mobility-aware cloud-fog-edge-iot collaborative framework for time-critical applications. IEEE Trans Netw Sci Eng

Ghosh S, Das J, Ghosh SK (2020) Locator: A cloud-fog-enabled framework for facilitating efficient location based services. In: 2020 International Conference on COMmunication Systems & NETworkS (COMSNETS), IEEE, pp 87–92

Ghosh SK, Ghosh S (2018b) Modeling individual's movement patterns to infer next location from sparse trajectory traces. In: IEEE International conference on systems, man, and cybernetics (SMC), IEEE, pp 693–698

Gong YJ, Chen E, Zhang X, Ni LM, Zhang J (2017) Antmapper: an ant colony-based map matching approach for trajectory-based applications. IEEE Trans Intell Transp Syst 19(2):390–401

Hassanalieragh M, Page A, Soyata T, Sharma G, Aktas M, Mateos G, Kantarci B, Andreescu S (2015) Health monitoring and management using internet-of-things (iot) sensing with cloud-based processing: Opportunities and challenges. In: 2015 IEEE International conference on services computing, IEEE, pp 285–292

Karatzoglou A, Schnell N, Beigl M (2018) A convolutional neural network approach for modeling semantic trajectories and predicting future locations. In: International conference on artificial neural networks, Springer, pp 61–72

Kaur PD, Chana I (2014) Cloud based intelligent system for delivering health care as a service. Comput Methods Progr Biomed 113(1):346–359

Kim SY, Koo HJ, Song HY (2018) A study on estimation of human personality from location visiting preference. J Ambient Intell Humaniz Comput 9(3):629–642

Krakiwsky EJ, Harris CB, Wong RV (1988) A kalman filter for integrating dead reckoning, map matching and gps positioning. In: IEEE PLANS'88., Position Location and Navigation Symposium, Record.'Navigation into the 21st Century', IEEE, pp 39–46

Liu Q, Wu S, Wang L, Tan T (2016) Predicting the next location: a recurrent model with spatial and temporal contexts. In: Thirtieth AAAI conference on artificial intelligence

Lv M, Chen L, Chen G (2012) Discovering personally semantic places from gps trajectories. In: Proceedings of the 21st ACM international conference on information and knowledge management, pp 1552–1556

Mukherjee A, De D (2014) Femtocell based green health monitoring strategy. In: 2014 XXXIth URSI general assembly and scientific symposium (URSI GASS), IEEE, pp 1–4

Mukherjee A, De D, Ghosh SK (2020) Fogioht: a weighted majority game theory based energy-efficient delay-sensitive fog network for internet of health things. Internet of Things, p 100181

Papandrea M, Giordano S (2014) Location prediction and mobility modelling for enhanced localization solution. J Ambient Intell Humaniz Comput 5(3):279–295

Salomón S, Tîrnăucă C, Duque R, Montaña JL (2018) User identification from mobility traces. J Ambient Intell Humaniz Comput 11:1–10

Solanas A, Patsakis C, Conti M, Vlachos IS, Ramos V, Falcone F, Postolache O, Pérez-Martínez PA, Di Pietro R, Perrea DN et al (2014) Smart health: a context-aware health paradigm within smart cities. IEEE Commun Mag 52(8):74–81

Tuli S, Mahmud R, Tuli S, Buyya R (2019) Fogbus: a blockchain-based lightweight framework for edge and fog computing. J Syst Softw 154:22–36

Verma P, Sood SK (2018) Fog assisted-iot enabled patient health monitoring in smart homes. IEEE Internet Things J 5(3):1789–1796

Vlachos M, Kollios G, Gunopulos D (2002) Discovering similar multidimensional trajectories. In: Proceedings 18th international conference on data engineering, IEEE, pp 673–684

Yang J, Sun Y, Shang B, Wang L, Zhu J (2019) Understanding collective human mobility spatiotemporal patterns on weekdays from taxi origin-destination point data. Sensors 19(12):2812

Ye Y, Zheng Y, Chen Y, Feng J, Xie X (2009) Mining individual life pattern based on location history. In: 2009 tenth international conference on mobile data management: systems, services and middleware, IEEE, pp 1–10

Zhang C, Zheng Y, Ma X, Han J (2015) Assembler: Efficient discovery of spatial co-evolving patterns in massive geo-sensory data. In: Proceedings of the 21th ACM SIGKDD international conference on Knowledge discovery and data mining, pp 1415–1424

Zhang J, Zheng Y, Qi D (2017) Deep spatio-temporal residual networks for citywide crowd flows prediction. In: Thirty-first AAAI conference on artificial intelligence

Zhang J, Zheng Y, Sun J, Qi D (2019) Flow prediction in spatio-temporal networks based on multitask deep learning. IEEE Trans Knowl Data Eng

Zheng Y (2015) Trajectory data mining: an overview. ACM Trans Intell Syst Technol (TIST) 6(3):1–41

Simulation Modelling Practice and Theory 100 (2020) 102043

Contents lists available at ScienceDirect

Simulation Modelling Practice and Theory

journal homepage: www.elsevier.com/locate/simpat

Spatio-Fog: A green and timeliness-oriented fog computing model for geospatial query resolution

Jaydeep Das*,[a], Anwesha Mukherjee[b], Soumya K. Ghosh[c], Rajkumar Buyya[d]

[a] Advanced Technology Development Centre, Indian Institute of Technology Kharagpur, West Bengal 721302, India
[b] Department of Computer Science, Mahishadal Raj College, Garkamalpur, Mahishadal, Purba Medinipur, West Bengal 721628, India
[c] Department of Computer Science and Engineering, Indian Institute of Technology Kharagpur, West Bengal 721302, India
[d] Cloud Computing and Distributed Systems (CLOUDS) Laboratory, School of Computing and Information Systems, The University of Melbourne, VIC 3010, Australia

ARTICLE INFO

Keywords:
Geospatial query
Fog computing
Cloud computing
Delay-sensitive
Power-efficient

ABSTRACT

Geospatial data analysis is an emerging area of research today. Systems need to respond to user requests in a timely manner. In this paper we have proposed a fog computing framework namely Spatio-Fog, where the fog devices contain the geospatial data of their current region and process geospatial queries using resources in the proximity. The geospatial query resolution is performed by the fog device either itself or using cloud servers or fog device of other region depending on the geographical region related to the geospatial query. We have performed both empirical study and experimental analysis to demonstrate feasibility of our proposed approach. The empirical study illustrates that the proposed architecture Spatio-Fog reduces the power consumption and delay by approximately 43–47% and 47–83% respectively over the use of existing geospatial query resolution system. The experimental analysis demonstrates that the proposed framework reduces the power consumption and delay by 30–60% approximately than the existing geospatial query resolution system.

1. Introduction

Geospatial information storage, processing, and query resolution is a promising research area [1]. There are several industrial applications of geospatial data analysis such as mapping, telecom and network services, hot spot analysis, urban planning, transport services, environmental impact analysis, health and human services, disaster management, resource management, geology. Google Maps is a popular application of a web-based mapping solution on geospatial data, which is used for navigation services. Geospatial data analysis also helps in road traffic management, transport and urban planning. For risk assessment and disaster management geospatial data analysis also important. Usually, cloud servers are used to store and process the geospatial information [2]. However, as geospatial information is related to geographical regions, storing and processing large volume geospatial data inside the remote cloud servers can suffer from delay and energy consumption. Geospatial query processing involves geospatial data analysis along with different geospatial services, which have been discussed later in Section 3. While mobile devices request for any geospatial information, then to process the respective geospatial queries geospatial big data analysis is required. However, accessing geospatial data inside the remote cloud servers may degrade the quality of user experience by enhancing delay [3] and energy. Moreover,

* Corresponding author.
E-mail addresses: jaydeep@iitkgp.ac.in (J. Das), anweshamukherjee2011@gmail.com (A. Mukherjee), skg@cse.iitkgp.ac.in (S.K. Ghosh), rbuyya@unimelb.edu.au (R. Buyya).

https://doi.org/10.1016/j.simpat.2019.102043
Received 2 October 2019; Received in revised form 28 November 2019; Accepted 14 December 2019
Available online 16 December 2019
1569-190X/

Electrical, Computer and Electronics Engineering (UPCON), 2016 IEEE Uttar Pradesh Section, IEEE, 2016, pp. 613–618.
[16] R.K. Barik, A. Tripathi, H. Dubey, R.K. Lenka, T. Pratik, S. Sharma, K. Mankodiya, V. Kumar, H. Das, MistGIS: optimizing geospatial data analysis using mist computing, Progress in Computing, Analytics and Networking, Springer, 2018, pp. 733–742.
[17] M. Das, S.K. Ghosh, V. Chowdary, A. Saikrishnaveni, R. Sharma, A probabilistic nonlinear model for forecasting daily water level in reservoir, Water Resour. Manag. 30 (9) (2016) 3107–3122.
[18] S. Bhattacharjee, M. Das, S.K. Ghosh, S. Shekhar, Prediction of meteorological parameters: an a-posteriori probabilistic semantic kriging approach, Proceedings of the 24th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems, ACM, 2016, p. 38.
[19] F. Gu, On-demand data assimilation of large-scale spatial temporal systems using sequential monte carlo methods, Simul. Model. Pract. Theory 85 (2018) 1–14.
[20] A. Dasgupta, S.K. Ghosh, P. Mitra, A technique for assessing the quality of volunteered geographic information for disaster decision making, International Conference on Computational Science and Its Applications, Springer, 2018, pp. 589–597.
[21] O. Chakraborty, J. Das, A. Dasgupta, P. Mitra, S.K. Ghosh, A geospatial service oriented framework for disaster risk zone identification, International Conference on Computational Science and Its Applications, Springer, 2016, pp. 44–56.
[22] S. Pal, S. Ghosh, A large-scale data-oriented intelligent system for urban growth simulation, Geospatial Infrastructure, Applications and Technologies: India Case Studies, Springer, 2018, pp. 143–154.
[23] S. Ghosh, S.K. Ghosh, Modeling of human movement behavioral knowledge from GPS traces for categorizing mobile users, Proceedings of the 26th International Conference on World Wide Web Companion, International World Wide Web Conferences Steering Committee, 2017, pp. 51–58.
[24] S. Ghosh, A. Mukherjee, S.K. Ghosh, R. Buyya, Mobi-IoST: mobility-aware cloud-fog-edge-iot collaborative framework for time-critical applications, IEEE Trans. Netw. Sci. Eng. (2019), https://doi.org/10.1109/TNSE.2019.2941754.
[25] S.M. Vicente-Serrano, S. Beguería, L. Gimeno, L. Eklundh, G. Giuliani, D. Weston, A.E. Kenawy, J.I. López-Moreno, R. Nieto, T. Ayenew, et al., Challenges for drought mitigation in africa: the potential use of geospatial data and drought information systems, Appl. Geogr. 34 (2012) 471–486.
[26] A.H. Weerts, J. Schellekens, F.S. Weiland, Real-time geospatial data handling and forecasting: examples from delft-fews forecasting platform/system, IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens. 3 (3) (2010) 386–394.
[27] N.N. Kussul, B.V. Sokolov, Y.I. Zyelyk, V.A. Zelentsov, S.V. Skakun, A.Y. Shelestov, Disaster risk assessment based on heterogeneous geospatial information, J. Autom. Inf. Sci. 42(12) 32–45.
[28] C.-R. Shyu, M. Klaric, G.J. Scott, A.S. Barb, C.H. Davis, K. Palaniappan, GeoIRIS: geospatial information retrieval and indexing system content mining, semantics modeling, and complex queries, IEEE Trans. Geosci. Remote Sens. 45 (4) (2007) 839–852.
[29] J.-H. Hong, Z.L.-T. Su, E.H.C. Lu, A recommendation framework for remote sensing images by spatial relation analysis, J. Syst. Softw. 90 (2014) 151–166.
[30] D. Warren, Method and apparatus for providing location based data services, 2003, US Patent 6,611,751.
[31] L. Qi, X. Zhang, W. Dou, Q. Ni, A distributed locality-sensitive hashing-based approach for cloud service recommendation from multi-source data, IEEE J. Sel. Areas Commun. 35 (11) (2017) 2616–2624.
[32] S. Nishimura, S. Das, D. Agrawal, A.E. Abbadi, MD-HBase: a scalable multi-dimensional data infrastructure for location aware services, 2011 IEEE 12th International Conference on Mobile Data Management, 1, IEEE, 2011, pp. 7–16.
[33] S. Nishimura, S. Das, D. Agrawal, A.E. Abbadi, MD-HBase: design and implementation of an elastic data infrastructure for cloud-scale location services, Distrib. Parallel Databases 31 (2) (2013) 289–319.
[34] A. González, C. Aliagas, M. Valero, A data cache with multiple caching strategies tuned to different types of locality, International Conference on Supercomputing, Citeseer, 1995, pp. 338–347.
[35] M. Kandemir, A. Choudhary, J. Ramanujam, N. Shenoy, P. Banerjee, Enhancing spatial locality via data layout optimizations, European Conference on Parallel Processing, Springer, 1998, pp. 422–434.
[36] P. Gerolymatos, S. Sioutas, N. Nodarakis, A. Panaretos, K. Tsakalidis, SMaRT: a novel framework for addressing range queries over nonlinear trajectories, J. Syst. Softw. 105 (2015) 79–90.
[37] G. Roumelis, M. Vassilakopoulos, A. Corral, Y. Manolopoulos, Efficient query processing on large spatial databases: a performance study, J. Syst. Softw. 132 (2017) 165–185.
[38] H. Samet, The quadtree and related hierarchical data structures, ACM Comput. Surv. (CSUR) 16 (2) (1984) 187–260.
[39] I. Kamel, C. Faloutsos, Hilbert R-tree: an improved R-tree using fractals, Tech. rep. (1993).
[40] T. Sellis, N. Roussopoulos, C. Faloutsos, The R+-Tree: A dynamic index for multi-dimensional objects, Tech. rep. (1987).
[41] N. Beckmann, H.-P. Kriegel, R. Schneider, B. Seeger, The R*-tree: an efficient and robust access method for points and rectangles, ACM Sigmod Record, ACM, 1990, pp. 322–331. 19
[42] G.R. Hjaltason, H. Samet, Speeding up construction of PMR quadtree-based spatial indexes, Int. J. Very Large Data Bases 11 (2) (2002) 109–137.
[43] T. Dokeroglu, M.A. Bayir, A. Cosar, Robust heuristic algorithms for exploiting the common tasks of relational cloud database queries, Appl. Soft Comput. 30 (2015) 72–82.
[44] M. Malensek, S. Pallickara, S. Pallickara, Analytic queries over geospatial time-series data using distributed hash tables, IEEE Trans. Knowl. Data Eng. 28 (6) (2016) 1408–1422.
[45] K. Karantzalos, D. Bliziotis, A. Karmas, A scalable geospatial web service for near real-time, high-resolution land cover mapping, IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens. 8 (10) (2015) 4665–4674.
[46] K. Evangelidis, K. Ntouros, S. Makridis, C. Papatheodorou, Geospatial services in the cloud, Comput. Geosci. 63 (2014) 116–122.
[47] A. Rezgui, Z. Malik, C. Yang, High-resolution spatial interpolation on cloud platforms, Proceedings of the 28th Annual ACM Symposium on Applied Computing, ACM, 2013, pp. 377–382.
[48] J. Wenjue, C. Yumin, G. Jianya, Implementation of OGC web map service based on web service, Geo-Spatial Inf. Sci. 7 (2) (2004) 148–152.
[49] P.A. Vretanos, Web feature service implementation specification, Open Geospatial Consort. Specif. 1325 (2005) 04–094.
[50] P. Schut, A. Whiteside, OpenGIS web processing service, Version 1.0. 0, OGC 05-007r7, Open Geospatial Consortium, Inc 87.
[51] R. Barik, H. Dubey, S. Sasane, C. Misra, N. Constant, K. Mankodiya, Fog2fog: augmenting scalability in fog computing for health GIS systems, Proceedings of the Second IEEE/ACM International Conference on Connected Health: Applications, Systems and Engineering Technologies, IEEE Press, 2017, pp. 241–242.
[52] G. Buehrer, B.W. Weide, P.A. Sivilotti, Using parse tree validation to prevent SQL injection attacks, Proceedings of the 5th international workshop on software engineering and middleware, ACM, 2005, pp. 106–113.
[53] R.P. Haining, R. Haining, Spatial Data Analysis: Theory and Practice, Cambridge University Press, 2003.
[54] T. Brinkhoff, H.-P. Kriegel, B. Seeger, Efficient Processing of Spatial Joins Using R-Trees, ACM, 1993. Vol. 22
[55] J. Das, A. Dasgupta, S.K. Ghosh, R. Buyya, A learning technique for VM allocation to resolve geospatial queries, Recent Findings in Intelligent Computing Techniques, Vol. 1, Springer, 2019, pp. 577–584.
[56] A. Mukherjee, D. De, R. Buyya, E2R-F2N: energy-efficient retailing using a femtolet-based fog network, Software 49 (3) (2019) 498–523.

Wireless Personal Communications
https://doi.org/10.1007/s11277-020-07144-1

Power and Delay Efficient Multilevel Offloading Strategies for Mobile Cloud Computing

Debashis De[1,2] · **Anwesha Mukherjee**[3] · **Deepsubhra Guha Roy**[4]

Abstract
Mobile cloud computing has introduced offloading to save the battery life of mobile devices. In mobile cloud computing optimization of power and delay for offloading has become a vital research scope. However, migration of the storage and computation from the mobile device to the remote cloud server enhances the delay and power consumption. To overcome this difficulty, cloudlet comes which is located nearby the mobile device. Since the cloudlet may not be able to fulfill all the offloading requests, sometimes remote public cloud server is used for the same. As a result the power and delay consumptions are increased. For solving this difficulty, private cloud server is used in our scheme along with the cloudlet and public cloud server. In this paper multilevel full and partial offloading strategies are proposed based on cloudlet, private and public cloud servers. The power and delay consumption in the proposed methods are determined and compared with the existing offloading methods. The theoretical and experimental analyses demonstrate that the proposed multilevel offloading methods are power and delay efficient. The simulation results show that the proposed multilevel full and partial offloading strategies reduce the power consumption by approximately 8–9% and 20% respectively than the existing methods.

Keywords Cloudlet · Delay aware · Multilevel · Offloading · Power optimization · Private cloud · Public cloud

Debashis De and Deepsubhra Guha Roy: Formerly, West Bengal University of Technology.

✉ Debashis De
dr.debashis.de@gmail.com; dr.debashis.de@ieee.org

Deepsubhra Guha Roy
roysubhraguha@gmail.com

[1] Department of Computer Science and Engineering, Maulana Abul Kalam Azad University of Technology, West Bengal, B.F.-142, Sector-I, Salt Lake, Kolkata, West Bengal 700064, India

[2] Department of Physics, University of Western Australia, 35 Stirling Hwy, Crawley, WA 6009, Australia

[3] Department of Computer Science, Mahishadal Raj College, Garhkamalpur, Purba Medinipur, West Bengal 721628, India

[4] Department of Information Technology, Maulana Abul Kalam Azad University of Technology, West Bengal, B.F.-142, Sector-I, Salt Lake, Kolkata, West Bengal 700064, India

Published online: 22 January 2020

22. Mahmud, R., Kotagiri, R., & Buyya, R. (2018). Fog computing: A taxonomy, survey and future directions. In *Internet of everything* (pp. 103–130). Singapore: Springer.
23. Yi, S., Li, C., & Li, Q. (2015, June). A survey of fog computing: concepts, applications and issues. In *Proceedings of the 2015 workshop on mobile big data* (pp. 37–42). ACM.
24. Yi, S., Hao, Z., Qin, Z., & Li, Q. (2015, November). Fog computing: Platform and applications. In *2015 third IEEE workshop on hot topics in web systems and technologies (HotWeb)* (pp. 73–78). IEEE.
25. Vaquero, L. M., & Rodero-Merino, L. (2014). Finding your way in the fog: Towards a comprehensive definition of fog computing. *ACM SIGCOMM Computer Communication Review, 44*(5), 27–32.
26. Orsini, G., Bade, D., & Lamersdorf, W. (2015, October). Computing at the mobile edge: Designing elastic android applications for computation offloading. In *2015 8th IFIP wireless and mobile networking conference (WMNC)* (pp. 112–119). IEEE.
27. Mach, P., & Becvar, Z. (2017). Mobile edge computing: A survey on architecture and computation offloading. *IEEE Communications Surveys & Tutorials, 19*(3), 1628–1656.
28. Chang, Z., Zhou, Z., Ristaniemi, T., & Niu, Z. (2017, December). Energy efficient optimization for computation offloading in fog computing system. In *GLOBECOM 2017–2017 IEEE global communications conference* (pp. 1–6). IEEE.
29. Du, J., Zhao, L., Feng, J., & Chu, X. (2018). Computation offloading and resource allocation in mixed fog/cloud computing systems with min-max fairness guarantee. *IEEE Transactions on Communications, 66*(4), 1594–1608.
30. Ning, Z. et al. (2018). A cooperative partial computation offloading scheme for mobile edge computing enabled Internet of Things. *IEEE Internet of Things Journal*, *6*(3), 4804–4814.
31. Mukherjee, A., Deb, P., De, D., & Buyya, R. (2018). C2OF2N: a low power cooperative code offloading method for femtolet-based fog network. *The Journal of Supercomputing, 74*(6), 2412–2448.
32. Rao, X., Zhao, L., Liang, K., & Wang, K. (2019). Edge caching and computation offloading for fog-enabled radio access network. *Wireless Personal Communications*, *109*(1), 297–313.
33. Zhang, J., Xia, W., Yan, F., & Shen, L. (2018). Joint computation offloading and resource allocation optimization in heterogeneous networks with mobile edge computing. *IEEE Access, 6,* 19324–19337.
34. Chen, M., & Hao, Y. (2018). Task offloading for mobile edge computing in software defined ultra-dense network. *IEEE Journal on Selected Areas in Communications, 36*(3), 587–597.

Dr. Debashis De (M'13–SM'15IEEE) is a Professor and Director of the Department of Computer Science and Engineering of Maulana Abul Kalam Azad University of Technology, India and Adjunct Research Fellow of University of Western Australia, Australia. His research area includes energy and latency optimization in mobile cloud computing. He has received Young Scientist award both in 2005 at New Delhi and in 2011 at Istanbul from International Union of Radio Science, H. Q., Belgium.

Anwesha Mukherjee has received her B. Tech. degree from Kalyani Govt. Engineering College under West Bengal University of Technology in the year 2009. She has received her M. Tech. (Gold Medalist) degree from West Bengal University of Technology in 2011. She has received Young Scientist award from International Union of Radio Science, H. Q., Belgium in 2014 in Beijing, China. She is presently an Assistant Professor and Head of the Department of Computer Science, Mahishadal Raj College (Under Vidyasagar University). She has submitted her Ph.D. thesis as a DSTINSPIRE Fellow in the field of mobile network. She has received Ph.D. from Maulana Abul Kalam Azad University of Technology, West Bengal (Formerly known as West Bengal University of Technology) in 2018. She has worked as a Research Associate in the Department of Computer Science, Indian Institute of Technology Kharagpur. Her research interest includes Location and Handoff Management and Green Mobile Network Development.

Deepsubhra Guha Roy is currently working as a faculty of department of Information Technology in West Bengal University of Technology and pursuing his Ph.D. in the field of Mobile Cloud Computing towards Internet of Things. He is the founder developer of Centre of Mobile Cloud Computing in West Bengal University of Technology. His research area is QoS aware offloading strategies in mobile cloud computing towards IoT.

Animal Reproduction Science 219 (2020) 106528

Contents lists available at ScienceDirect

Animal Reproduction Science

journal homepage: www.elsevier.com/locate/anireprosci

Functions of interleukin-6 in ovulation of female climbing perch, *Anabas testudineus*

Ankit Chatterjee[a], Rajkumar Guchhait[a,c], Sukhendu Maity[a], Dilip Mukherjee[b], Kousik Pramanick[a,*]

[a] Integrative Biology Research Unit, Department of Life Sciences, Presidency University, 86/1, College Street, Kolkata 700073, India
[b] Endocrinology Laboratory, Department of Zoology, University of Kalyani, Kalyani, 741235, India
[c] P.G. Department of Zoology, Mahishadal Raj College, Purba Medinipur, India

ARTICLE INFO

Keywords:
Interleukin 6
Teleost fish
Ovulation
Gonadotropin
TNFα

ABSTRACT

In mammals, interleukin 6 (IL-6) has an important function during ovulation, however, the functions of IL-6 in fish have not been elucidated. In the present study, there was quantification of *de novo* synthesis of ovarian IL-6 and tumor necrosis factor-alpha (TNFα) in control and hCG-treated fish and results were compared with those from an *in vitro* study where there was evaluation of the regulatory functions of gonadotropins and TNFα of IL-6 secretions. Relatively greater concentrations of ovarian IL-6 at the post-GVBD (post-germinal vesicle breakdown) stage indicates IL-6 modulates ovulatory processes. The hCG-induced increase in relative abundance of *IL-6* (*in vitro*) mRNA transcript and secretion from the ovary were attenuated when there was administration of the inhibitor of TNFα secreting enzyme, TAPI-I, which indicates TNFα modulates IL-6 secretion. Treatments with IL-6 induced a marked increase in ovulation rate *in vitro* when there was induction of activating matrix metalloproteinase (MMP). Furthermore, treatment with IL-6 resulted in production of prostaglandin as indicated by the IL-6 induced increase in the abundance of *ptgs2* mRNA transcript in the ovary of *Anabas testudineus*. Furthermore, results indicate the source of IL-6 in the ovary is the granulosa cells with secretion of IL-6 being induced by the additions of hCG and TNFα in the medium. There was also an IL-6-induced increase in abundance of receptors (IL-6 Rα and gp130) to which it binds indicating IL-6 autoregulates this population of receptors. Results from this study, for the first time, elucidate the reproductive functions of IL-6 in a teleost fish.

1. Introduction

In teleost, the process of reproduction not only depends on the gonadotropins and steroids, but different cytokines also have important functions in regulation of the ovarian functions (Hoek et al., 1998; Salmassi et al., 2001; Richards et al., 2008; Liu et al., 2009; Sirotkin, 2011; Sauté et al., 2014; Stassi et al., 2017). It is well established that the ovulatory process is similar to the inflammatory responses (Xu et al., 2010; Wissing et al., 2014; Liu et al., 2017) and in the ovary, gonadotropins are the primary regulatory factors of ovulation (Richards et al., 2008; Smolikova et al., 2012). After the pre-ovulatory surge release of gonadotropins, ovarian cytokines have important functions in cumulus oocyte complex (COC) expansion (Liu et al., 2009) or prostaglandin (PG) production (Brannstrom and Norman, 1993).

* Corresponding author.
E-mail address: kousik.dbs@presiuniv.ac.in (K. Pramanick).

https://doi.org/10.1016/j.anireprosci.2020.106528
Received 1 February 2020; Received in revised form 8 June 2020; Accepted 9 June 2020
Available online 18 June 2020
0378-4320/

Walters, K.A., Allan, C.M., Handelsman, D.J., 2008. Androgen actions and the ovary. Biol. Reprod. 78 (3), 380–389.
Wang, L.J., Brännström, M., Robertson, S.A., Norman, R.J., 1992. Tumor necrosis factor α in the human ovary: presence in follicular fluid and effects on cell proliferation and prostaglandin production. Fertil. Steril. 58, 934–940.
Wei, L., Jiao, P., Song, Y., Cao, L., Yuan, R., Gong, L., Cui, J., Zhang, S., Qi, W., Yang, S., Liao, M., 2013. Host immune responses of ducks infected with H5N1 highly pathogenic avian influenza viruses of different pathogenicities. Vet. Microbiol. 166, 386–393.
Wissing, M.L., Kristensen, S.G., Andersen, C.Y., Mikkelsen, A.L., Høst, T., Borup, R., Grøndahl, M.L., 2014. Identification of new ovulation-related genes in humans by comparing the transcriptome of granulosa cells before and after ovulation triggering in the same controlled ovarian stimulation cycle. Hum. Reprod. 29, 997–1010.
Xu, F., Stouffer, R.L., Muller, J., Hennebold, J.D., Wright, J.W., Bahar, A., Leder, G., Peters, M., Thorne, M., Sims, M., Wintermantel, T., Lindenthal, B., 2010. Dynamics of the transcriptome in the primate ovulatory follicle. Mol. Hum. Reprod. 17, 152–165.
Zhu, Y., Liu, D., Shaner, Z.C., Chen, S., Hong, W., Stellwag, E.J., 2015. Nuclear progestin receptor (pgr) knockouts in zebrafish demonstrate role for pgr in ovulation but not in rapid nongenomic steroid mediated meiosis resumption. Front. Endocrinol. 6, 1–10.
Zolti, M., Meirom, R., Shemesh, M., Wollach, D., Mashiach, S., Shore, L., Rafael, Z.B., 1990. Granulosa cells as a source and target organ for tumor necrosis factor alpha. FEBS Lett. 26, 1253–1255.
Zou, J., Secombes, C.J., 2016. The function of fish cytokines. Biology 5, 1–35.

J. Environ. & Sociobiol. : **17**(1) : 39-42, 2020 Print : ISSN : 0973-0834
Received : 07 March, 2020 / Reviewed & Accepted : 16 June, 2020 / Uploaded Online : August, 2020

AN ASSESSMENT OF MACROPHYTE AND WATER CHARACTERISTICS OF PAHAR DIGHI, PURBA MEDINIPUR, WEST BENGAL

Soma Chanda* **and Bhaskar Bhowmik**
Department of Botany, Mahishadal Raj College, Purba Medinipur, West Bengal
*Corresponding author: somac10@gmail.com

ABSTRACT

A preliminary survey of macrophytic plant species and water quality of Pahar Dighi wetland of Mahishadal Raj Garh area, Purba Medinipur, West Bengal is conducted. Altogether 38 plant species belonging to 27 families have been documented and different physico-chemical parameters of water studied are reported.

Key words: *Macrophytes diversity, Water characteristics, Pahar Dighi, Mahishadal.*

INTRODUCTION

Mahishadal Raj Garh area is a place of historical importance and hence this preliminary work was undertaken to document macrophytic plant species and water characteristics of Pahar Dighi of Mahishadal Raj Garh area, Purba Medinipur, West Bengal in post monsoon season.

MATERIALS AND METHODS

Study site: Pahar Dighi situated in between 22.1814° N and 87.9898° E, is a manmade stagnant water body of about 0.137 ha in area, 162 ft. in length and 70 ft. in diameter under the mouza Garkamalpur, created by King Satis Prasad Gargh. It is an extended part of central canal system (the Raj *Parikha*), isolated from the main water body. The water body is surrounded by Madha Hingli in south, Khagra in west, Jagannathpur in east and Basulya in the north (Fig. 1).

Study methods: Several field surveys have been conducted during September to December, 2019. The phyto-resources have been documented with field notes and the herbarium sheets made for identification following standard literature (Cook, 1996; http//www.theplantlist.org; http://www.ipni.org) and kept in the Department of

Dighi wetland of Cooch Behar District, West Bengal. There are other important works on macrophytic composition of wetlands in different districts of West Bengal (Bala and Mukherjee in 2007, 2010; Palit and Mukherjee, 2012; Chowdhury and Das, 2013; Gupta and Palit, 2014; Parveen *et al.,* 2014; Singh and Rajan, 2015)

Table 2. Water characteristics of Pahar Dighi, Mahishadal, West Bengal

Parameters	Postmonsoon
pH	8.5
Dissolve oxygen (DO)	6.8 mg/lit.
CO_2 content	44 mg/lit.
Hardness	150 mg/lit. in CaCo3
Alkalinity	140 mg/lit.
Ammonia	0.25 mg/lit.
Phosphate	2.5 mg/lit
Chloride	160 mg/lit
Nitrate	0.05 mg/lit
Nacl/Salinity	263.68 mg/lit.

The present wetland, Pahar Dighi, is an isolated part of the central canal system of Mahishadal Raj Garh (the Raj *Parikha*). The water source is limited here, but present throughout the year. However, being stagnant, the water quality parameters may need to be monitored for different bio-resource productive purposes.

ACKNOWLEDGEMENT

The authors are grateful to Dr. Asim Kumar Bera, Principal, Mahishadal Raj College for his encouragement to carry out the research work done in Botany Department of this college. The article is free from conflicts.

REFERENCES

Bala, G. and Mukherjee, A. 2007. A census of wetland macrophytes in Nadia district, West Bengal. *Environ. & Ecol.,* **25**: 287-290.

Bala, G. and Mukherjee, A. 2010. Inventory of wetlands of Nadia district, West Bengal, India and their characterization as natural resources. *J. Environ & Sociobiol*: **7**(2): 93-106.

Cook, C. D. K. 1996. *Aquatic and Wetland Plants of India*. Oxford University Press, Oxford, 385 pp.

Chowdhury, M. and Das, A. P. 2013. Present status of flora, fauna and vegetation structure in the wetlands of Maldah district of West Bengal. *NBU J. Pl. Sci.*, **7**(1): 29-34.

Goswami, G., Pal, S., Palit, D. 2010. Studies on the physico-chemical characteristics, macrophyte diversity and their economic prospect in Rajmata Dighi: a wetland in Cooch Behar District, West Bengal, India. *NeBIO.,* **1**(3): 21-27.

Gupta, S. and Palit, D. 2014. Biosurvilance of wetlands in eastern India (Birbhum, West Bengal) for wise use. *Int. J. Sci. Environ. Technol.* **3**(6): 2136-2144.

Palit, D. and Mukherjee, A. 2012. Studies on water quality and macrophyte composition in wetlands of Bankura district, West Bengal, India. *Ind. J. Pl. Sci.,* **1**(2-3): 97-115.

Parveen, M., Chatterjee, N. C. and Tah, J. 2014. Study of macrophyte diversity with reference to their phyto-sociological study in Chupisar, West Bengal. *Int. J. Pure App. Biosci.,* **2**(2): 131-136.

Singh, D. M. and Rajan, S. G. D. 2015. Survey of wetland macrophytes from wetlands of Haliyal Taluk. *Int. J. Pure App. Biosci.,* **3**(4): 166-172.

Lost years of a nomad: Exploring Indian experience in Nuruddin Farah's oeuvre

Asis De

Lost years of a nomad: Exploring Indian experience in Nuruddin Farah's oeuvre

To honor Nuruddin Farah's fifty-year-long writing journey, this article explores his time in India (1966—69) and the influence it had on making him a leading postcolonial writer. My approach is largely biographical. I begin with his decision to turn down a scholarship at an American University, which some critics view as immature or even eccentric. I challenge this view of his choice instead to enroll for a degree in philosophy, literature and sociology at the Government College of Panjab University at Chandigarh in 1966 and to make what was then a country of poverty and even famine his first diasporic destination. I argue that this was a well-thought-out, politically correct and wise decision in the global context of international relationships in the 1960s. I also explore Farah's brief association with Indian culture and the knowledge he acquired of Indian philosophy and literature to explain his decision to adopt a feminist perspective to write on injustice against women and the powerless and religious intolerance rather than focus on issues such as independence realpolitik like leading African writers at the time. His first manuscript, published in 1970 as ***From a Crooked Rib,*** was a Penguin modern classic by 2004. I argue that this novel was importantly shaped by his Indian experience. I also explore the influence of two novels on the young Farah, on his personal life, ideology and writing even before he went to India: W. Somerset Maugham's novel ***The Razor's Edge*** (1944) and Thakazhi Sivasankara Pillai's classic ***Chemmeen*** (1956). This is the first substantial investigation of the effect of Farah's Indian experience. **Keywords:** biographical criticism, Indian experience, nomad, cosmopolitan.

When he was a schoolboy, long before Somalia gained its political independence from Britain and Italy, Nuruddin Farah Hasan (1945–) dreamt of becoming a writer. He is now about to celebrate the golden jubilee of his career as a writer. To date, Farah has published fourteen novels, a non-fiction book and several plays. He was named after a prince in *One Thousand and One Nights*. When he was being interviewed by Ahmed I. Samatar in 2001, he revealed that he used to delight in cutting out the name "Nuruddin" from pages in *One Thousand and One Nights* and gluing the small pieces of paper onto the cover pages of his exercise books (Samatar 87). He also enjoyed giving the animal characters in his English language textbooks human names and attributes. His linguistic talent was evident from an early age. As is well known, Farah assisted his mother to compose *buraanbur* or Somali oral poetry that is sung during social celebrations and community rituals. By the time he was a teenager, he was able to converse equally well in five languages: Somali, Arabic, Amharic, Italian and English. However, Farah found the local education system disappointingly alien. He comments sadly that "the textbooks we were taught from, belonged in the mind and culture of other people" ("Why I Write" 3). Though the mind and culture of "other people" initially shaped the vision of Somalia's first Anglophone writer, Farah has written about Somalia and Somali characters for most of his career. Several decades of diasporic separation have not weakened Farah's bond with Somalia and its people, just as almost fifty years of being away from Indian soil has not dimmed his memory of the people there.

His time as a graduate student at the Government College of Panjab University might have gone unnoticed had he not written his debut novel during his stay on this campus and later become one of the leading African writers of his generation. Those who knew him at the time would probably not have guessed that he would return to the campus at the age of seventy-two to receive an honorary doctorate from Panjab University in 2017. His success as a writer is often ascribed to two 'immature' decisions that he made. The first decision concerns his choice to enroll at Panjab University in India rather than take up a scholarship to study at the University of Wisconsin-Madison

Asis De is associate professor of English at Mahishadal Raj College, West Bengal, India, and has published extensively on transculturality, diaspora studies and ecological humanities in Anglophone literatures.
Email: ademrc@gmail.com
https://orcid.org/0000-0002-8018-4940

DOI: dx.doi.org/10.17159/2309-9070/tvl.v.57i1.8059

DATES:
Submitted: 27 May 2019; Accepted: 4 July 2019; Published: 28 April 2020

I remember from university is that I was doing English literature at one point and taking a novel exam—there was a course [...] 'The English Novel'" (35).

2. An interesting similarity between Pillai and Farah: the story goes that the Indian novelist Pillai wrote *Chemmeen* in just 8 days, while Farah took 28 days to write *From a Crooked Rib*, from 19 March to 15 April, 1968. (Vetticad)
3. The "wooden comb" on the head of the 'savant' resembling "an Indian Sikh" in *From a Crooked Rib* is one of the five articles of faith (Five 'K's: *Kesh* [uncut hair], *Kara* [steel bracelet], *Kanga* [wooden comb], *Kachera* [cotton underwear] and *Kirpan* [ceremonious steel sword]) according to the religio-cultural practice of the Khalsa Sikhs in India.
4. When Farah was staying in India, the Fourth Five-Year Development Plan (1969–74) accelerated family planning efforts by establishing a separate Department of Family Planning within the Ministry of Health and Family Welfare. Naturally, new campaign strategies were adopted to bring the target of family planning to fruition. During my recent trip to Chandigarh in March, 2019, I visited the Chandigarh office of the All India Radio (now called Prasar Bharti), which purportedly had archival material on Farah's works. To my astonishment, the responsible officer informed me that documents related to the production and broadcasting history of a time fifty years back were not there. The explanation given was that the papers, which dated back to a pre-cyber age, had been burnt as useless rubbish that was taking up office space.
5. Padmini Ramachandran (1932–2006) was a famous Indian actress and dancer who performed in more than 250 Indian films. Later she settled in New Jersey with her physician husband and started a school of Indian classical dance known as the Padmini School of Fine Arts.
6. Padmini Ramachandran (1932–2006) was a famous Indian actress and dancer who performed in more than 250 Indian films. Later she settled in New Jersey with her physician husband and started a school of Indian classical dance known as the Padmini School of Fine Arts.

Works Cited

Alden, Patricia & Louis Tremaine. "How Can We Talk of Democracy? An Interview with Nuruddin Farah." *Emerging Perspectives on Nuruddin Farah*, edited by Derek Wright. Africa World Press, 2002, pp. 25–46.

Appiah, Kwame Anthony. "For Nuruddin Farah." *World Literature Today*. vol. 72, no. 4, 1998. p. 703. DOI: https://doi.org/10.2307/40154254.

____. "Princeton Professor K. Anthony Appiah interviewed African novelist Nuruddin Farah about his recently released novel, *Knots*." *YouTube*. 21 Feb. 2007, www.youtube.com/watch?v=jY1Xh9hHK-E. Accessed 24 Apr. 2019.

Bardolph, Jacqueline. "Dreams and Identity in the Novels of Nuruddin Farah." *Research in African Literatures* vol. 29, no. 1, 1998, pp. 163–73.

Farah, Nuruddin. *From a Crooked Rib*. Penguin. 2006.

____. *Hiding in Plain Sight*. Riverhead, 2014.

____. "Ibsen, In Other Words." *Nordlit* vol. 34, 2015, pp. 15–22. DOI: https://doi.org/10.7557/13.3350.

____. "Why I Write". *Emerging Perspectives on Nuruddin Farah*, edited by Derek Wright. Africa World Press, 2002. pp. 1–13.

Farah, Nuruddin & F. Fiona Moolla. "Reflecting back, projecting forward: A conversation with Nuruddin Farah." *Tydskrif vir Letterkunde* vol. 57, no. 1, 2020, pp. 19–25.

Gray, Stephen. "Interview with Nuruddin Farah." *English in Africa* vol. 27, no. 1, 2000, pp. 131–9. www.jstor.org/stable/40238895.

Jaggi, Maya. "Nuruddin Farah: A Life in Writing." *The Guardian*. 21 Sep. 2012, https://www.theguardian.com/culture/2012/sep/21/nuruddin-salah-life-in-writing. Accessed 24 Apr. 2019.

Hawley, John C. "Nuruddin Farah—Tribalism, Orality, and Postcolonial Ultimate Reality and Meaning in Contemporary Somalia." *Ultimate Reality and Meaning* vol. 19, no. 3, 1996, pp. 189–205. DOI: https://doi.org/10.3138/uram.19.3.189.

Hitchcock, Peter. *The Long Space: Transnationalism and Postcolonial Form*. Stanford U P, 2010.

Metz, Helen Chapin. *Somalia: A Country Study*. Federal Research Division Library of Congress, 1993.

Moolla, F. Fiona. *Reading Nuruddin Farah: The Individual, the Novel & the Idea of Home*. James Currey, 2014.

Moore, Gerald. H. "Nomads and Feminists: The Novels of Nuruddin Farah." *The International Fiction Review* vol. 11, no. 1, 1984, pp. 3–12.

Samatar, Ahmed I. "Interview with Nuruddin Farah." *Bildhaan: An International Journal of Somali Studies* vol. 1, 2001, pp. 87–106.

Sethi, Rumina. "Rumina Sethi in conversation with Nurrudin Farah, Department of English, Panjab University." *YouTube*. 27 Apr. 2017. www.youtube.com/watch?v=lNxxpcDY0OA. Accessed 21 May 2019.

Vettica, Anna M. M. "Golden milestone." *The Hindu BusinessLine*. www.thehindubusinessline.com/blink/watch/golden-milestone/article7899728.ece

Wright, Derek. "Parenting the Nation: Some Observations on Nuruddin Farah's *Maps*." *College Literature* vol. 19, no. 10, 1993, pp. 176–84.

HPU

Indian Journal of Australian Studies

Volume 10

Special Issue on MULTICULTURALISM

I J A S

Centre for Australian and New Zealand Studies
Himachal Pradesh University, Shimla

2019

IJAS is an interdisciplinary journal published annually by the Centre for Australian and New Zealand Studies, Himachal Pradesh University, Shimla.

ISSN: 2229-7863
A Peer Reviewed Journal

Editor
Neelima Kanwar

Published by
Centre for Australian and New Zealand Studies
Himachal Pradesh University, Shimla 171 005 India

Printed at
New Era Graphics
Shimla 171 002 India

Annual Subscription
Institution: Rs. 200/- Aus $ 20 US $ 15
Individual: Rs. 150/- Aus $ 15 US $ 10

Bank Drafts should be in the name of Centre for Australian and New Zealand Studies, Himachal Pradesh University, Shimla.

IJAS
2019

HPU

Indian Journal of Australian Studies

Volume 10

Special Issue
on
MULTICULTURALISM

EDITOR
Neelima Kanwar

Centre for Australian and New Zealand Studies
Himachal Pradesh University, Shimla

Editorial Advisory Board

CONTENTS

Transnationality, Multiculturalism and 'New' Cosmopolitanism: Indo-Australian Interface in *of Sadhus and Spinners: Australian Encounters with India*

Asis De

At the beginning of the final decade of the twentieth century, the world has witnessed two very significant events shaping the politico-economic environment both in the West and in the East: the end of the Cold War (1947-1991) and the introduction of Globalization, or, in other words, 'economic liberalization'.In the post-Cold War era (following the collapse of the Soviet Union on 31 December 1991), precisely in the mid-nineties of the last century, Australia started adopting the policy of 'Look West' with a particular interest in the Indian Ocean Region (IOR)—specifically with India and South Africa expecting a rapid development in the economic relationship. India complements this Australian policy by openingwindows for bilateral cooperation in the field of trade and investment, on the issue of military and political security, on collaborative educational activities and cultural exchangein the 1990s after adopting economic liberalization. On the issue of academic and cultural exchange, the formation of the *Indian Association for the Study of Australia* in the year 2000 is preciselyan important step towards making different "facets of Australian society including culture, humanities, social sciences, international studies, media and literature" (cf. *Webpage of IASA*) familiar to the people in India. The IASA and the AIC (Australia-India Council), working in close association with India's premier Universities like Jawaharlal Nehru University, IGNOU in Delhi, the University of Madras in Chennai, or even Mohanlal Sukhadia University in Udaipur, have taken crucial roles in shaping the forums for the discussion of the cultural and literary interrelationship between India and Australia. So, it is undeniable that in the last twenty-five years, the Indo-Australian interface has taken a remarkably positive turn and a

Elizabeth Webby, CUP, 2010, pp. 183-208.

Dasgupta, Sanjukta. "The Two Way Flow: Connecting Cultures, Understanding Others" in *Landscape, Place and Culture: Linkages between Australia and India*, edited by Deb Narayan Bandopadhyay, Paul Brown and Christopher Conti, Cambridge Scholars Publishing, 2011, pp. 2-13.

Delanty, Gerard. "Introduction: The Emerging Field of Cosmopolitanism Studies" in Routledge Handbook of Cosmopolitanism Studies, Edited by Gerard Delanty, Routledge, 2012, pp. 1-8.

Earnshaw, John. "Lang, John (1816–1864)", *Australian Dictionary of Biography*, National Centre of Biography, Australian National University, http://adb.anu.edu.au/biography/lang-john-3985/text6301.Accessed on 24 October 2018.

Huggan, Graham. *Australian Literature: Postcolonialism, Racism, Transnationalism*. Oxford University Press, 2007.

Bandopadhyay, Deb Narayan, Paul Brown and Christopher Conti, eds.*Landscape, Place and Culture: Linkages between Australia and India*. Cambridge Scholars Publishing, 2011.

Singh, Supriya. *Money, Migration and Family: India to Australia*. Palgrave Macmillan (Springer Nature), 2016.

Strydom, Piet. "Modernity and Cosmopolitanism: From a Critical Social Theory Perspective," in *Routledge Handbook of Cosmopolitanism Studies*, edited by GerardDelanty,Routledge, 2012, pp. 25-37.

ISSN-2231-5616

Sambalpur Studies in Literatures and Cultures

Series 5, 2019

Department of English

Sambalpur University

Odisha

INDIA

Cultural Ecotone and Transformation of the Human Geography in Mahasweta Devi's *Chotti Munda and His Arrow*

Asis De

It is by now a well-accepted historico-cultural reality that the imperial and mercantile aggression of European colonial enterprise has ruthlessly altered not only the bioregions of the colonized countries, but made substantial changes in the human geography on the planet as well. With the end of the twentieth century, more specifically saying, with the end of the European colonialism, the world has witnessed several historical changes in the value-systems, perceptions, thoughts and attitudes, which one may fairly assemble under the single umbrella term: 'postcolonialism'. Ecological consciousness could probably be seen as one of the major products of the post-colonial time. Apart from the scientific study of the relationship between the bio-organism and the environment, ecology now-a-days includes new disciplines like 'social ecology' or 'human ecology' which insist mostly on the changes in the 'human' environment. In his book *The Ecological Thought* (2010), Timothy Morton argues:

> Ecology isn't just about global warming, recycling and solar power—and also not just to do with everyday relationships between humans and nonhumans... It has to do with capitalism and with what might exist after capitalism.... It has to do with concepts of space and time.... It has to do with society. It has to do with coexistence. (2)

Taking this view as the basic premise I would like to argue that an ecological consciousness affects numerous aspects of human life, culture and community. Morton's opinion sounds quite proverbial when he says: "Human beings *are* each others' environment" (4; original emphasis). The interconnectedness and coexistence of human communities and cultures produce diverse landscapes, which can well be compared with the diversity of human geography and the notion of the 'ecotone' in ecology.

The idea of an 'ecotone' is primarily inspired by an ecological consciousness that tends to see the earthly paradigm as a cluster of 'biomes'[1] or specific climatic regions with particularly unique sets of living organisms and their biotic and abiotic environments. Environmental scientists like to see an 'ecotone' as a space that exists on the very 'border-edge' of two or more ecosystems. So, an ecotone is essentially an ecological frontier, where the most crucial reality is that of the border. But at the same time it should be equally clear that an ecotone is not only a space

Morton, Timothy. *The Ecological Thought.* Cambridge, MA: Harvard University Press, 2010.

Sharma, Vandhana and kaurQ. "Articulating Tribal History: The Fallouts of Caste in Mahasweta Devi's Chotti Munda and His Arrow".*European Academic Research.*Vol. I, Issue 12(March 2014): 5875-5904.

Sreelatha, R. "Tribal Perceptions of the Forest: A Study of Mahasweta Devi's *Chotti Munda and His Arrow*".*Essays in Ecocriticism.*Eds., Nirmal Selvamony et al.OSLE-India, Chennai and Sarup & Sons: New Delhi, 2007. Print.

Sutton, Mark Q and E. N. Anderson.*Introduction to Cultural Ecology* (3rd edition).Lanham/ Maryland: Alta Mira Press (A Division of Rowman & Littlefield), 2014. Print.

■■

ISSN 0972-6756 UGC CARE ENLISTED JOURNAL

Food, Festivals and Sweets: Creating Cultural Identity of Bengal in the 21st Century

Swati Basak

Assistant Professor, Mahishadal Raj College,

Abstract

Food is an important part of culture and creates our identity. The term multiculturalism is also associated with food. Food has some social significance also. Food is important for understandings our society and has deep impact on different rituals. It creates relationships between people and strengthens bonds. Modernization, nationalism is important while we discuss ritualistic food. We cannot get the real picture of the Bengali dishes if we don't give any description of sweets. From ancient times Bengalis prepared sweets and offered to Gods. On every occasion we prepare sweets. It creates our identity and differs us from others. From ancient period to modern times there are mention of preparing and consuming sweets by the Bengalis. Sweets are part of our different religious practises. In ancient or medieval times sweets were not prepared from channa or curdled milk. It was the Portuguese who first introduced channa in Bengal and sweets were prepared from it after that. We are grateful to Nabin Chandra Das who invented rosogolla in Bengal. Apart from that sandesh, pantua, makha sandesh, kalojam, kanchagolla etc are made and consumed by the sweet lovers of Bengal. 19th century is regarded as the golden age of Bengali sweets and from this time sweet creates the identity of the people of Bengal.

Food is not just to satiate our appetite but it is the expression of our cultural identity. We share our cultural tradition, identity, practices and customs with each other and create a new cultural identity and food is the medium of creating the identity. Like language food has the power to interact with each other belong to different cultural zones. It strengthens social bonds by expressing cultural identity. Sociologist Robin Fox pointed out that our religion, ethnicity and social classes all these are reflected in our food habits. Sometimes food creates · 'forge alliances' with others because sometimes we are compelled to stay in a situation and consume that kind of food with which we are not habituated with. Fox said "Food is almost always shared; people eat together; mealtimes are events when the whole family or settlement or village comes together. Food is an occasion for sharing- for the expression of altruism."[1]

Food creates multiculturalism, not only food but sometimes ritualistic

cultural identity in a very exclusive way. It is the expression of [illegible] and hospitality. It is an integral part of our religious rituals. In this [illegible] different types of sweets on different occasions and their process of [illegible] have been discussed to prove the fact that how sweet influences the [illegible] mind and sentiment. In this way a deep and rich culture developed in [illegible] It strengthens the bonds between different people and brings them [illegible] close together. It has some symbolic meaning which creates a platform [illegible] association for people belong to different or same group. Many times [illegible] make different and special kind of sweets to make the occasions very [illegible] and memorable. It will not be wrong to say that sweet marks the [illegible] identity of Bengal and makes our culture rich and colourful.

References

1 Fox, Robin, "Food and Eating: An Anthropological Perspective" in *Social Issues* [illegible] *Centre*, La Trobe University, 2014, Vol. 12, pp. 1-22.

2 Ibid.

3 Kothari, Geeta, "If You Are What You Eat, Then What Am I?" in *Kenyo* Kenyon College, Gambier, 1999, vol. XXI, No. I, pp 1-17.

4 Cwiertka, J., Katarzyna, *Food and war in Mid-Twentieth Century East Asi* Publishing Limited, 2013, p.409.

5 Allen Matthew and Rumi Sakamoto, *Popular Culture, Globalization a* Routledge, 2006.

6 Ibid.

7 *Food and Identity: A Global Approach,*found in www.foodandidentity.word date of access 08/05/2019.

8 Ibid.

9 Sen, Sukumar, *History of Bengali literature,* Sahitya Academy, 1960.

10 Achaya, K.T., *The Illustrated Food of Jndia: A-Z,* Oxford University [illegible] 2008.

11 Dey, lshita, "Crafting Sweets in Bengal: Practices and Rituals," in *Overview,* 5 2017, found in https:www.sahapedia.org, date of access, I 0/09/2019.

12 Kaviraj, Krishnadas, *Chaitanyacharitamrita,* Sri Sukumar Sen (ed), Sahity New Delhi, 1963.

13 Haldar, J., *Bengal Sweets: Revised and Enlarged,* Facsimile Publisher, 2015.

14 Ibid.

15 Roy, Pratap Kumar, "Food of Calcutta-Past and Present," www.geocities.ws>cuisines-past, date of access, I l/09/2019.

16 "The Poi la Baisakh Sweet Platter" found in https://m.telegraphindia.c access, 02/04/2019.

17 Roy, Pratap Kumar, "Food of Calcutta-Past and Present".