



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

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19th Dec 2019 to 21st Dec 2019

**INDUSTRIAL & MANAGEMENT
ENGINEERING DEPARTMENT
INDIAN INSTITUTE OF
TECHNOLOGY KANPUR, INDIA**





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XXIII Annual International Conference of the Society of Operations Management (SOM2019)



Devanath TIRUPATHI

Dean, Amrut Mody School of Management, INDIA

President, SOM

On behalf of the Society of Operations Management (SOM), it is my great pleasure to welcome you to the XXIII Annual conference of the Society, hosted by the Department of Industrial & Management Engineering at the Indian Institute of Technology Kanpur. The society is grateful to the conference hosts for hosting the 2019 conference.

The annual conference is the flagship event of SOM. The event attracts operations management (OM) scholars and managers from all over the country and provides a strong basis for exchange of ideas and perspectives on contemporary operations issues. As the society continues to grow, we look forward to another exciting year. One of the highlights of the SOM conference is the Doctoral consortium that inspires OM doctoral students to present their research and provides a vibrant platform for research collaborations.

The conference hosts have put in a remarkable effort to provide us a wonderful experience at the conference. I hope that you will find the conference both valuable and enjoyable.

Please visit www.soc-om.org for regular updates on the activities of the society.

We welcome your suggestions to make the society more meaningful and resourceful to the academic community.



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)



Abhay KARANDIKAR
Director IIT Kanpur, INDIA
Chief Patron, SOM 2019

It gives me great pleasure to note that Industrial & management Engineering (IME) Department along with Society of Operations Management (SOM) is organizing the XXIII Annual International Conference of the Society of Operations Management at IIT Kanpur, INDIA from 19th to 21st December 2019. Since the scientific advancements made by Frederick W. Taylor, W. Edwards Deming and others, Operations Management has flourished independently as a subject in its own right, and its applications can be seen in areas as diverse as Supply Chain Management, Production systems, Manufacturing, etc. Furthermore, OM applications are witnessing a transformation by the usage of BIG data and it is appropriate that SOM2019 is highlighting this through an interesting panel discussion session. Finally, in today's world as India realizes the ***Make in India*** dream it becomes imperative that OM be able to dovetail both theory and practice in a manner to bring OM's benefit more comprehensively. I wish SOM2019 team all the best to realize this dream.



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)



Manindra AGARWAL
Deputy Director, IIT Kanpur, INDIA
Patron, SOM 2019

Industrial & Management Engineering (IME) Department started as an Interdisciplinary Program (IDP) in 1974 and became a department in 1988. Since then IME has grown to include four different academic programs which are PhD, MTech, MBA and VLFM. In the course of its journey IME has kept its focus on research and industry interaction, and in the process kept pace with the development in areas of Operations Research (OR), Decision Sciences, Operations Management (OM) and their applications. The department actively collaborates with different departments in IIT Kanpur and also with other institutes/industry partners. With such a rich experience, IME department is the right venue for the XXIII Annual International Conference of the Society of Operations Management. I am sure the quality of work presented will once again highlight the relevance of Operations Management (OM) and its applications in today's world. I wish IME Department and SOM all the best for SOM2019 conference and hope to see such future endeavors grow exponentially to bring in the spirit of collaborative academic work.



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)



Raghu Nandan SENGUPTA

IME Department, IIT Kanpur, INDIA

Conference Chair, SOM 2019

In light of ever-increasing competition and environmental uncertainties, management of resources has become a matter of critical importance for every organization. In this context, Operations Management (OM) can play a pivotal role in the efficient and effective conversion of resources into desired products and services. Thus, SOM2019 provides a platform for the academicians and the practitioners in the field of OM and allied areas where they can share knowledge and experience and discuss new ideas on the traditional as well as contemporary topics in OM. Department of Industrial & Management Engineering, Indian Institute of Technology Kanpur feels proud to be associated with SOM2019 and welcomes all the participants and delegates for this prestigious conference.



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
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IIT Kanpur, INDIA <<http://www.iitk.ac.in>>

Indian Institute of Technology, Kanpur (IIT Kanpur) is one of the premier technical institutions established in 1959 by the Government of India with the collaboration of a consortium of nine universities from the USA. From the day of its inception, the aim of the institute has been to provide meaningful education, to conduct original research of the highest standard and to provide leadership for the growth of this country. At present IIT Kanpur has a sprawling residential campus of 1055 acres with about 2500 undergraduate and 1500 postgraduate students, 330 faculty members and more than 1500 supporting staff. The institute has a well designed faculty building, fully equipped classrooms, seminar and conference rooms, computer science building, biological sciences building, residential quarters for the faculty & staff members, hostels for the students, an excellent library, etc. The presence of lush green trees, manicured lawns, wide roads make the campus picturesque and well endowed. IIT Kanpur has always strived to develop itself into an institution of excellence in education and research in consonance with the contemporary and future needs of India. The institute has made special efforts to recruit talented faculty on a worldwide basis and admits students in the different programs from all over the country by a very careful selection process. In addition to offering formal undergraduate, post-graduate and Ph.D. programs, the institute has also been involved in continuing education and research & development in areas of value to both the industry and the society. The vision of the institute is to emerge as an international centre of excellence in all facets of technical and management education by being a melting pot of academia, industry and research, but at the same time being rooted in Indian ethos and societal values.



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Industrial & Management Engineering Department <<http://www.iitk.ac.in/ime>>

The Department of Industrial & Management Engineering (IME) at Indian Institute of Technology Kanpur (IIT Kanpur), INDIA was established with the aim of synergizing technology with management in a comprehensive manner so that the knowledge gained may be used for the benefit of the society at large. The journey started in 1988 with the Ph.d and M.Tech programmes, and in 2001 the department introduced the MBA programme. The focus of the department is to develop techniques and the skills sets relevant to students with diverse backgrounds, and who may wish to subsequently pursue a career in academics or in different technical and managerial positions in Industrial & Management Engineering related industries. The department has 17 faculty members, 5 staff and about 200 plus students in different programs like PhD, MTech, MBA and VLFM. The core research of the department covers a whole gamut of areas in Industrial & Management Engineering, that includes Operations Research, Operations Management, Production & Supply Chain Management, Quantitative Methods & Decision Making, Marketing/Services Management, Business/Social Media Analytics, Innovation & Entrepreneurship, Organizational/Human Resource Management, Business Economics, Infrastructure & Public Systems, Financial Markets and Models, Enterprise Information and Knowledge Systems, etc. The department has Syndicate Bank Entrepreneurship Research and Training Centre (SBERTC), Energy Analytics Lab (EAL), Simulation Lab, etc., apart from dedicated lab for its PhD, MTech and MBA students.



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 1

NEW PRODUCT DEVELOPMENT: CASE STUDIES ON TWO GREEN UNITS

Shrushti Bajpai

National Sugar Institute, Kanpur

Abstract

There are a lot of waste materials which craves attention for using in newer ways, may be by composition of various different type of waste materials which may generate or reproduce such products that may be more welcome some in future. Although an ambitious project of renewable energy from wastage and garbage was launched in Kanpur under which the garbage from household was collected to be generated for electricity, the unit was also visited by very distinguished people including Farooq Abdulla but that unit proved to be a flop show and huge garbage stands piled up at the site. There has been successful utilization of coal as thermal plant in making of fabricated bricks. Apart from them, the enthusiastic entrepreneurs at Kanpur have successfully come up and established appreciable products for which we discuss in the following manner. This paper tries to study the concept of new product development in light of an organization HelpUsGreen which manufactures incense cones, incense sticks and vermicompost and Cawnpore Bio Energies which manufacture bio coal.

Keywords: *New Product Development, Competition, Marketing, Products*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 2

**AGENT BASED SIMULATION OF RFID POTENTIAL IN AIRCRAFT REVERSE
LOGISTICS**

Bardia Dejam, Anjali Awasthi
Concordia University, Canada

Abstract

Reverse Logistics (RL) has become increasingly popular in different industries especially aerospace industry over the past decade due to the fact that RL can be a profitable and sustainable business strategy for many organizations. However, executing and fulfilling an efficient recovery network needs constructing appropriate logistics system for flows of new, used, and recovered products. On the other hand, successful RL network requires a reliable monitoring and control system. A key factor for the success and effectiveness of RL system is to conduct real-time monitoring system such as radio frequency identification (RFID) technology. The RFID system can evaluate and analyze RL performance timely so that in the case of deviation in any areas of RL, the appropriate corrective actions can be taken in a quick manner. In this study, an agent based model is proposed to design and construct a RL system. “AnyLogic 7.1” software is used. A case study for a Helicopter Company is conducted. The results of our study show that with exploiting RFID technology, the total disassembly time of a single helicopter was decreased.

Keywords: *Reverse Logistics (RL), Radio Frequency Identification (RFID), Aerospace Industry, Unified Modeling Language (UML), Agent-Based Simulation, Bell Helicopter company, AnyLogic*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 3

Sustainable mobility project selection using a fuzzy axiomatic design based approach

¹Anjali Awasthi, ²Mahesh Sharma

¹CIISE, Concordia University, Canada, ²JMSB, Concordia University, Canada

Abstract

Sustainable mobility project evaluation is a challenging problem for transportation decision-makers. The specific context of each city and multiple stakeholder objectives combined with lack of quantitative data make the problem challenging. In this paper, we propose a fuzzy axiomatic design based approach for prioritizing sustainable mobility projects. The criteria (attributes) for sustainability evaluation are generated using Affinity Diagram. Fuzzy Delphi is used to rate the criteria and the alternatives. The final rankings for the projects are generated using Fuzzy Axiomatic Design. The best project(s) are the one(s) with highest ranking. A numerical application is provided.

Keywords: *Sustainable mobility, Axiomatic design, Affinity diagram, Delphi technique, Fuzzy set theory*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 4

Consumer Choice Behavior and Models: Implications for Retail Assortment Planning

Soumyadeep Kundu, Ashutosh Sarkar

Indian Institute of Management, Kozhikode

Abstract

Assortment planning problems are one of important decision problems in the retail sector that are taken based on the cognizance gathered of the consumers' behavior. Therefore, a comprehensive understanding of the consumers' choice process would help retailers in adopting suitable assortment plans. This paper reviews the literature on the consumer choice processes and classifies them under three heads: (i) consumer choice behavior, (ii) consumer information search, and (iii) consumer decision strategy, with further classifications under each head. It was observed that a consumer, while visiting a store, has prior information regarding products, her information search and purchase decision strategy is largely influenced by the assortment of the retailer. The study also proposes a model incorporating the influence of the retailers' assortment on the consumers' information search and purchase decision strategy.

Keywords: *Consumer choice, information search, decision strategy, assortment planning, retail*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 7

Review of Blockchain in Supply Chain

Joe, AbouJaoude, Raafat, George Saade, Mahesh Sharma

*Department of Supply Chain and Business Technology Management Concordia University,
Montreal, Canada*

Abstract

Introduction: In the last 10 years, digital commerce, innovation and transformation has made yet another significant impact on supply chain mechanisms. A host of mobile devices, such as the iPhone, capable of taking advantage of internet commerce resulted in fueling the Internet of Things (IoT) (smart cities) and the integration of artificial intelligence in all areas of life producing intelligent devices. This phenomenon and technological revolution would have the most transformation potential in the area of supply chain mechanisms where artificial intelligence would become the dominant manager of processes and functions. Moreover, exchange of good, information and financial services (at a local, regional and global levels), will change the established structures of traditional chains.

The introduction of cryptocurrencies and other forms of decentralized transactions between partners in the supply chain, coupled with innovations in mobile payment technology such as apple and android pay, are helping to increase processing efficiencies (Zheng et al., 2017) – yet some view this disruptive and are finding it difficult to adapt. This change plays an important role in the evolution of the internet of things. Under this IoT paradigm, supply chain partners would be able to not only transact and fulfill exchanges, but to disintermediate themselves from the process by enabling the devices to transact on their behalf. Moreover, a multitude of smart devices and technologies containing sensors and other data collection components would be able to transfer useful and real time information seamlessly throughout the networks, allowing for more intuitive and intelligent decisions. Furthermore, the interconnected nature of the technology has become the catalyst for evolution of supply chain service technology via artificial intelligence by the introduction of autonomous systems through system x to x communication and the streamlining of global supply chain mechanisms via the use of automated device information exchanges (Christidis and Devetsikiotis, 2019).



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

The underlying enabling technology allowing for autonomous global supply chain mechanisms in the realm of the Internet of Things, is Blockchain.

Blockchain: Blockchain is the newest digital innovation technology enabling the paradigms of “Internet of Things”, and artificial intelligence. Blockchain has created a buzz in some industry seeking opportunities for enhanced business processes and building trust, however in others, such as the financial sector it is viewed as a disruptive technology and a threat to their traditional business paradigm. Blockchain represents a method with which a supply chain network can use to validate, keep and synchronize the content of a bilateral/multi-lateral transaction ledger which is replicated a large number of times. A Blockchain transaction is decentralized (Yli-Huumo et al., 2016, Aste et al, 2017).

Today, the majority of transactions between supply chain partners are centralized through trusted third-party organizations. However, trust is a dubious construct, as the third-party can modify the content to their advantage. In short, the true service or commodity offered by a third-party is trust, and that is precisely what Blockchain proposes not to depend on.

Moreover, Blockchain’s decentralized environment where no third-party is in control of the data is achieved through a peer-maintained self-sovereign system where transactions are time-stamped in a ledger chronologically. The transactions broadcasted to the partners who participate in the system such that the ledger can be publicly audited (Aste et al., 2017). Since the transaction information is copied and maintained with the entire supply chain community, it cannot be altered or modified without the approval and update of the ledger. This prevents fraud and ensures a digital form of verification allowing for “trustless” partner-to-partner transactions. This proposition offers several advantages: transparency; publicly available data for everyone to check and validate without needing to go through a central authority; faster processing of transactions; enhanced and more efficient information exchanges; the information remains anonymous via a set of public and private keys associated to an account originating the transaction. The public key is available to everyone, the private key is strictly known by the individual and the identity of that party remains anonymous.

Blockchain & Supply Chain: Relatively speaking, research efforts of Blockchain application in general are still relatively few as evidenced from the published body of knowledge. In an article by AbouJaoude and Saade (2019), they identified the primary sectors at which



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Blockchain applications have been studied, namely Energy, Finance, Healthcare and Government. Studies in other domains have been published but they are dispersed and scarce and include fields/areas in education, insurance, supply chain, rights management, transportation, business process management, fraud detection, exchange and resource management.

More specifically, a recent exploratory literature review on the application of Blockchain in supply chain shows that there is an increase in publications. Using google scholar, we found that around 25 articles were published in various outlets including conferences and journals. Most of those articles were published in 2018 – 2019 and all were descriptive in nature and as they relate to specific sectors such as airline, pharmaceuticals, and agriculture. The points of discussion are primarily related transparency and trust.

AbouJaoude and Saade (2019) demonstrate how research on the application of Blockchain is still very young by any standard and descriptive in nature. They also show the gap in the body of knowledge. More specifically, research of Blockchain and supply chain is even less with just a small increase in publications during the last two years.

In this article, we advocate the need for more research on Blockchain and supply chain. Although descriptive analysis of benefits is useful, the following type of research is necessary: impact of Blockchain components (trust, transparency, contracts, data security, data privacy, algorithm) on supply chain mechanisms; empirical studies, and analytical studies that look into the influence of various algorithms on supply chain operations. From a research perspective, there are many areas that need to be studied, including but not limited to, implications of implementation, adverse effects, change management, Blockchain innovation transformation, altered supply chain paradigms, impact of blockchain-dependent innovations on the IoT, and crypto-currency and supply chain.

Keywords: *Blockchain, Supply Chain Management, Crypto currency*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 8

**Robust Multi-Objective Solution Approach for Multiple Quality Characteristic
Optimization Problems**

Abhinav Kumar Sharma, Indrajit Mukherjee

Shailesh J. Mehta School of Management, IIT Bombay, India.

Abstract

Simultaneous optimization of multiple critical-to-quality (CTQ) characteristics or responses is known as multiple response optimization (MRO) problem. As multiple responses are often correlated, trade-off solutions are inevitable. Thus, multiple efficient trade-off solutions or non-dominated solutions are sought for specific MRO problem. In this context, the empirical functional relationship between process control factors and responses [or response surface (RS) models] play a critical and important role. However, due to RS model parameters and response estimation uncertainties, determination of implementable robust optimal process setting conditions is arduous. Besides, the sensitivity of setting condition also needs to be considered to derive efficient and robust solutions. This study proposes a multi-objective optimization (MOO) approach for MRO problems to derive robust solutions. The sensitivity of a setting condition, RS parameters, and predictive response uncertainties are considered in the proposed approach. Non-dominated Sorting Genetic Algorithm-II (so-called 'NSGA-II') is used to identify efficient robust solutions. The proposed approach is verified using a mean response MRO case instance taken from literature. The robust derived solutions are contrasted with earlier reported best solutions.

Keywords: *Critical-to-Quality; Multiple Response Optimization Problem; Multi-objective Optimization Approach; Response Surface; Model Parameter Uncertainties; Response Uncertainties; Non-dominated Sorting Genetic Algorithm*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 11

Designing green logistics for sustainable supply chain

Mahamaya Mohanty

Bennett University (INDIA)

Abstract

Various companies are recognizing the environmental management as a key strategic issue having a massive impact on organizational performance. The goal of sustainability is to establish an interaction among economy, ecology, and societal related factors. Green Logistics includes the description about all the attempts considered to measure and minimize the ecological impact of logistics activities. It includes all the activity flows of the supply chain both in forward and reverse direction. This can be achieved through intermodal freight transport, path optimization, vehicle saturation, and city logistics. The green supply chain has an additional entity role known as dismantlers apart from suppliers, manufacturers, retailers, and customers. Dismantlers lead green logistics to operate with additional functionalities such as recovery, recycling and land filling. Efficient uses of resources, shortest routes from the sources to destinations and proper usage of energy required for inventory holding reduces the costs as well as creates less Greenhouse Gases emissions. Generally, transportation in current research focuses on the fuel-based method or distance-based method to calculate CO₂. Distribution of durables and transportation operation networks are important operational characteristics that affect the Green Supply Chain. Balancing both economic and environmental factors to design green supply chain is a major concern to be achieved. Here, a delivery re-scheduling strategy is introduced which includes the fleet size, homogeneous fleet, single depot, deterministic demand, and finally the goal of minimizing distances. As product delivery and environmental optimization are considered to be the keys to reduce the cost and amount of CO₂ emissions and Greenhouse gases emissions, so the model aims at minimizing the transportation distance, the cost incurred in transportation, and hazardous emissions.

Keywords: *Supply Chain, Green Supply Chain, Logistics*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 12

**A game theoretic analysis of carbon emission and congestion cost in the presence of
competition between airlines**

¹Aasheesh Dixit, ²Suresh Jakhar, ³Anjali Awasthi

^{1,2}*IIM Lucknow*, ³*Concordia University, Canada*

Abstract

In this study, we use game-theoretic approach to model and analyze the competition between two airlines. We compare different power structures to study the impact of pricing, carbon emission reduction and congestion cost on the performance of airlines. Most specifically we use Nash game and Stackelberg game to analyze the competition. We also present numerical simulations to demonstrate the impact of customer's sensitivity towards pricing, carbon emission reduction on the profit of airlines. At the end of the study, we also discuss the theoretical and practical implication of airline competition.

Keywords: *Game theory, Carbo Emission, Congestion Cost, Competition, Airline Industry*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 13

Prioritization and Evaluation of barriers to implement CSCM using fuzzy-AHP

Chitranshu Khandelwal, Mukesh Kumar Barua

Department of Management Studies, Indian Institute of Technology Roorkee

Abstract

Circular Supply Chain (CSC) has gathered significant momentum across the globe due to its potential to optimize resource usage and minimize waste. Developing nations lag behind in the adoption of CSC practices due to the presence of several challenges. This paper tries to investigate and prioritize barriers in the implementation of CSC management practices in Indian plastic industries so that organizations can design their strategies to tackle them based on priority. This article proposes a multi-criteria decision-making model based on fuzzy analytic hierarchy process (FAHP) to prioritize and rank the barriers of CSCM implementation. The fuzzy framework has been applied to take account of the impreciseness and uncertainty involved in real-world situations. In total, 24 barriers have been identified based on the literature review and experts' opinion. These barriers are classified into five major categories viz. institutional, organizational, market related, technological, and economic barriers. The findings of the study reveal that three barriers viz. unsupportive tax rebate policies, poor enforcement of rules and regulations relating to environmental protection and excessive cost of eco-friendly materials and packaging are the major hurdles to adopt CSCM in Indian plastic industry. The findings will assist the decision makers in making their firms sustainable by curbing the significant barriers.

Keywords: *Circular Supply Chain Management (CSCM), Fuzzy Analytical Hierarchy Process (FAHP)*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 14

Optimization of Quality of Life Index with α -level of Significance of Linear Constraints

Tsuknungchila Jamir, Prem Prakash Mishra

National institute of technology, Nagaland

Abstract

A statistical quantification approach has been presented to optimize the Quality of Life Index(QOLI) in a specific region subject to linear constraints. The QOLI is based on certain parameters of vital life which measures Physical, Psychological, Economical, Social and Environmental conditions in terms of ranking. Principle Component Analysis(PCA) contributes to the formation of the QOLI and plane of regression provides information about the linear constraints with an α -level of significance. An exhaustive case study of QOLI for Nagaland, India has been done in support of this mathematical model.

Keywords: *Quality of life Index, principle Component Analysis, Linear Programming, Plane of regression*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 15

**Quality-Cost Trade-off Problem: Smart IOT Based Optimization of Construction
Projects**

Saikat Mukherjee, Sourav Das, Bivash Mallick, Ankita Ray
Maulana Abul Kalam Azad University of Technology (WB)

Abstract

Construction projects are facing lack of real time planning during execution. Currently, developed optimization techniques cannot control cost, time and quality constraints of large projects. Several solutions take heuristic approaches but, those are dependent on managers' decisions. None of this paper uses real time optimization technique for scheduling of resources. Hence, higher numbers of projects are unable to complete within their deadlines. In this study, network optimization technique is developed to support an organization during real time project planning. In this paper, whole project is represented through complex networks. If one activity of the network is failed to start, the resource of that activity will be allocated to another best possible activity, may not be scheduled at that time. Since, a network optimization technique always provides an integer solution. Therefore, new allocation may change the critical path of that project. So, this path needs to be optimized to get the best result of that project with respect to cost, time and quality. CPLEX is used to solve the network model. It will screen all the alternative activities and allocate the resource to the best alternative. For real time planning, it is also necessary to do a tactical planning for next one month at least to make the optimization process more streamlined.

Keywords: *Construction management; Network optimization; Real time scheduling; Quality-cost trade-off*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 16

“Is your supply chain visible?”

Mirzaayan Ahmed Begg, Sarnendu Paul

Department of Mechanical Engineering, Asansol Engineering College, Asansol, India.

Abstract

The supply chain management is very complex. The end to end supply chain from basic procurement of raw material to final product for its demand customer is Opaque. As a result the inherent cost involves in managing the supply chain increases. To overcome this disruption in this paper a novel approach of blockchain technology is proposed. A blockchain technology is distributed database of records more specifically it is a public ledger of all transactions that have been executed and shared among all the existing participating parties. The blockchain contains certain and verifiable records of every single transaction ever made, the information's once entered can never be erased. This paper describes the complexities in the supply chain network and how does blockchain technology solves the problems creating more reliability, traceability and transparency in the supply chain network.

Keywords: *Supply chain management, blockchain technology, distributed ledger*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 17

Planned fashion obsolescence in the light of supply chain uncertainty

Reena Susan Philip, Aswathi Mary Anian, Dr. Anand Shankar Raja M

Department of Commerce, CHRIST (Deemed to be University), Hosur Road, Bengaluru

Abstract

An exorbitant consumption habit has developed amongst consumers, who are convinced that they need to revamp their wardrobe as per the latest trends in spite of their clothes being perfectly functional. This has led the fashion industry to become the second-largest polluter in the world. This research seeks to comprehend how media influences customers' to indulge in fast fashion and subsequently how the phenomenon of fast fashion leads to supply chain uncertainty. A qualitative approach whereby a maximum variation sample comprising of customers, supply chain partners, and marketers has been adopted in this study. An Interview schedule is undertaken to facilitate the assessment of variables researched in the past in connection to the present-day scenario. From the variables selected with the help of Dedoose, a model is framed to comprehend the problems faced by suppliers in the planned obsolescence cycle and the role of customers in the same. Findings suggested that a step away from the fast-fashion mentality needs to be taken which can be realized only with awareness and the reform of high street stores. The mindsets of consumers need to be transformed to address the problem of fast fashion. The same tactics adopted by media to drive consumers towards fast fashion can be used to steer them towards sustainability as well. In this article the importance of Artificial Intelligence in SCM and the modern tools used in industry 4.0 is also discussed.

Keywords: *Supply Chain Uncertainty, Fast Fashion, Media, Circular Economy*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 18

Market Structure in Agriculture Supply Chain

Dewang Pagare, Amit Agrahari, Indranil Biswas

IIM Lucknow

Abstract

In this paper we study how market structure influences market clearing prices for agricultural products. Specifically, we investigate simultaneous influence of an alternative market along with the traditional market on optimal marketing price of any agricultural product using signalling game framework. In India, agricultural markets are regulated under the Agricultural Produce Marketing Committee (APMC) act where farmers can sell their produce through a commission agent to traders. The price discovery in this marketplace depends on the market conditions and hence we call this marketplace as Dynamic Marketplace (DM). To save the smallholder farmers from the price uncertainty faced in DM and to ensure sufficient supply of a crop, government intervenes by announcing a minimum support price at which it will procure from the farmers. As the price received by farmer is stable in this case, we call this a Static Marketplace (SM). Recently, due to higher price uncertainty and inefficiency at DM and SM, new market intermediaries are emerging connecting the farmers to businesses (processors, retail stores etc.) and consumers. These intermediaries are technologically-driven posted price channels and we refer to them as Controlled Dynamic Marketplaces (CDM). We analytically develop a supply chain model considering DM as the base scenario. We study the impact of presence of alternative marketplaces SM and CDM on farmers, consumers, intermediary firm and the government by considering effects of product quality, quantity and transportation cost on product pricing.

Keywords: *Agricultural supply chain, Market structure, Signalling game*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 19

On a Non-Customer-Intensive Service Queue with Impatient and Patient Customers

S. Srivatsa Srinivas, Rahul R. Marathe

Department of Management Studies, Indian Institute of Technology Madras

Abstract

We consider a capacitated non-customer-intensive M/M/1 visible queue consisting of two types of customers. The first set of customers are impatient and make strategic balking decisions. On the other hand, the latter set of customers are patient and do not make strategic decisions. In the ensuing symmetric game between the impatient customers, we show that there exists at least one pure threshold strategy equilibrium. Further, we also analyse how the pure threshold strategy equilibrium and the blocking probability vary with respect to the proportion of impatient customers and the waiting area capacity. Importantly, we find that the blocking probability does not always decrease with the increase in the waiting area capacity.

Keywords: *Queue; Game Theory; Equilibrium; Capacity*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 20

Strategic Channel Choice and Impact of Gray Markets on the Supply Chain and Social Welfare

Abhishek Srivastava¹, Arqum Mateen²

Quantitative Methods & Operations Management Department, Indian Institute of Management Kozhikode Kerala, India - 673570

Abstract

Diversion of manufacturers' branded products outside its authorized channel is becoming a major concern in supply chain. Unauthorized intermediaries often know as 'gray marketers', purchase products from manufacturer's authorized distributors and resell in the consumer market at a relatively lower price. This can create unfair competition in the market, negatively affect brand reputation of the manufacturer and result in profit loss. Therefore, products which involve high research and development (R&D) cost or have high brand equity can suffer in the presence of gray markets (GMs). However, GMs can benefit consumers and enhance social welfare by making product available to the consume segments having low purchasing power. In this study, we analyze impact of the presence of GMs on consumer surplus and social welfare and strategic channel choice of the manufacturer. We consider a supply chain which consists a manufacturer who sells through a retailer. Retailer has access to a GM channel which he can use to divert its excess product inventory. Consumers in the market are strategic in nature who maximize their utility by deciding which channel to buy. We show that for the standard product categories, the presence of GMs facilitates manufacturer to expand their sales volume and also results higher consumer surplus and social welfare. However, when the market goods belong to the category of luxury brand or there is involvement of high R&D cost then the presence of GMs adversely affect manufacturer's brand reputation and profitability. In such a scenario, our research suggests that policy makers should provide legal mechanisms for the manufacturing firms to curb the emergence of GMs.

Keywords: *Gray markets, Channel structure, Consumer surplus, Social welfare*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 22

Profitable Market Mechanism Design for Online Aggregator Taxi Services

Swaminathan Rammohan, Rahul R. Marathe, and Nandan Sudarsanam

Department of Management Studies, Indian Institute of Technology Madras

Abstract

The omnipresent internet has lead a way to a new class of taxi services that connects passengers and drivers on mobile platforms. Most of the aggregators use a fixed posted price strategy for passengers and likewise taxi drivers are charged a fixed platform fee by the aggregator. Nevertheless, the rigidity of this posted price channel leaves passengers and drivers with no choice, but to accept or reject rides. We propose a profitable pricing mechanism for the aggregator that increases the demand for taxi services by capturing a new segment of passengers at a reduced price. Moreover, the increase in demand of passengers is captured by the taxi drivers through additional bidding channels offered by the aggregator. Additionally, we develop bounds for the valuations of passengers in the proposed segments and study the buying behavior of passengers in the dual channel. Also, we analyse the effect of incentives on taxi drivers' bidding behavior in the auction channel. Finally, we demonstrate that the proposed mechanism maximizes the utility of passengers, drivers and aggregator in certain parameter ranges, and it is more preferable to all the agents compared to the existing mechanism.

Keywords: *Market mechanism, Pricing mechanism*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 24

Comparing blockchain perception from SCM context in Indian manufacturing and service industries

Amit Karamchandani, Samir Srivastava, Sushil Kumar

IIM Lucknow

Abstract

This paper compares the perception of blockchain on six dimensions of SCM in Indian manufacturing and service industries. It is one of the first studies which compares the blockchain perception among practitioners in the manufacturing and service industry. It identifies the supply chain dimensions, whose improvement by blockchain adoption can result in incremental profitability. The data collection was carried out through a survey questionnaire conducted among practitioners from Indian manufacturing and service industries. The survey received a total of 494 valid responses. The scales for “blockchain benefits” were developed and the hypothesis was tested by covariance-based structural equation modeling (CB-SEM) on AMOS 24. The application of CFA identified 16 benefits of blockchain for service industry, while 15 benefits for the manufacturing industry. The results show that both sectors perceive improvement in six aspects of SCM, arising from blockchain adoption and its resulting benefits. We find significant differences as well. While the manufacturing industry expects an increment in profitability through improvement in delivery reliability and mass customization, increment in profitability for the service industry is expected through improvement in information quality, mass customization, service quality, supply uncertainty, and delivery reliability. The results show that service industry is more optimistic about blockchain’s contribution to increment in profitability. For both the sectors, the hypothesized relationships are found to be moderated by organization size and geographical dispersion, while they are not found to be moderated by job level of respondents, level of supply chain integration and level of supply chain IT integration.

Keywords: *Block Chain, Supply Chain Management, Covariance based Structural Equation Modeling*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 25

Better Price for Farmers: How computerization affects agriculture prices?

Charu Naithani, Amit Agrahari, Indranil Biswas

IIM Lucknow

Abstract

Information and communications technologies (ICT) work as enablers for developing economies by creating capabilities such as shortcuts and substitutes for inadequate infrastructural facilities. In this study, we investigate if the implementation of ICT in agriculture sector in India has been beneficial for farmers. In India, agriculture is the most prominent industry which employs more than 50% of the country's population and has major share in the country's GDP. In spite of it being such a vast market, the farmers are committing suicides due to various farming reasons including lower price for their harvest. The procurement process through the marketplace or mandis lacks ICT intervention and is not transparent. Farmers remain deprived of correct price for their harvest, and traders often exploit their distress. Government of India is aiming to double farmers income by 2022-23 and seeks to build a more transparent system to help farmers get visibility into the process and protect them from trader's manipulation. In our study on six crops traded in these mandis, we analyse prices quoted by traders in various auctions for four months. Findings suggest that computerised markets show significant improvements in prices discovered. Results further indicate that reference points of farmers and traders influence pricing. Transparency allows the marketplace system to achieve better price revelation of commodities.

Keywords: *Information and communications technologies for development, Computerized Auction, agriculture supply chain, true price revelation, procurement, price discovery*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 26

Duopoly Airline Network Design Decisions: A case of Co-opetition

Ankit Sharma

Operations Management Group, Indian Institute of Management Lucknow

Abstract

With growing aviation market and increasing demand for air travel, a number of airlines operate between every origin to destination pair (OD), leading to price wars and lower margins on one end and ever growing operating costs on the other. The study develops a two staged formulation for duopoly cooperative single allocation hub location problem (DCSAHLP). Two players that initially operate in separate networks collaborate with each other for establishing links between these networks for overall market expansion and simultaneously compete with each other on the newly established routes for gaining individual market share. This co-opetitive setting give rise to opportunities of not only gaining additional revenue but also reducing the operating costs of the participating players. The methodology adopted is solving an integer programming formulation in the first phase to establish the individual hub and spoke network for the two airlines followed by a second phase where a profit maximizing all pair shortest path hub level network is solved to derive the most profitable links to connect the two networks. The study analyses the resultant profit margins of both the players in the cooperative setting and the implications of designing cooperative networks in the aviation sector.

Keywords: *Hub location problem, competition, integer programming, network design, airlines*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 27

The PRV Problem – Solution and Extensions

S Rahul and G Srinivasan

Department of Management Studies Indian Institute of Technology Madras

Abstract

This paper addresses the Product Rate Variation (PRV) problem (Miltenburg, 1989). This problem has wide application in JIT systems where schedules are created to minimize variation in product rates so that at any point the corresponding proportion of the demand is manufactured for all the products. This problem has been shown to be NP-hard (Kubiak, 1993) and several researchers have proposed heuristics to solve it. In this paper we present a branch and bound algorithm and a heuristic algorithm to solve the PRV problem. We propose a lower bound based on the properties of the PRV problem and extend it to a given partial sequence and develop a branch and bound algorithm. This algorithm has been tested on problems up to size 40 and takes less than 1 second CPU time for the cases that we could solve optimally. The heuristic algorithm has been tested on problem sizes up to 5000 jobs and gives less than 1% deviation from lower bound. We also establish application of the PRV problem in round robin tournament scheduling such as in Cricket World cup and the IPL. We discuss the applicability of this idea in job interview scheduling problem. We also propose an alternative objective function to PRV. The objective is to minimize Earliness given start and end due dates for the jobs and ensuring that all jobs are completed within the end due date.

Keywords: *Product rate variation (PRV), JIT, NP-hard*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 29

Learning in a closed loop supply chain

Pinakhi Suvadashini, Somdeep Chatterjee, Indranil Biswas

IIM Lucknow

Abstract

Many firms worldwide have adopted refurbishment owing to its economic and environmental benefits. Motivated by the growth of original equipment manufacturer (OEM) affiliated refurbished used-car firms in India like Maruti True Value, Mahindra First Choice, Toyota U trust etc., we try to develop a stylized model to investigate the impact of cost learning effect in a closed loop supply chain performance. We model a collection system, in which a third party firm (TRP) authorized by the OEM collects the returned products directly from customers, the OEM refurbishes the products and later the TRP sells it in a secondary market channel. We consider a multi-period game, where the OEM undergoes cost reduction in the refurbishment operations due to the cost learning effect. Similar to manufacturing operations, refurbished industries in a closed loop supply chain also consists of repeated operations and labour-intensive tasks. This points towards the presence of cost learning effect in refurbished firms. Through this study, we try to examine how the cost learning rate impacts the OEM's production decision, pricing strategies for both the new and refurbished products both in a centralized and a decentralized case. We also investigate the equilibrium strategic decisions in the presence of competition among the OEMs.

Keywords: *Refurbishing, cost learning effect, used cars, game theory, closed loop supply chain*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 30

How many people in your party? – An experimental research to predict consumer demand in restaurants

Dr. Bidhi Kashyap, Dr. Ranjith P. V.
CMS Business School, Jain University

Abstract

“What makes a customer come to my restaurant?” “How many customers can I anticipate today?” “How can I entice more people to come in?” – these are probably some of the questions that probe a restaurant owner into designing his restaurant’s marketing strategy. Marketing efforts play a vital role in predicting and influencing demand which in turn contributes towards the restaurant’s production planning. The current study is an attempt to predict consumer demand based on the marketing efforts made by quick-service restaurants. Restaurants are part of services industry and as such, the 7Ps of marketing has been considered in the study to comprise of marketing efforts. Stimuli has been introduced to represent each element of the 7Ps to constitute 7 unique experiments. This helps in focusing on the impact of each marketing initiative independently and shed light on its effectiveness. Experimental observations of choice have been used to derive insights into the marketing efforts made by a restaurant. Further, the data has been analyzed using discrete choice model in econometrics, translating into multinomial logit choice model to forecast the potential demand of a restaurant.

Keywords: *Forecasting demand, 7Ps, restaurant*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 32

Multi-Channel Closed-Loop Supply Chain Models with Product Remanufacturing

Dhanshyam Mahavadi, Indranil Biswas and Samir K Srivastava

Indian Institute of Management Lucknow

Abstract

Remanufacturing used products into equivalent new ones has been an important research area in the closed loop supply chain literature. Previous studies which address the issues such as choice of appropriate reverse channel structures, corresponding choice of the collection efforts by the agents, and the differential investment by the agents, reveal the supply chain profit advantage due to joint optimisation of the forward and reverse chains. In this paper, we extend the logic to multi-agent system comprising of a single-channel forward chain and multi-channel arrangement for used product collection, with manufacturer undertaking the remanufacturing. Given the relative cost advantage of remanufacturing, the manufacturer wishes to maximise the total collection. We consider two simultaneous reverse channels – (i) retailer and (ii) a third-party vendor who invest in collection of used products, and sell them to the manufacturer, against a per unit transfer payment. By modelling the manufacturer as a Stackelberg leader, we estimate the unit prices, respective collection efforts, profits of the agents, and the total supply chain in case of a wholesale price contract. The comparison of these outcomes with those of the benchmark centralised case shows significant loss of total supply chain surplus, necessitating appropriate coordination mechanisms. We illustrate how a cost-sharing contract in the reverse chain where the manufacturer shares the variable cost of collection results in supply chain coordination in the form of increased total collection, remanufacturing percentage, reduction in the wholesale and retail prices, and improvement in supply chain profits.

Keywords: *Multi-channel reverse supply chains; closed-loop supply chains; remanufacturing; channel structure; sustainable supply chains*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 33

Renewable Energy Procurement Game in Developing Economy

Jaya Shankar Singh, Amit Agrahari, & Indranil Biswas

Indian Institute of Management Lucknow

Abstract

India is improving its energy mix to make it sustainable by reducing carbon footprint. In order to achieve this, India has set an ambitious target of producing 175 GW through renewable energy by 2022. India uses electronic reverse auction as well as feed-in tariff mechanisms to attract efficient investment in renewable energy sector. First wind energy procurement auction in India has led to a record drop in procurement tariff. Wind turbine manufacturers lost their trust in Indian government as aggressive independent power producers overpowered them. Across the world, similar phenomena have been observed in the context of renewable energy procurement where procurement agents enter into trade agreement in spite of having inherent mistrust about each other. However, the extant literature primarily focuses on mechanics of different price regimes. In order to model this mistrust among procurement agents we develop a dynamic game of incomplete information for renewable energy procurement. This game theoretic framework addresses the issue of trust between the government and an energy producer. Our model demonstrates that belief of the government about an energy producer's type motivates her to choose an appropriate price regime. The belief of an energy producer about the government's type motivate her to make appropriate investment decision. Finally, our model demonstrates that it is imperative for the government to build trust for attracting investment in renewable energy sector.

Keywords: *Renewable energy procurement, government, feed-in tariff, electronic reverse auction, game theory, trust*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 34

A Conceptual Block Chain Frame work for Optimal Automotive Supply Chain

¹Raj Kumar Reddy K, ²Dr. P. Kalpana

¹*Indian Institute of Information Technology Design and Manufacturing, Kancheepuram*

²*Department of Mechanical Engineering, Indian Institute of Information Technology Design and Manufacturing, Kancheepuram*

Abstract

Automotive supply chain is a complex network and results less effective in sharing real time demand and inventory details compared to other industries; it has issues with data duplications, inconsistency and redundancy. There is a lack of transparency in optimizing automotive parts visibility, Inventory management, routing the supply chain and traceability in logistics. Lack of visibility, high fixed and variable costs and the intermediaries impact profitability of the automotive manufacturers. Maintaining the intellectual property and licensing with enforcing agreements for an effective collaboration is still a challenge for an OEM. To contend with counterfeit parts and defect driven product recalls, traceability is crucial in understanding the vehicle's post scale moments in real time. To maintain safety and reliability, makers must be able to track vehicle movements for regulations and purchases. Impact of external factors significantly disrupts the automotive supply chain and it's every step is underpinned by payments.

In contrast to BCT (Block Chain Technology) applications in financial sector, the application of BCT in SCM is still in its infancy. The core value for financial applications is information security; whereas for SCM applications, it is system transparency and traceability.

Using BCT we can establish an end to end optimized supply chain with transparency, traceability and security; also it removes intermediation and necessary paper work leading to improved business efficiency. We can possibly have a supply chain which has faster transactions with distributed and equitable access to stake holders for monitoring quality of parts in real time in order to increase the efficiency of OEM products. BCT can also help us to have a better control on products to follow up with aftersales services and warranty.

Keywords: *Block Chain Technology, Supply Chain Management*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 35

**Status Evaluation and Characterization of Existing Waste Management System in
Kalyani- Kanchrapara-Gayespur city: A Case Study**

Rupak Sarkar, Ankita Ray

Maulana Abul Kalam Azad University Of Technology (WB)

Abstract

One of the most common problems in our society is how to manage municipal waste sustainably. The increasing population is a significant issue that increases difficulties in managing municipal solid waste. Former literature presented that many developing cities in India already adopted a different approach to control this environmental demon. This paper focused on waste management practices in Kalyani, Kanchrapara and Gayeshpur municipality covered by Kolkata Metropolitan Development Authority (KMDA) in West Bengal. Kalyani, a planned city is located on the bank of Hooghly River and it was famous for American Airbase during World War II, Industrial Belts. Kanchrapara city is known as “Mini Kolkata” and it is famous for the Railway workshop. On the other hand, Gayespur also is located on the bank of the Hooghly River and it is famous for small to medium manufacturing enterprises. This study aims to focus on the entire process of municipal waste management (MWM) practices and develop a framework based on the present situation of managing the waste of Kalyani, Kachrapara and Gayespur municipality. Meanwhile, this study also used “wasteaware” benchmark indicators for examining municipal waste management practices. The Matrix method used to support the “wasteaware” benchmark indicators in examining the existing methods. Finally, the objective of the work is to identify sustainable waste management practices in this area.

Keywords: *Municipal waste management (MWM) practices; Matrix Method; “Wasteaware” benchmarks*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper 36

**Determining The Importance Of Supplier Selection Process In Chemical Industry: A
Case Study**

Raj Shinde, Pushkar Morye, & Dr. Ashish Deshmukh

NMIMS, Mumbai

Abstract

Supply Chain Management is termed as an architecture of flow of products and commodities from the point of conception to the point of utilization. Supplier selection plays an important role in supply chain management as it takes several criteria under consideration for decision making that includes quality and quantity characteristics. In the recent scenario due to a rise in the competition, supplier selection influences the organizational success at a high rate. Environmental crisis in the recent years has grabbed the focus and inclination of the chemical industries in western countries to adopt the green factors which are not been the case with Indian chemical industries; as Indian chemical industries depend upon traditional factors for supplier selection in the supply chain. This research lays down the hypotheses which focus on traditional and green criteria of supplier selection in the chemical industry's supply chain management. Hypotheses are laid down based on five major criteria which include cost, quality, delivery, manufacturing according to environment requirement and environmental performance further having twenty sub-criteria. Based on these factors we developed a questionnaire. "Statistical Package for the Social Sciences (SPSS)" software was used to carry out reliability assessment. The results obtained confirmed the internal consistency and further based on means and standard deviations a test was carried out.

Keywords: *Supply Chain Management, Supplier Selection Process, Reliability Assessment*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 37

Cyber-risk assessment model for DDoS attacks using data mining methods

Kalpita Sharma, Arunabha Mukhopadhyay

Indian Institute of Management Lucknow

Abstract

Malicious hackers resort to Distributed Denial of Service (DDoS) attacks to disrupt business globally, by preventing legitimate users from accessing the original website. Last year alone the financial cost of a DDoS attack ranged from US\$120K to US\$2M, including direct and indirect losses. In 2018, DDoS attacks were 37% larger in size than the previous year. DDoS attacks flood the network with data packets as large as 300 Gbps to overwhelm the routers and servers. But in most cases, these attackers use any army of botnets, which carry out the DDoS attack. Thus, it is difficult to detect the attacker and prevent the attackers in future. In this study we wish to investigate the following: (a) what is the probability of correctly identifying a DDoS attack, (b) what is the expected loss due to a DDoS attack on an organization, and (c) how can an organization mitigate a DDoS attack. In this study, we use a dataset of DDoS attacks reported by a globally reputed Content Delivery Network (CDN). We employ data preprocessing steps such as hierarchical clustering and k-means clustering to divide our data into an optimal number of classes to increase class wise as well as the overall accuracy of the classifier. We use a Naive Bayes classifier that provides us with the probability of such an attack happening across different industries. In addition, we calculate the expected loss or opportunity cost that firms have to bear when under such an attack. Subsequently, we suggest ways to mitigate the losses occurring due to restricted access to your firms cyber- resources when under a DDoS attack.

Keywords: *Distributed Denial of Services (DDoS), Content Delivery Network (CDN), Naive Bayes Classifier*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 38

A model to identify predictors of demand for regional air-transport

Amit Kumar Das, Amit Kumar Bardhan

Faculty of Management Studies, University of Delhi

Abstract

Government of India has implemented Regional Connectivity Scheme (RCS) to increase civil aviation footprint in India. The scheme offers subsidy to air carriers to offset potential operating loss for flying to remote and regional airports. It is envisaged that, the scheme would stimulate demand growth and eventually, the routes can be left to the market forces. Since 2016, the scheme has added many unserved and underserved airports to the national network. Under the scheme airline companies have to bid for routes and winner is decided based on minimum subsidy sought. Over the last two years, some routes are steadily operating. There are also a few routes, which have ceased operations. It is becoming evident that a correct estimate of passenger demand is important for service providers as well as for the sustainability of the scheme.

The process of predicting demand for new routes starts with identification of its drivers. The objective of this paper is to find predictors of demand for air-transportation on regional routes. This topic has received little attention in comparison to demand prediction for mainstream routes. We propose a model, which is based on evaluation of relationships of the demand for regional aviation with macro and micro factors viz. population, economic wellbeing, distance, travel time, airfare, level of Service, availability and quality of alternatives etc. We also tried to measure influence of tourism and religious travel potential, industrial and strategic location advantage of cities having airports under RCS. The model was validated using secondary data on passenger demand, and variables for economic and transport related factors. From analysis of data using the proposed model, a number of implications emerge and these are critically analysed in the article.

Keywords: *Regional Connectivity Scheme (RCS), Demand, Regional, Sustainability*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 39

Analysis of impact of collaborative mechanism on sustainability in Indian Automobile Industry

Debopriyo Mukherji, Ankita Ray

Maulana Abul Kalam Azad University of Technology (WB)

Abstract

In current market condition uncertainty is one of the issues in supply chain management in India. Companies are facing tough competition, so for decrease the lead time and improve the product variety and delivery process collaboration may be the solution. Now days reverse supply chain gained considerable attention from manufacturing industries as sustainability in terms of environmental and social value is related to the manufacturing process. In case of collaborative supply chain, manufacturing organizations establish healthy relations with other supply chain members to improve economic performance, environmental duties as well as societal values instead of involving in competitive business environment. In this study, we focused on impact of collaborative reverse supply chain on the overall growth of the product recovery activities of the organizations. In this paper, we used survey method to study different automobile industries that perform product recovery activities and already involved in collaborative system or wanted to implement collaborative reverse supply chain in Indian context. This study also investigated the impacts (beneficial and adverse sides) of collaborative reverse supply chain on sustainability.

Keywords: *Reverse supply chain; Collaboration; Survey method; Automobile industry*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 40

Analysis of Issues of ELV management in India: A Fuzzy Analytical Hierarchy Process Approach

Sima Kundu, Ankita Ray, Bivash Mallick,

Maulana Abul Kalam Azad University Of Technology (WB)

Abstract

In today's developing world most of the industry is lagging due to scarcity of materials and facing challenges in meeting that demand. Demand of resources increased in automobile industry also. The ELV (end of life vehicle) can meet the demand by renewing and recycling the material. Arora et al. (2018) identified the issues related to ELV recovery in India. In this paper we analyse the issues for an automobile company that focuses on product recovery activities. In this study we used Fuzzy Analytical Hierarchy Process method to prioritize the issues based on expert's opinion. The findings of this paper helps to take necessary steps to remove the boundaries of ELV recovery management of automobile sector in India.

Keywords: *ELV Management; Fuzzy AHP; Automobile industry; Product recovery*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 41

Impact of Airport Congestion on Airline Profitability

Harshit Sharma, Suresh K Jakhar

Indian Institute of Management Lucknow

Abstract

One of the major challenge which the aviation industry is currently facing is reducing the congestion in major airports. The existing airport facilities, especially at hub airport, are much smaller to accommodate the huge number of passengers and cargo, especially at the peak hours leading to lost sales and decrease in overall efficiency of the process. The study aims to understand the impact of this airport congestion on Airline profitability by utilizing secondary data to develop a relational model between airline profitability and factors effecting the same including the congestion at the airport, their relative importance and to give recommendations to overcome this problem.

We will be conducting secondary research utilizing tactical reports from platforms like Bloomberg, Gartner etc. along with HBR articles to develop a thorough understanding of the aviation industry and following the latest news articles. The research will be utilizing the articles concerning economies of airport concession pricing considering the cases when the carries are asymmetric and how is inefficiency in slot allocation is effecting the overall profitability of the industry to highlight the white spaces and how we can overcome the same to increase the overall profitability.

Keywords: *Airport Congestion, Airline Profitability*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 42

Implementing lean thinking in e-commerce industry – An Exploration

Deepak Srivastav, Anand Gurumurthy

Indian Institute of Management, Kozhikode

Abstract

The philosophy of Lean Thinking (LT) has been in existence for the last five decades. In the past, LT has provided a framework for improvement for many manufacturing organizations. However, in recent times, successful implementation of principles and practices of LT can be observed in service industries such as healthcare, retail banking, software, and airlines. The meteoric rise of the e-commerce sector has resulted in increased competition and hence have opened a new horizon for application of LT. Hence, this study aims to explore and understand the application of LT in detail within this upcoming sector. A systematic literature review was carried out to identify the relevant papers, understand the current status and thereby identify potential areas for research. The review revealed that although e-commerce sector follows certain practices, which are inherently aligned with certain principles of LT, there exist further scope of research. Specifically, LT can be applied in key functions of an e-commerce firm (that operate under the marketplace model) such as supplier selection, procurement, inventory management, warehousing, logistics, and delivery, which incur a huge cost. Further, it also identifies potential tools and techniques of lean, performance measures, which are commonly used in this domain of the service industry.

Keywords: *Lean thinking, Service sector, E-commerce, Literature review*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 43

Quality and Pricing Decisions of Web based Applications

¹Sunanda Katewa, ²Tarun Jain

¹Indian Institute of Management, Udaipur, ²Indian Institute of Management, Ahmedabad

Abstract

There are a lot of applications available in the market place for a given use but they all need some platform to work on in order to provide services. The applications launched on these platforms which are developed by an independent developer are known as third party applications. In order to use these platforms, these independent app developers are abided by the contract where they need to pay a platform fee. Additionally, the platform owners themselves launch applications on their platform, which acts as an alternative to the third party applications to consumers.

Since there is a competition among apps, both the app developers try to attract a greater number of consumers by enhancing their app quality. We have considered such quality improvement efforts by these app developers. Further, we have considered one more scenario where the platform owner can affect the quality of the third party app. Platform owner can help the third party app developers in improving their app quality and thus, the business of third party app developer.

The key insights which we got from the paper are as follows:

The quality decided by the players may increase or decrease with the contract parameters. We also find that the profit of third party app developer may increase or decrease with contract parameters. We provide new insights on the relative quality decisions of both third party app developer and platform firm.

Keywords: *Quality, Pricing decision, third party applications*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 44

**Information Preferences in the Supply Chain under Strategic Inventory and Demand
Uncertainty**

¹Abhishek Roy, ²Stephen M. Gilbert, ²Guoming Lai

¹*Department of Marketing and Supply Chain Management, Fox School of Business, Temple
University, Philadelphia, Pennsylvania, USA*

²*Department of Information, Risk, and Operations Management, McCombs School of
Business, The University of Texas at Austin, Austin, Texas, USA*

Abstract

This paper investigates the information preference of the two supply chain parties in a single supplier-single retailer channel, where the downstream retailer may hold strategic inventory. Prior literature that studies strategic inventory has typically assumed deterministic demand and observable inventory, while the literature that studies supply chain information strategies has often been based on a static setting. In our study, the supplier and the retailer repeatedly contract in two periods using linear wholesale prices under uncertain demand, where the retailer privately learns the demand information from the sales. Two information setups are considered: under full-information, the supplier knows the retailer's sales and can observe the retailer's inventory; under no-information, the supplier neither knows the retailer's sales nor can observe the retailer's inventory.

We find that in both information setups, the retailer continues to hold inventory in equilibrium and the supply chain benefits from strategic inventory. Interestingly, we find that in contrast to the typical findings in the information sharing literature, the supplier prefers not learning the retailer's sales and inventory information when the demand uncertainty is low, while the retailer prefers complete information sharing. We find that the information asymmetry moderates the level of strategic inventory. However, when the demand uncertainty is high, the preferences change; the retailer prefers not sharing the information, while the supplier's preference for no-information decreases with the increase in demand uncertainty. There exists a range of demand variability for which both the supplier and the retailer prefer not sharing the retailer's sales and inventory information.

Keywords: *Strategic inventory, game theory, supply chain coordination, private information*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 45

Assessment of various work-related musculoskeletal disorders among the construction workers in West Bengal, India

Koushik Bag, Sibamay Dasgupta

IEM, Maulana Abul Kalam Azad University Of Technology (WB)

Abstract

The construction industry is one of the fast-emerging industries all over the world. A lot of construction projects are also happening in developing countries like India. The work done in those sites are mostly physical work-related. Most of the workers in these industries are subjected to continuous manual loading which creates various musculoskeletal disorders(MSD). The objective of this study is to assess the various MSDs on Indian construction workers and understand its root causes. Questionnaires were designed to collect first-hand data on MSD along with various working postures on 25 male workers in a construction site located in West Bengal. On analysis of data, it was found that the reasons for the MSDs were due to repetitive tasks, heavy manual loading which affected the occupational health of the workers and wrong postures. The outcome of the survey resulted in understanding several MSDs including lower back pain, shoulder and neck pain, pain in various joints in the body. Both the workplace and work-rest schedule must be reorganized to reduce the physical stresses on the worker's body.

Keywords: *Construction; work-related; manual loading; musculoskeletal disorder; MSD; occupational health*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 46

A Lagrangian approach for solving the Team Orienteering Problem with Non-Identical Agents

Shuvabrata Chakraborty* and Yogesh K. Agarwal

Indian Institute of Management Lucknow

Abstract

The Team Orienteering Problem (TOP) is one of the most widely studied variants of the family of Vehicle Routing Problems with Profits. In this variant, a team of agents is required to serve a subset of given customers such that each customer is served by at most one agent. A reward or profit is typically associated with each customer, and a travel time restriction is imposed on each route from origin to destination. The objective is to find a set of routes for the agents such that the total profit collected from the visited customers is maximized. The classical TOP in literature has considered the service by a team of only identical agents, however, for practical applications, a team of non-identical agents is very much relevant. An interesting example of such a scenario is an election campaign where a team of non-identical campaigners has to canvass at different locations subject to constrained time durations available to each campaigner. The team of agents in such cases can have several aspects of heterogeneity such as different maximum allowable time limits, different travel times between the nodes, and different rewards that each agent can collect from the same customer. In this paper, we explore a Lagrangian approach to solve the TOP with non-identical agents. The proposed methodology promises not only high-quality solutions within a reasonable time but also a firm measure of the quality in the form of duality gaps. The effectiveness of the algorithm is demonstrated through computational analysis.

Keywords: *Team Orienteering Problem, Non-identical, Heterogeneous, Lagrangian Relaxation, Heuristics*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 47

An Internal Credit Scoring Model for SMEs using BWM and TOPSIS

P. K. Roy, Dr. Krishnendu Shaw

Department of Management Studies, Indian Institute of Technology (ISM), Dhanbad

Abstract

SMEs have played a major role in the development of any economy. However, easy access to the formal source of finance from banks/FIs has remained a key challenge to them. Similarly, banks/FIs have also faced difficulties while selecting potential SMEs. Credit scoring models are used by banks/ FIs to find potential borrowers, pricing of its products and requirement of collateral. However, internal rating-based approaches got significant importance after Basel- II recommendation of using it to measure capital requirement. Analyzing the creditworthiness of SMEs not only depends on its financial parameters but also on non-financial parameters. Researchers have developed models mainly based on financial parameters. Realizing the relationship between credit granting and non-financial factors of SMEs, in this study, a credit scoring model has been proposed based on a novel Best Worst Method, using both financial and non-financial factors. In a three-phased proposed model, after finalizing the criteria based on its appearance in literature and extensive discussions with industry experts, BWM has been used to calculate the weight of criterion. The credit standing of applicant SME has been derived from the basis of distance to default using TOPSIS. The proposed model is applied to a large sample of SMEs to evaluate their correspondence ratings. The results are compared to their latest available external rating. The results indicate that the proposed model shows its accuracy to predict the creditworthiness of SME applicants. Hence, it can be helpful to rate the SMEs, consequently, banks/FIs can utilize the model for their internal rating purpose.

Keywords: *Credit Scoring Model, SMEs, Banks/Financial Institutes, Best Worst Method (BWM), TOPSIS*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 48

**Measuring Sustainability Efficiency of Fast Moving Consumers Goods Companies using
DEA Model**

Vijayta Fulzele

*Department of Decision Sciences, operations Management & Information Systems School of
Management & Entrepreneurship Shiv Nadar Univerity Uttar Pradesh*

Abstract

Sustainable management involves balanced emphasis on economic, environment and social aspects of the businesses. In fact, it demands approaches that can develop and integrate new performance goals with the company's traditional performance management system. While the companies are setting sustainable goals and implementing sustainability practices but their overall impact on the business processes remains partially known. Further, the challenge with the businesses is to swiftly respond to the increasing market competition introduced by the business leaders in terms of sustainability. This requires benchmarking tools that can constantly monitor and contrast the relationship among the organizations. In this context, this study provides a benchmarking tool known as data envelopment analysis (DEA) that can measure and rank various organizations on the overall sustainability performance. The study ranks the organizations that are involved in producing and selling fast moving consumers good (FMCG) in the Indian market. The DEA model used in this study has the capability to deal simultaneously with different dimensions of the sustainability and conduct multi-period efficiency evaluations. This benchmarking model will help the FMCG industry of the Indian market to improve their overall share in the sustainability principles. The results show that FMCG companies that have good brand reputation in the market have achieved higher level of sustainability as compared to their peers in the industry.

Keywords: *Sustainability, Benchmarking, Data Envelopment Analysis (DEA), Fast Moving Consumer Goods (FMCG)*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 49

Wireless Charging of Electric Vehicle

¹Ajoyjit Ghosh, ²Pranjit Kumar Roy

¹*Maulana Abul Kalam Azad University Of Technology (WB), ²Jalpaiguri Government
Engineering College*

Abstract

Electric vehicle (EV) is the future of transportation system in our world. It causes lesser emission which helps to reduce pollution and greenhouse effect. Charging is one of the big issues of EVs. Wireless charging (WC) is the new technology in charging EVs. In this type of charging no plug is used to connect with the vehicle. Here the charging is automatically start after the vehicle is placed over the transmitting coil. This type of charging can be used in parking spot, shopping mall. Here two coils are used, transmitting coil is placed at the ground of the charging station and receiving coil is placed at bottom of the chassis of EV. The transmitting coil will connect the power supply of charging station. The charging station is connected to main grid. Power is taken from grid. Then it is connected to AC/DC converter, after that it is fed to DC/high frequency AC converter to finally fed the power into the coil. Here we use AC charging because though it is a slow charging process but the loss is very less compared to DC charging. On the EV side a receiving coil is placed in the bottom side of the chassis. Here this coil is connected to AC/DC converter to store the power in battery. The Wireless power transfer is of four different types like inductive, capacitive, permanent magnet and resonant inductive. In the wireless charging we connect the grid into EVs via some high frequency power electronic devices like inverter, converter and rectifiers. Here I compare all the different types of charging and which is the most suitable in our country.

Keywords: *Electric Vehicle, Wireless Charging, High frequency converters, Wireless power transfer, Vehicle to grid*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 50

**Determinants of Customer Satisfaction on Service Quality of State Road Transportation
Sector of Eastern India**

Mainak Das, Mainak Ghosh, Sourav Das, Bivash Mallick

Dept. of Industrial Engineering & Management,

Maulana Abul Kalam Azad University Of Technology, West Bengal

Abstract

In today's competitive age, it is highly necessary to use quality management tools & methods efficiently and effectively to gain an extra edge over others. In last few years, approach to quality has changed from inspection level to strategic level. Especially in the field of public services, quality should be managed strategically to enhance customer satisfaction. Considering the public transportation sector of India, where the environment is intensively competitive, state transport organizations need to have a better understanding of the expectations, requirements, and priorities of their customers for serving them in the best possible way. That is why the need for measuring quality of service within this sector has increased its importance significantly. It is to remember that basic quality management tools and techniques have develop gradually from the manufacturing and production industry. User satisfaction can be significantly improved if quality management tools can be applied with proper adaptation of these tools and techniques taking into consideration about the special features of the applied sector that is transportation in this case. This research finds out the determinants of service quality using modified SERVQUAL scale adapted for state road transportation especially bus services of Eastern part of India namely, Bihar, Jharkhand, Odissa and West Bengal and analyses the gap between expected service and perceived service. Further, this also proposes a framework to improve the service quality of those bus services.

Keywords: *Transportation; quality; SERVQUAL*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 51

**A Conceptual Framework for Using Location Allocation Model to Optimise the Inland
Water Port- Dry Port River Logistics Infrastructure System**

Prayash Baruah, Tridib Ranjan Sarm

Department of Business Administration, Tezpur University

Abstract

Owing to its overall cost effectiveness, water transport has emerged as the focal point of infrastructure investments for the developed and developing nations of the world. In this context, it must be noted that the sea logistics infrastructure system for most countries is significantly developed as compared to the inland water network system and relative to other modes of domestic transport, inland water transport is largely unutilised. However, as far as inland water transport (IWT) investments are concerned, a lot depends on building the correct linkages for IWT ports and multimodal/intermodal facilities such as dry ports, container depots and so on. A dry port provides extended connectivity and terminal capacity increase to IWT ports and thus, location of dry ports plays an important role in optimising river logistics infrastructure system. In this paper, an extensive review of existing literature on the quantitative models used for optimising seaport/inland water port-dry port network system has been carried out and among these models, location allocation model which is primarily used for identifying optimal locations using various factors such as routes, distances, proximity has been found to be highly effective. The basic parameters identified through comparison of various research findings related to location allocation analysis can be extrapolated to fit specific requirements. By developing a conceptual framework, the key parameters and usability of location allocation model pertaining to a particular geographic scenario can be assessed and this can serve as guidance for policy makers to consider while making investment decisions for inland water infrastructure.

Keywords: *Location allocation model; inland water transport; water logistics; dry ports; logistics optimisation model*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 52

Knowledge Worker Productivity: The Obscure Perception

Abhay Joshi

Abstract

Customers seek to optimise the value they get from products and services by maximising cost benefits, therefore to a certain extent, may contribute to the factors that influence the market price. In today's open and immensely competitive market economy, to produce goods or services, it is impossible to retain technological edge, and or material; equipment exclusivity. This leads to an intrinsic focus to achieve higher and higher output value with lesser and lesser input value in terms of cost, quality & time; in other terms higher productivity. For repetitive activities (like manufacturing of product) enough research has been done and universally accepted framework has been defined to measure, optimise and standardise the work methods, to achieve higher efficiency. Although the research so far indicates knowledge worker productivity (Office Productivity) is not easy to establish and until now there isn't any unanimously approved framework.

Keywords: *Perceived productivity, productivity, knowledge worker productivity, office productivity, efficiency, workplace productivity*



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XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 54

Critical Success Factors across Industry Sectors of Indian Public Sector Projects

Debabrata Samanta¹ Gourav Dwivedi²

¹*AIMA-AMU (All India Management Association - Aligarh Muslim University)*

²*Department of Management Studies (DMS), Indian Institute of Technology Delhi*

Abstract

Projects from Construction, Information Technology (IT) / Information and Communication Technology (ICT), Enterprise Resource Planning (ERP) and Public Private Partnership (PPP) differ in terms of size and scope, still there are certain similarities in project management processes. Therefore, finding Critical Success Factors (CSFs) across various such projects is interesting, this paper aims to bring together those critical success factors. The research is explicitly focused on identifying and comparing CSFs based on literature review and input from the field experts. The CSFs such as vision, top management support, communication are considered most common critical success factors across projects. However, our study also identifies that there are other CSFs which are not common across different sectors. Exploring such success factors both common and unique ones from various sectors will enable management to apply it for better planning on sector specific future projects. This revelation will facilitate project managers in designing the project execution methods by developing success criteria and monitoring the same, thus maximizing project success for projects of any size from any sector. To the best of the authors' knowledge and from a limited review of literature, no study seems to have adopted a similar perspective to present comparative analysis of CSFs across industries for public sector projects.

Keywords: *Critical success factors; public sector organizations; developing economy*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 55

**Boosting Technological Innovativeness in Indian Manufacturing SMEs: A Novel
Approach**

Anup Chawan and Hari Vasudevan

Dwarkadas J. Sanghvi College of Engineering, Mumbai 400056, India

Abstract

Technological innovativeness and firm performance have not been discussed much in the context manufacturing Small and Medium Scale Enterprises (SMEs) in India. This study was conducted in the context of manufacturing SMEs and it revealed the importance of technological alliances for arriving at better firm performance. The attempt has been to explore as to how effectively a mobile based application can enhance the technological innovativeness of Indian SMEs for better firm performance. The study shows that the SMEs engaged in different sectors should be made aware of how they can be benefited through different type of technological alliances to stay competitive in the market. There is a need to identify firms engaged in technology development around the globe for future planning of technological alliances. The mobile based application should explore the core technologies available as well as that are not available in India. It should also explore technologies developed by Indian research institutions. There is also a need for SMEs to identify technology related educational courses available across the globe. The study recommends the need for providing help-desk centers in different states to assist the SMEs in forming technological alliances. SMEs must also emphasize on design innovativeness and process innovativeness to stay ahead in global competition.

Keywords: *Technological innovativeness; technological alliances; small and medium scale enterprises (SMEs)*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 56

Modeling and Analysis of a Financially Constrained Supply Chain

Bhawna Priya, Indranil Biswas

Indian Institute of Management Lucknow

Abstract

This work models a dyadic supply chain with a financially constrained (FC) retailer facing stochastic demand. To fund the cash deficit, the retailer borrows money through bank loan or trade credit. In trade credit, supplier establishes a credit line wherein the retailer is given a window to make payment and the wholesale price for postponed payment is higher than upfront cash payment. Given the credit terms, the retailer decides optimal stocking quantity and the amount to be borrowed and thus finances the inventory with a mix of her own equity and credit amount. The developed model replicates the financing strategies followed by prominent online retail firms and provides insights on the optimal stocking decision of a cash constrained retailer. Additionally, we have incorporated limited clearance sale strategy for leftover inventory wherein a portion of leftover is salvaged at predetermined price and remaining inventory is bundled with other products for sales promotion. This kind of clearance sale helps in controlling excessive brand dilution often associated with the practice of deep online discounts. We present numerical results to illustrate that a FC retailer can earn higher profit by using limited clearance sale strategy compared to fixed salvage for leftovers. Finally, we develop channel coordination mechanism using buyback and revenue sharing contracts. The supplier can achieve channel coordination only under full information setting wherein he has information on retailer's equity and borrowing rate.

Keywords: *Financially constrained; newsvendor bank; loan; trade credit; limited clearance sale inventory; coordination; contracts*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 57

Carbon Footprint Implications of Demand and Supply Uncertainties in Supply Chains

Vikas Kumar, Debadyuti Das, Amit Kumar Bardhan

Faculty of Management Studies, University of Delhi, India.

Abstract

Bullwhip Effect is experienced due to supply chain uncertainties. It increases consumption of natural and financial resources of the supply chain, thereby adversely affecting its environmental and economic performance. Economic consequences of bullwhip effect are well researched, whereas study of environmental consequences is a growing area of active research. It is worthwhile to understand whether efficient supply chains are greener, in terms of carbon footprints, than supply chains characterized by high level of responsiveness.

In this paper, carbon emissions of two most important logistical activities i.e. warehousing and transportation, are considered. Sources of carbon emissions of the logistical activities under study have been identified by adopting an elementary approach. A quantitative framework has been devised for a four tier linear supply chain for calculating various supply chain metrics and related carbon emissions. Simulation experiments have been carried out in MATLAB to study how variations in inputs for supply chain decisions viz. demand, lead time, etc. affect its carbon emissions.

Preliminary results show direct relations between carbon emissions, cost and uncertainties present in the supply chain. It is also shown that through certain operational adjustments, significant savings in carbon emissions can be achieved with only marginal increase in supply chain cost. An analysis of data from tendering of regional air transportation service.

Keywords: *Carbon footprint, carbon emissions, Demand and Supply Uncertainties, Supply Chains*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 59

**An Analysis of Data from Tendering of Regional Air Transportation Service and its
Implications**

Amit Kumar Bardhan and Amit Kumar Das

Faculty of Management Studies, University of Delhi, Delhi

Abstract

Three rounds of tendering have been undertaken since 2016, by the ministry of civil aviation, the government of India for air transportation routes connecting regional and remote locations in the country (Regional Connectivity Scheme, RCS). For established airlines who can participate in the tendering, the rules are not simple. Bids are decided among other things based on the subsidy demanded per passenger flown. Bidder seeking the minimum subsidy wins and winning probability is higher if bids are made for a network of routes vis-à-vis individual routes. Moreover, airlines are obligated to allocate part of their capacities to these routes (airports) under regulatory requirements known as Route Dispersal Guidelines (RDG) which is supplementary to the scheme governing the tendering. Still, the number of large airlines participating and winning the exclusive rights to fly RCS routes have increased. This trend is unlike those observed in other regions e.g. USA, Europe etc.

In this article, we critically evaluate the tendering process, specifically the effectiveness of subsidy cap (limit on subsidy offered per seat), the invitation of counter bids and route vs. network options. Large airlines adopt a hub and spoke strategy for their operational efficiency. Though this strategy helps passengers offers passengers more frequent connectivity, studies have shown, it could also increase airfares in the long run. Based on data from RCS tendering we analyse the bidding strategies of large airline operators and their operating policies. Results provide important implications for achievements of RCS objectives and sustainability of the scheme.

Keywords: *Regional Connectivity Scheme (RCS), Route Dispersal Guidelines (RDG), efficiency*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 60

**Reducing Patient Waiting Time in a Primary Health Network Using Location-
Allocation Model**

Kaushal Kumar, and Amit Kumar Bardhan

Faculty of Management Studies, University of Delhi, Delhi

Abstract

In a developing country like India, congestion at public health facilities is a common experience. Due to the excessive load, the quality of healthcare also suffers. Interestingly, it is not uncommon to find facilities that are under-utilized. Many patients, therefore, visit private practitioners or facilities located at far-off places. As a result, they incur large out-of-pocket expenses towards travelling, consultation, medicines, diagnostic services, loss due to foregoing work etc. Published surveys have found out-of-pocket expenses constitute a major portion of household incomes in India and the economically weaker section is most affected by it. This is a hurdle towards the achievement of universal health care and policies directed towards reducing congestion at public health facilities should be implemented.

In this paper, an optimization model is proposed, which will assist decision-makers to efficiently manage capacity for reduction of congestion at facilities. The decision problem considers the reallocation of resources based on patient choice behaviour. The model also includes the option of engaging private players into the health care system under a public-private partnership. Numerical experiments are conducted to validate the model and draw management implications.

Keywords: *Public health; facility location; out-of-pocket expenditure; public-private partnership; waiting time*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 63

**A Clarke and Wright Based Heuristic Approach for Implementing Recall of Utility
Products**

Soumya Vaithinathan, Yogesh Agarwal, and Samir Srivastava

Indian Institute of Management Lucknow

Abstract

A product is recalled when it is unsafe to use it in its existing form due to some defect. A recall is often accompanied by a remedy such as free repair, replacement, refund etc. We focus on recalls of utility products such as automobiles, mobile phones, laptops etc. Since these products are used extensively, their absence causes immense inconvenience to the customer. Hence, instead of asking the consumers to take the product to a dealer location, the firm may decide to offer repairs at the choice of customer location. The affected consumers are asked to provide two locations along with respective time windows for which the product will be available at those locations. For example, the customer's car/laptop may be at his office in the mornings and home in the evenings. To implement the repairs, the recalling firm has to arrange mobile repair vans which contains repair tools/components and the repairman. The firm has to ensure that the mobile vans visit each customer at one location while satisfying constraints imposed by time windows at customer location and work hours of the repairman. Thus the firm has to decide how to pick the customer location and in which order to visit the selected customer locations so that minimum number of mobile repair vans are required. We solve this variant of Vehicle routing problem with time windows of selecting one out of two locations by using a heuristic approach based on Clarke and Wright algorithm.

Keywords: *Vehicle routing with time windows; product recall; Clarke and Wright based heuristic*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 64

A Multidimensional Healthcare Service Model for Service Satisfaction and Behavioral Intentions in Emerging Economies

Shailly Chaurasia, Anandakuttan B. Unnithan

Indian Institute of Management Kozhikode

Abstract

Health Care sector is the fastest growing sector in service economy such as India. Furthermore, it is progressing by leaps and bounds in developing nations due to increase in economy, percentage of aging population, increasing customer awareness, emerging trends and technologies. Hence, Service Satisfaction is of utmost importance in this area and better quality is essential for health services and hospitals. A conceptual framework for multidimensional network model has been introduced for better service quality to overcome previous models. Present research studies four primary dimensions for service quality such as interpersonal quality, technical quality, environmental and administrative quality. These dimensions included sub dimensions such as interaction, relationship, tangibles, outcome, expertise, operation, timeliness and support. Service quality behaved as a mediator between service satisfaction and behavioral intentions. This model validated a holistic view of model for Indian hospital with desirable Normed Chi-square value of 1.931 as good model fit. This research work is based on primary data findings developed and validated empirically to enhance health service quality in terms of service satisfaction, better quality perception and sustainable health care management in hospitals in emerging economics such as India.

Keywords: *Service quality; SERVQUAL; service satisfaction; behavioral intentions; structural equation modelling*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 66

**Deep Learning and Cross-Temporal Hierarchies Based Framework for Demand
Forecasting**

Sushil Punia, Surya Prakash Singh, and Jitendra K. Madaan

Department of Management Studies, Indian Institute of Technology Delhi

Abstract

This paper proposes the use of a temporal hierarchical framework as a strategy for forecasting in retail. The proposed framework uses the temporal hierarchies to generate short-term up to long-term coherent forecasts for a multi-channel retailer. For base forecasts for the hierarchical framework, we used deep learning with long-short-term-memory networks for time-series forecasting. We evaluated the performance of the proposed forecasting approach on point-of-sales data from a large multi-channel retailer. Several performance metrics and statistical test were employed to test the accuracy of forecasts from the proposed framework and evidence suggest significant improvements across all metrics.

Keywords: *Deep learning; temporal hierarchies; demand planning*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 68

Joint Optimization of Airline Pricing and Seat Allocation under Choice-Based Demand

Aparna Jayaram¹, R. K. Amit¹, Kavitha Balaiyan¹, Amit Agarwal², Xiaodong Luo³

¹*Department of Management Studies, IIT Madras, Chennai, India,* ²*Sabre Inc., Bangalore, India*

³*Sabre Inc., Southlake, USA*

Abstract

Although airline revenue management techniques have evolved to capture customer behavior, airline pricing and seat allocation continue to be implemented separately. We address this shortcoming by developing a non-linear optimization model in which product prices and their allocation quantities are both decision variables. We use the JFM-PA demand forecasting model proposed by Balaiyan et al. [Balaiyan, K., Amit, R. K., Malik, A. K. et al. 2019. Joint forecasting for airline pricing and revenue management. *J Revenue Pricing Management*] as the input to our model. We propose to solve the model sequentially, wherein product price changes are made in the master problem and the optimization is performed in the sub-problem. The sub-problem is solved with fixed prices, making product allocation quantity the sole decision variable. A transformation technique has also been employed to convert the non-linear programming problem into a linear program. In addition to producing increased revenue in comparison with the non-linear model, the linear model is also able to solve the full-scale optimization problem within desirable computational time. The concept of elasticity is utilized in making changes to the product prices in the master problem. The self and cross elasticity of demand have been derived and computed for each product in order to determine the direction of change of prices. Data generated from real historic airline data by Airline Planning and Operations Simulator (APOS) has been used to implement the model for a subset of products in a given market.

Keywords: *Airline Pricing, Seat Allocation under Choice-Based Demand, Airline Planning and Operations Simulator (APOS)*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 70

Modeling Reverse Logistics Network for Post-Sale Service under International Ecosystem

Shraddha Mishra, Surya Prakash Singh

Department of Management Studies, Indian Institute of Technology Delhi

Abstract

The paper proposes a mixed integer non-linear program (MINLP) to design a reverse logistics network considering international parameters. The proposed work primarily concentrates on post-sale service provided by the firm under warranty returns. The proposed model assumes that existing warehouses can also serve as collection centre or repair centre for reverse logistics. However, if a product cannot be repaired at warehouse, it is transported to the plant for remanufacturing. In addition to the existing plants and warehouses, the model also explores the possibility of new facility establishment. Furthermore, the model considers capacity expansion of the existing plants and warehouses to incorporate reverse logistics. Objective of the model is to minimize the overall cost of the network including fixed and variable cost of production, repair and remanufacturing costs along with import/export costs and depreciation expense. Further, the proposed MINLP formulation is linearized to mixed integer linear program (MILP) to reduce the computational time. The usefulness of the model is illustrated using a hypothetical but realistic case. The model identifies: a) optimal locations/allocations of the existing/ new facilities b) distribution of returned product for refurbishing and remanufacturing c) capacity expansion of the existing plants and warehouses to facilitate the remanufacturing and repair services.

Keywords: *Refurbishing; remanufacturing; facility network; mixed integer non-linear program (MINLP)*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 72

A systematic analysis of complex synergy among KPIs relevant to IFPRS

Ashish Dwivedi, Jitendra Madaan

IIT Delhi

Abstract

Product recovery is the act of minimizing the amount of waste sent to landfills by recovering materials and parts from old products by means of recycling and remanufacturing. Product recovery decisions are perplexing due to the lack of information linked with returned products. The purpose of this paper is to present a systemic analysis of the complex synergy among key performance indicators (KPIs) relevant to information facilitated product recovery system (IFPRS). The application of analysis and modelling was constrained to the qualitative aspects of the methodology. The study interprets a participative process capable of acknowledging the differing perspectives of industry professionals and academicians involved in IFPRS.

Keywords: *Information Facilitated Product Recovery System (IFPRS), Key Performance Indicators (KPIs), Group model building*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 74

Application of Deep Learning for Throughput Forecasting in Container Supply Chain

Sonali Shankar, P.Vigneswara Ilavarasan

IIT Delhi

Abstract

The paper proposes a portfolio of time series forecasting models which includes, 1) conventional econometric model like ARIMA, TBATS etc.; 2) Machine learning based model like neural network; 3) Hybrid model and; 4) Deep learning based long short-term memory (LSTM) network. For empirical analysis, models are evaluated on the real-world dataset of container throughput at the port of Singapore. The dataset constitutes of monthly throughput generated at the port from year 1995-2018. The performance metrics is evaluated to measure bias, variance and accuracy. The novelty of the paper is application of LSTM network to predict container throughput and it is found to outperform other widely used time series methods. The results obtained are further substantiated via Diebold-Mariano statistical test.

Keywords: *Port Logistics, Forecasting, Deep Learning, Maritime Supply Chain, LSTM*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 80

Distribution Network Design of Public Health System: Lessons from Select Indian States

Rahul Kumar* & Debadyuti Das

Faculty of Management Studies, University of Delhi

Abstract

Distribution network plays a significant role in the delivery of essential medicines to the public health facilities. A developing country like India, where a majority of population depends on public health care system needs to have an efficient and responsive drug distribution system. In India, the procurement and distribution of essential medicines is taken care of by National Health Mission (NHM). Public Healthcare systems make use of distribution networks for smooth delivery of essential medicines to all types of public health facilities ranging from district and large hospitals to the Sub-centre level facilities. The studies carried out by several national and international agencies in several states reveal that the public health distribution system is still inefficient in India. Moreover, different states in India follow different types of procurement strategies such as centralized, decentralized or a mix of both. Each state is characterized by different types of distribution network design that depend on population density, distribution of demand across different regions, availability of warehousing and cold storage facilities, quality of roads, ease and mode of transportation etc. It becomes quite challenging for public healthcare professionals to select one particular distribution network which would be appropriate for all Indian States. The research question attempted to be addressed in this work involves which particular public health distribution network (PHDN) is efficient, which one is responsive and which one is both efficient and responsive. Keeping this in mind, the present study has taken up the existing PHDN of essential medicines of four Indian States, namely Himachal Pradesh, Uttarakhand, Punjab and Tamil Nadu and studied the networks of four States in terms of efficiency (Cost) and responsiveness (service). The elements of cost and the same of service have been hierarchically shown under cost and service respectively. The study has utilized the concepts of Analytic Hierarchical Process (AHP) to make a thorough evaluation of PHDN of all four Indian States. Towards the end, the managerial and policy implications of the findings are discussed.

Keywords: *Distribution Network Design, Public Health, Analytic Hierarchical Process (AHP), Efficiency, Responsiveness*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 82

Manpower Planning in a Hyper-Local Food Delivery Organization: A Case Study

Dr. Debadyuti Das*, Chirag Yadav

Faculty of Management Studies, University of Delhi

Abstract

The present work attempts to study the existing practices of estimating the Delivery Executives' requirement in a prominent hyper-local food delivery organization based in Bangalore. The study reveals that the demand for food varies within a day, since most users are likely to place orders during lunch and dinner times. Further the demand patterns vary across days within a week, with heavier traffic occurring over the weekend as compared to the weekdays. Currently the firm utilizes three categories of Delivery Executives: Full-time, Part-time and Weekend-only. Full-time Delivery Executives operate throughout the day and cater to 'lunch peak' demand while the Part time Delivery Executives operate in the evening along with the full-time Delivery Executives and cater to the 'dinner peak' demand. Weekend-only Delivery Executives operate during the entire duration of 2-day weekend along with the full-time and part-time Delivery Executives. Currently the firm attempts to identify the maximum number of orders occurring during both 'lunch peak' and 'dinner peak' on both weekdays and weekend and estimates the number of Delivery Executives to be hired across all three categories for the next week. The underlying logic behind this approach is that if the firm could cater to maximum demand during peak demand periods, it would be able to meet the demand during the remaining periods as well. However, this approach has indicated that the Delivery Executives remain unutilized during periods of low demand, which has resulted in increase in manpower cost. In view of this, the present study has developed a two-phase model for finding out an optimal number of Delivery Executives without compromising with the service level provided to the customers. The first phase of the model involves the development of an integer linear programming model in which the decision variables include the number of Delivery Executives required in a particular shift of a weekday or weekend in one area of Bangalore. A total of 25 areas in Bangalore have been considered for the present study. Three overlapping shifts have been considered within which Delivery Executives' requirement in 4-hourly interval has been estimated. The second phase of the study involves the computation of different categories of Delivery Executives across both weekdays and weekend by following a simple algorithm. The suggested model demonstrated a savings of 20% savings in manpower cost. The managerial implications of the study were also discussed.

Keywords: *Manpower Planning, Hyper-local Food Delivery, Delivery Executives, Integer Linear Programming*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 86

Impact of contract sequence on three-echelon supply chain coordination under uncertain environment

¹Rohit Gupta, ²Indranil Biswas, ²B.K. Mohanty, ²Sushil Kumar

¹*IIM Ranchi*

²*IIM Lucknow*

Abstract

Uncertainties due to product supply, consumer demand, manufacturing cost etc. for a supply chain cannot be ignored. It reduces the overall effectiveness of whole supply chain. It can be captured and estimated by fuzzy variables. The purpose of this study to explore the three-echelon supply chain coordination under uncertain environment for different contract sequences. The three-echelon supply chain consists of a supplier, a manufacturer and a retailer. The supplier manufactures a semi-finished or WIP product and sells it to the manufacturer. The manufacturer produces the finished goods (FG) from the WIP and sells it to the retailer. The retailer sells the FG in the final market. Final customer demand and marginal cost associated with uncertainty, which is described by fuzziness. Based on the four contract sequences, we study one centralised and four decentralised supply chain structures. We obtain optimal prices and maximum expected profit expressions for corresponding cases using fuzzy game-theoretic approach. Further, we examine the three echelon supply chain coordination for different contract sequences. We find out that three-echelon supply chain can be coordinated under uncertain environment when both supplier and manufacturer offer linear two-part tariff (LTT) contract. Finally, we propose a numerical analysis which illustrates the effectiveness of the theoretical results and provide managerial insights.

Keywords: *Supply chain coordination; Contract sequence; Stackelberg game; Fuzzy demand*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 87

An Analysis of Pricing Decisions in the Internet Value Chain

*Sudha Madhavi Dastrala, Rajeev R. Tripathi

*Production and Operations Management Area, Indian Institute of Management-Bangalore,
Bengaluru, India*

Abstract

The digital content supply chain starts with content creation followed by content aggregation, content serving, internet service and content consumption. Content service providers follow different revenue models such as subscription-based, advertising-based, freemium etc. and additionally, for the value chain to function effectively, there is a need to consider the Internet Service Provider (ISP)-Content Provider (CP) relationship. The formation of consortiums between an internet service provider and content service providers has been discussed in the literature. Members in the consortium share costs and investments and this seems to be helpful for the players in the market. As an extension, different market structures (both competition and cooperation) along with different revenue models of content providers can be considered together. In this paper, we therefore, consider a simplified interaction between two CPs and an access ISP and attempt to understand what kind of revenue model (subscription or advertising-based) should the content providers (CPs) opt for? Further, this paper studies the impact of type of content provider (advertising or subscription-based) on ISP pricing strategies. Lastly, this paper also explores ISP pricing strategies in net-neutrality scenario.

Keywords: *Game Theory, Internet Value Chain, Pricing, Revenue Model*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 88

**Performance Evaluation of Indian Management Institutions: Pre/Post Liberalization
Period**

Chandan Jha and Amit Sachan

Operations Management Department, Indian Institute of Management Ranchi

Abstract

The purpose of this study to evaluate the performance of the Indian Management Institutions, established in pre-liberalization and post-liberalization period. In this study, data envelopment analysis (DEA) methodology has been used, and authors have collected the required data related to performance measures from the National Institutional Ranking Framework web portal and other government websites. In this study, authors have evaluated the performance of the Indian Management Institutions by using two different DEA models. In the first model, institutes have been categorized into two categories based on their establishment year, i.e., institutes established before 1991 and after 1991. However, in the second model, authors have grouped these institutions into three categories, i.e., institutes established before 1991, between 1991-2000 and post-2000. The findings of this research study will help the policymakers in the decision-making process during the budget/resource (financial/non-financial) allocations for these institutions.

Keywords: *DEA, Higher Education, Performance Evaluation, Pre/Post Liberalization*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 89

Pricing Decision of A Two-Sided Platform With Heterogeneous Sellers

Rajeev R Tripathi

Production and Operations Management Area, Indian Institute of Management Bangalore

Abstract

In this paper, we study pricing decision of a two-sided platform that deals with heterogeneous sellers. Some of these sellers may be owned or operated by the platform. A traditional two-sided platform's pricing decision necessitates endogenizing cross-side externalities and adopting a strategy where the more elastic side of the platform often subsidizes the less elastic side. Unlike the traditional two-sided platforms, a platform involving heterogeneous sellers faces both same-side and cross-side externalities. A price-subsidization strategy that is based on demand elasticities of the two sides may lead to a pricing structure that is perceived as biased against one side and favoring the other side. This problem further gets amplified when there is heterogeneity among players on the same side and the pricing decision fails to endogenize the same-side externalities. In this paper, we address the following research question: how much subsidization is fair in a two-sided market? To answer that, we convert a given two-sided platform's problem into a coalitional game problem which we call a two-sided platform game. We analyze the two-sided platform game using a fairness-based solution concept from coalitional game theory to characterize a fair pricing structure.

Keywords: *Coalitional game theory; two-sided markets; pricing structure; fairness*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 90

Supply Chain Management Practice And Supply Chain Performance: A Conceptual Systematization Of Terminology And Key Factors Affecting SCM Practice And SC Performance In Manufacturing Industry

Rohit Kumar, Sushil Kumar Poddar

NIT Allahabad

Abstract

Over the last decade the concept of SCM practice has expanded and has become a key subject in the field of supply chain operation area. Therefore a set of practices of SCM have been implemented worldwide without measuring its real impact on SC performance and competitive advantage. Thus a significant set of recent research has attempted to find impact of SCM practice on SC performance and competitive advantage worldwide. However these attempts have been hampered by the diversity and lack of standardization of the used nomenclature that characterize the SCM practice and SC performance. In this context firstly this paper presents a conceptual systematization of the used nomenclature that characterizes SCM practice and SC performance worldwide. Secondly, this paper aims to recognize the factors that affect the SCM practice. Therefore the present research work is to identify the key factors that affect SCM practice in Small and medium size manufacturing enterprise using extensive literature review. This paper is very helpful for practitioners, policy makers, and regulatory bodies, CEO and managers to develop an in depth understanding of nomenclature that characterize the SCM practice, SC performance and key SCM practice that positively affects the SC performance and competitive advantage.

Keywords: *SCM, Supply Chain Management Practice, Supply Chain Performance*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 91

A Machine Learning model for Forecasting Domestic LPG Demand

¹Praveen Kumar, ²Debasis Jena

¹Indian Oil Corporation Ltd., ²RGIPT, Uttar Pradesh.

Abstract

Liquefied Petroleum Gas (LPG) is the primary fuel of choice for cooking in urban areas. Recently, there has been a thrust by Government of India to encourage semi-urban and rural households to switch to this cleaner alternative. It's ambitious schemes such as Ujwala and Gram Swaraj Abhiyaan (GSA) aims to achieve full conversion to LPG in every village of the country by the end of the current financial year. With these new initiatives, the LPG demand has surged thus widening the existing gap between the supply of LPG by domestic refiners and the existing market demand for LPG. This shortfall is met by importing LPG by the incumbent Oil Marketing companies and supplying it through their distribution networks across the country. However, deciding the quantity of LPG that needs to import has always been a challenge, with lead times of more than 6 months and absence of researched forecasting models. At best, the forecasting models employed in the country involves an extrapolation of the existing demand into the future and some corrections for regional disparity and demand fluctuations. This paper is an attempt to develop a scientific researched model for forecasting the demand for LPG in the country using Machine Learning and Advanced Analytics econometric Time Series model Auto Regressive Integrated Moving Average (ARIMA).

Keywords: *Supply Chain, Demand Management, Forecasting, Optimization*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 92

**Material Flow Optimisation of a Capacitated Vehicle Routing Problem in a
manufacturing plant by using Real Coded Genetic Algorithm**

^{1,2}Bhosale K.C*, ¹Pawar P.J.

¹*Department of Production Engineering, K. K. Wagh Institute of Engineering Education and
Research, Nashik, Savitribai Phule Pune University, Pune, Maharashtra. India.*

²*Department of Mechanical Engineering, Sanjivani College of Engineering, Kopergaon.
Savitribai Phule Pune University, Pune, Maharashtra. India.*

Abstract

Vehicle Routing Problems (VRP) are used to solve the problems related to industry, agriculture, supply chain management, transportation to minimise the distance travelled. In capacitated Vehicle Routing Problems (CVRP), additional constraint of vehicle capacity is considered and the objective is considered to minimise the material flow. In this work, a case study based on Iniesta et al. (2013) is considered. To solve this problems, Real coded genetic algorithm (RCGA) is employed to optimise the material flow. The results show that, the results obtained by RCGA are dominating to previously used algorithms.

Keywords: *Capacitated Vehicle Routing Problem (CVRP), Real Coded Genetic Algorithm (RCGA), material flow*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 93

**Scientific Evidence, Public Opinion And Ground Reality Of Health Impacts Of Mobile
Tower Radiations On Human - A Case Study**

Monika Sharma

Amity International Business School, Amity University Uttar Pradesh

Abstract

Purpose: In today's world, technological development brings social and economic expansions to large segments of society; however, the health consequences of these changes can be difficult to predict and manage. The purpose of this paper is to have an insight into the consumer's risk perception in a safety, health, and environment aspect towards mobile tower radiations. **Design/methodology/approach** – Case study technique has been used to study the impact of mobile tower radiations on consumer perception. The SAP-LAP framework categorizes situations based on sources of learning. **Findings** – The suggested conceptual situation-actor-process, learnings-actions-performance (SAP-LAP) hills framework helps to develop risk mitigation strategies for different associated risks related smartphone usage and the dominating matrix provides insight to the actions and actors that need attention to improve the processes and performance. For the academic, use of research model validates the identification of risks that are recognized in the telecom sector and prioritizing the risks that need to be addressed. **Research limitations/implications:** This case study focuses on the electromagnetic radiations from a smartphone and telecom towers and it supports to create awareness among the consumers and also helps to design counselling plans and marketing strategy for them. The synthesis of SAP leads to LAP, which bridges the gap by suggesting improvement actions based on the learning from the current situation, actors and processes.

Keywords: *SAP-LAP, Smartphone usage, Electromagnetic Radiation, Risk mitigation strategies*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 96

The relationship between Project Governance and Project Performance: An Empirical Investigation

Gaurav Kabra, Assistant Professor

*Operations and Supply Chain Management, National Institute of Industrial Management,
(NITIE) Mumbai*

Abstract

The utilization of information technology (IT) in public and private sector is increasing to meet the ever-changing need of the customer. This results in the development of many critical software projects in India, such as digital attendance, digital locker, eHospital application, to name a few. These projects are unique and complex in organizational setup; deliberate design; and project ownership. The projects are spread across multiple governmental or private branches, and the rate of change of technology further enhance the expectation of the customer. However, organizations need to ensure the deliverables of the project are fit for their intended purpose with high customer satisfaction. Therefore, quality management practices are a prerequisite for project success. However, the literature has reported inconsistent results on the relationship between quality management practices and project performance.

Despite extensive research on project governance, there is a lack of research on the relationship between project governance, and quality management practices on project performance, with emphasis on IT projects. Therefore, this study aims to empirically investigate the relationship between project governance and quality management practices on project performance. The hypothesized relationship has been tested by analyzing data collected from 220 project managers working in India's information technology/software industry. Structural equation modelling was used to analyze the relationships. This paper attempts to improve the existing knowledge on project performance. The findings provide evidence that project governance and quality management practices have a positive impact on project performance. The results offer insights to policy and decision-makers to improve the project performance.

Keywords: *Project Governance; Project Quality; Project Performance; Empirical Investigation*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 97

Optimisation of Food Supply Chain considering Sustainability Dimensions and Food Waste Valorisation

¹Ramesh Krishnan* , ¹K. Arshinder and ²Renu Agarwal

¹*UTS Business School, University of Technology Sydney, AUSTRALIA*

²*Department of Management Studies, Indian Institute of Technology Madras,*

Abstract

In this contemporary business world, competition from globalisation, increased food mile, a changing consumer behaviour towards food preferences and rising population and government regulations places greater pressures on the food supply chain (FSC) On the other hand, “one third of the global food production is wasted or lost annually” - such wastage of food produce is a big challenge to global food security. All these factors show that sustainable practices are becoming a necessity rather than a preference. The network -design of all the entities involved in the FSC has influence on sustainability of FSC. Existing studies have focused on individual firms instead of considering whole FSC and majorly considered economic- objective alone. Very few studies considered both economic and environmental objective and rarely any studies considered the social aspect for network- design of FSC. Also, there is a lack of studies that incorporates food -waste valorisation in network -design. This study aims to address these gaps by developing a multi-objective optimisation model that considers minimisation of cost and environmental-impact while maximizing social-benefits from the FSC. The decision variables such as production quantity, transportation mode, number of job-opportunities created, etc. are considered in the model. In addition, food waste valorisation option has been introduced in the model. The result of this model will provide the trade-offs between the objective functions and how the introduction of food-waste valorisation impacts sustainability dimensions. This study will be of importance to industry-practitioners to improve their FSC network considering sustainability and understand the potential benefits of food waste valorisation.

Keywords: *FSC, Network Design, Multi Objective*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 98

Empirical Assessment Of Key Barriers Of Industry 4.0 In Manufacturing Industries

Naveen Virmani, Urmi Ravindra Salve

Department of Design, IIT Guwahati, India

Abstract

Dynamic market conditions have led the industries to adopt contemporary technologies and strategies. In today's globalized era, industries are required to manufacture high quality customized products at economical prices and hence to maximize resource utilization. Industry 4.0 concept is gaining more and more importance since last one decade. The term Industry 4.0 was coined by Germany in 2011; since then various researchers from industry and academia are working on its various aspects like cyber-physical system, cyber-security, Internet of Things (IoT), big data analytics, augmented reality etc. The objective of the paper is to find out and analyse key barriers of implementation of Industry 4.0 in Indian automobile manufacturing industries.

Keywords: *Industry 4.0 barriers, IoT, Cyber-Physical System, EFA and CFA*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 99

Comparative Study of Ergonomic Risk Assessment in Engine Stripping

Mangesh Joshi, Himanshu Shukla

Ramdeobaba College of Engineering and Management, Nagpur

Abstract

Work related musculoskeletal disorders (WMSDs) are very common in any industry setting. Reconditioning of engine involves variety of tasks from heavy-duty work to light duty work. Engine stripping activity requires medium to heavy human energy expenditure and hence its ergonomic evaluation is necessary. This study is carried out to investigating risk factors associated with different work activities involved in engine stripping by evaluating and comparing postures in performing various work elements using the Ovako Working posture Assessment System (OWAS), Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA). A significant difference was observed between the outputs from OWAS, and REBA, RULA methods. While the difference in risk to the musculoskeletal system was statistically significant in different work elements. Appropriate workstation should be developed which is suitable as per workers' anthropometry and help reduce MSD risk.

Keywords: *Engine Stripping, OWAS, REBA, RULA, Comparison, Posture evaluation*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 100

**Systematic Study Of Ergonomic Risks Assessment In Roof Sticks Manufacturing Of
Bus Body**

Mangesh Joshi, Himanshu Shukla

Ramdeobaba College of Engineering and Management, Nagpur

Abstract

Work related musculoskeletal disorders (WMSDs) are very common in any industry setting. It is dangerous as it affect productivity and worker absenteeism. Bus body building involves variety of tasks from heavy-duty work to light duty work. Roof stick manufacturing activity requires low to heavy human energy expenditure and hence its ergonomic evaluation is necessary. This study is carried out to investigate risk factors associated with different work activities involved by evaluating and comparing posters in performing various work elements using the Ovako Working Posture Assessment System (OWAS), Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA). A significant difference was observed between the output from OWAS, and REBA, RULA methods. While the difference in risk to the musculoskeletal system was statistically significant in different work elements. Appropriate workstation should be developed which is suitable as per workers' anthropometry and help reduce MSD risk.

Keywords: *OWAS, REBA, RULA, Comparison, Posture Evaluation, Ergonomic Intervention*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 102

Nurse Staffing and Scheduling Optimization Solution for a Healthcare Service Industry

Abhaya Kumar Sahoo, Rohit Sarada, Marie Goetzke, Dimitris Alevras

IBM India Pvt. Ltd.

Abstract

The Home Healthcare Companies faces significant challenges in optimal assignment of the nurse workforce to patients due to high turnover and unanticipated patient demand. The objective is to predict service delivery pull and align the hiring, staffing and scheduling of the nurses in line with predicted daily demand throughout across the country. The overall solution approach comprised of three broad modules: (1) Patient demand forecasting model (280 regions); (2) nurse staffing model (280 regions); (3) Nurse scheduling model for over 4000 weekly appointments across the nation-wide (52 states). This paper proposed a staffing workload measurement & scheduling solution based on the predictive patient's service duration for hiring and staffing nurses aligned with the patient location. The considered cost components are travel cost, service cost between full time, part time and agencies, nurse priority, treatment duration and additional hours of services. Optimized schedule plan is based on travel distance for giving priority for services over travel time for the Full-time, Part-time and CPNS nurses to improve overall utilization. We have applied hybrid optimization techniques which evaluate the potential feasible solution sets using nearest neighbor search (NNS) strategy and used these set of feasible solutions to mixed integer programming to get the global solution. We leveraged on IBM Watson Studio platform and IBM CPLEX Solver to create the demand forecasting, staffing model and generating optimal nurse scheduling solution. We proposed business value of 1-3% reduction on overall nurse travel cost. The model led to 10-12% nurse utilization improvement over baseline.

Keywords: *Patient appointments forecasting, nurse staffing model, resource utilization, nurse scheduling, planning horizon, home healthcare company (HHC), mixed integer linear programming (MILP)*



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XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 103

Inventory Model for the Deteriorating Items under Permissible Delay in Payments with Ramp Type Demand

¹Jitendra Kaushik and ²Ashish Sharma

¹*Department of Mathematics, Institute of Applied sciences and Humanities, GLA University, Mathura.*

²*Department of Master of Business Administration and PGDM, Sunstone Eduversity, Gurugram.*

Abstract

In real business environment delay payment is a common opportunity which was utilized by the seller. With the delay payment facility seller will earn more profit per unit time since he will earn profit by selling the products as well as earn the interest on the revenue. This facility will be more effective in case of deteriorating products. In this paper an inventory model for the deteriorating items for the ramp type, price and time dependent demand is presented. Shortages are allowed and partially backlogged. Solution procedure is illustrated with numerical example. Concavity of the profit function with respect to decision variable is discussed analytically. Numerical analysis shows that the profit per unit time increases with the delay payment facility.

Keywords: *Delay payment, deterioration, price and time dependent demand, partial backlogging*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 104

**Pharmaceutical Companies towards Environmental Stewardship: A Global
Comparative Study**

Sharvee Shrotriya, Somya Chaudhary

Banasthali Vidyapith

Abstract

The global pharmaceutical market continues to expand year by year and with it, the environmental issues are uplifting. "We are living on this planet as if we had another one to go to." - said Terri Swearingen, winner of The Goldman Environment Prize in 1997. Pharmaceutical pollution is constantly found as a risk to environmental conditions. Conforming to scientific study, the pharmaceuticals can penetrate into the atmosphere at all the stages of their life cycle (production, use, and disposal). This means through its operations, the pharmaceutical industry has a considerable impact on the environment, and they have a crucial role to play in addressing these issues and have a responsibility to foster environmental sustainability and undermine the pharmaceutical pollution at source and throughout their supply chain. This paper provides an insight into the strategies represented by the Indian pharmaceutical companies for addressing and measuring progress toward environmental sustainability and correlating them with approaches carried out by International pharmaceutical companies. The research data demonstrates that sustainability associated activity has intensified in dimension but activity is now being shifted toward corporate social duty, which is reflective of corporate demand to satisfy universal sentiment.

Keywords: *Pharmaceutical Market, Supply Chain*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 105

Sustainable Parallel Machine Scheduling: Trade-Off Between Tardiness And Energy Consumption

¹Athul Prem Unni*, ¹Bobin Cherian Jos, ²Chandrasekharan Rajendran

¹*Department of Mechanical Engineering, Mar Athanasius College of Engineering, Kerala.*

²*Department of Management Studies, IIT Madras*

Abstract

Sustainability and green aspects in industries are gone from a nice to do to a must to do. Energy being expensive and becoming scarce, energy conservation has gained a significant importance. Thus energy efficient sustainable manufacturing is the need of the hour. Scheduling has the potential to achieve sustainability in manufacturing, with less cost intervention. The energy consumption of machines vary with variable speed of machining operations. i.e., if the speed of machine is very high it would result in higher consumption of energy and vice versa. So controlling the speed of operations on machines prior to completion time, reduce the energy consumption ensuring satiable service level. In this study, we analyse the trade-off between minimizing the tardiness and total energy consumption, which make this a multi-objective optimization problem. A MILP model is formulated and ϵ -constraint method is used to obtain a Pareto front. An efficient algorithm is also proposed for the NP-Hard problem under study. The Pareto frontier serve as an aid for the decision maker, to reduce the energy consumption to a great extent by compromising with customers on due date. To the best of our knowledge, none of the works in the literature considered the impact of varying the speed of machining operation and its effect in energy consumption as an explicit factor along with tardiness in a scheduling problem with non-identical parallel machines. This study will help the future researchers to contribute more on sustainable scheduling with various machine characteristics under various machine environments.

Keywords: *Tardiness, Energy Consumption, MILP*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 107

**A Novel Two-Stage Network DEA Approach to Estimate Production Efficiency of The
Bus Transportation System**

¹Shivam Kushwaha, ¹Shankar Prawesh, and ²Anand Venkatesh

¹*Department of Industrial and Management Engineering, Indian Institute of Technology(IIT),
India*

²*Institute of Rural Management, Anand, India*

Abstract

Traditional data envelopment analysis (DEA) considers the production system as black-box due to which internal operations are often ignored and might result in misleading results. On the other side, it overlooks the inefficiencies stemming from its multiple activities. It may happen that the whole system is efficient but its sub-activities are not. Therefore, it is highly desirable to utilise information related to the internal structure and locate the inefficient sub-activities. In the extant literature, in contrast to the conventional measure of performance, several attempts have been made to estimate overall performance when multiple activities are present. However, production efficiency has not been examined at divisional level. To address this gap, we present a novel approach which combines two key divisions of the production system: maintenance and operations, connected in series with the shared resources. In particular, two-stage network DEA technique has been adopted in the proposed framework, to estimate overall production efficiency of the bus transportation system. Further, decomposition of production efficiency has been achieved using co-operative game-theoretical approach rendering optimal efficiency estimates for each division. For empirical application, we applied our proposed approach in Indian bus transportation system. Finally, we conclude with a discussion on policy implications of our research and recommendations for managers to improve overall production performance.

Keywords: *Production Efficiency, DEA*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 108

**PRACTITIONERS' PERSPECTIVES ON CHANNEL COORDINATION IN GREEN
SUPPLY CHAIN MANAGEMENT**

¹Tatavarty Guru Sant, ²Sanjeev Swami, ³Ravi Shankar

¹*Institute of Business Management, GLA University, Mathura.*

²*Department of Management, Faculty of Social Sciences, Dayalbagh Educational Institute, Agra.*

³*Amar S Gupta Chair Professor of Decision Science, IIT Delhi.*

Abstract

Analytical studies in green supply chain management (GrSCM) have often considered that green orientation of the product and processes help organisations in many ways through benefits such as branding, and ability to charge price premium. Further, greening also helps in cost reduction and demand expansion. Studies in literature have indicated that greener products have better market acceptability, and with changing consumer behaviour, companies are able to charge higher prices. The factors responsible for such assumptions are consumer consciousness, environmental awareness, willingness to purchase more, and green products acting as an indicator of quality. Different studies in the past have tried to model the various upstream and downstream conflicts in the distribution channel to explore the best possible strategy to be followed by the various actors of supply chain in order to maximise the supply chain profits as a whole. However, relatively few studies have explored the practical dimension of such analytical modelling. Therefore, in this endeavour, we have conducted an interview-based survey of industry experts and academicians working in the area of green supply chain management in order to explore the greening initiatives taken by the companies. It is also explored that how manufacturers and retailers are coordinating the efforts of greening in the supply chain. Further, the results obtained from modelling specific to the price premium effect of greening on various parameters such as price sensitivity, effectiveness of greening efforts, and cost of greening, on the optimal pricing and efforts decisions by the channel partners are analysed and compared from industry practice perspective. Further, the obtained results are summarised and presented in the form of four different case studies for projecting its application i.e. academic and practical implication.

Keywords: *Green Supply Chain Management, Consumer Behaviour*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 110

**Optimizing Multimodal transportation problem for efficient parcel movement in
Courier Industry**

Mahidhar Surapaneni, Abhaya Kumar Sahoo, Dr. Sarang Jagdale, Satish Saurav

IBM India Pvt. Ltd.

Abstract

Business involves movement of parcels using multimodal transportation (Air, road) to reach the delivery locations within the boundaries of given turn-around-time (TAT). The current business objective is to arrive at the most optimal transportation mode mix for pan-India parcel movement. There are close to 10,000+ origin-destination combinations along with multiple connections (2,000+) across modes with varying characteristics. This needs evaluation of more than 5,00,000+ variables every month to arrive at the solution; requiring the need for an optimization solution. IBM CPLEX Optimizer is used to generate solution for the client. MILP framework is used to capture and model the business requirements in mathematical form. Results of the work are: Around 14% reduction in the total movement cost across multiple product types. Identified origin-destination combination where TAT could be reduced leading to increased customer experience. Optimal alignment of spoke to hub depending on the direction of load movement. Reduction in planning time for planner allowing time for multiple scenarios runs.

Keywords: *Strategic Network design, collections time, multi-modal transportation, transfer time, distribution time, cooling time, Turn-around-time (TAT), Mixed Integer Linear Programming (MILP)*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 111

Sustainable Management of MSW: A Mathematical Modelling Perspective

Smeetasree Pati, Rajat Agrawal

Department of Management Studies, Indian Institute of Technology Roorkee, India

Abstract

Rapid urbanization, population growth and changing lifestyle are contributing in increasing the Municipal solid waste (MSW). Increased MSW is creating a lot challenges related to safe living. Local administration is also continuously under pressure for proper disposal of this solid waste which should be done in sustainable manner. Therefore, attention is moving towards “take-make-use-recycle-reuse” from “take-make-use-dispose” and giving enhanced opportunities to research in the area of MSW. Various activities involved in sustainable handling of MSW are collection-sorting-treatment-supply to market. Several operational issues related to these activities such as logistics, allocation of bin, locating facilities etc are solved by researchers using different optimization models with different assumptions and with the consideration of different types of decision variables, such as type of vehicles, size of roads, quantum of waste generated etc. Researchers in this area focused majorly from economic and environment perspective. But to achieve sustainability in the management of MSW, literature suggests to consider all three dimensions i.e; economic, environment and social perspective. In literature, various quantitative techniques are used to analyze and to provide solution for the management of MSW such as Linear Programming, Life Cycle Assessment, Fuzzy Logic etc. This study gives a detailed review of previous studies focusing on Mathematical Modelling of Sustainable management of MSW.

Keywords: *Municipal Solid Waste; Sustainability; Mathematical Modelling; Literature Review*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 112

Examining impact of user perceived e-procurement quality on firm performance

¹Nripendra Kumar, ²Kunal Ganguly

¹*Bharat Heavy Electricals Limited*, ²*Indian Institute of Management, Kashipur*

Abstract

The purpose of this research paper is to understand the impact of user perceived quality of e-procurement system/platform on different intermediate measures of e-procurement performance. Further, the study also examines how the impact on these intermediate performance measures by adoption of e-procurement translates into improvement in firm financial performance. The survey is conducted in India. The target population was purchasing professionals aware of B2B e-procurement platform. The measurement model was first tested by using confirmatory factor analysis (CFA) for reliability and validity, then SEM model was analysed to test the hypotheses of the research model using AMOS 22. The study identifies the e-procurement quality (EPQ) dimensions namely, content, processing and professionalism as antecedents to the e-procurement performance which ultimately leads to financial improvement of an organization by adoption of e-procurement. Present study makes valuable contribution to exiting knowledge by narrowing the research gap in understanding the impact of contextualized quality dimensions of IT systems in terms of system and support provision to users on success of IT systems such as e-procurement. The study also contributes by providing insight in to the interdependence of e-procurement performance measures and thus, enhances our understanding how the e-procurement system quality dimension's affects different aspect of performance of an organization to accrue the benefits to an organization in the terms of financial improvement. This is first study which attempted to identify the system and support provisions of e-procurement platform from internal customer perspective which are critical for firm financial performance.

Keywords: *Transparency; Firm Financial performance; E-procurement quality*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 113

Production Smoothing: Evidence in Indian Automobile Industry

Ajay Singh, RK Amit

Indian Institute of Technology Madras, India

Abstract

Production smoothing is defined as a firm that can smooth its production relative to sales i.e. variance of production is less than the variance of sales, by keeping inventory as a buffer. Such behavior is desirable when a firm faces convex production cost function (i.e., maintaining production at a constant level is less costly than varying the level of production) and when a firm faces predictable seasonality. The objective of this study is to investigate the production smoothing in the Indian Automobile industry at various segment i.e., passenger vehicle, commercial vehicle, two-wheeler, and three-wheeler. The Physical unit disaggregated and seasonally unadjusted data is used at a different segment and firm level, covering monthly observation from 2015:1 to 2019:8. We have found the production smoothing at all the segment, but it dominant in the commercial which has market share of 4% and 6 out of 8 firms shown production smoothing. Then in the passenger vehicle segment which has a market share of 13%, only 4 firms out of 10 show the evidence of production smoothing and In a three-wheeler segment which has a market share of 3% shown production smoothing in 3 firms out of 8. At last two-wheeler segment which has the largest market share of 81% shows the evidence of production smoothing in 3 firms out of 8. Hence we can conclude that the presence of production smoothing in the Indian automobile industry is there but not widely spread and explained the variation of results at different segments.

Keywords: *Production Smoothing, Passenger vehicle, Production smoothing*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 115

Modelling issues in implementing circular economy practices in food industries chain management for food security and food waste reduction

Saurabh Ardra, Mukesh Kumar Barua

Indian Institute of Technology Roorkee, India

Abstract

Food is perishable item so its supply chain is more vulnerable to losses as compared to manufacturing or service supply chain. United Nations released the SDG 2030 target in which they aims at halving food waste globally by 2030 at retail and consumption stage (SDG 12.3). Circular Economy is the concept which can make supply chains more sustainable. After reviewing current progress and new trends in the literature, this study highlights the issue of food waste. Food waste can be managed systematically by introducing circular economy practices. The ten risks of utmost priority were identified and their inter-relationship were developed using ISM-MICMAC methodology. The findings show that lack of public awareness regarding food waste is placed at bottom of the diagraph. Unclear vision in regards of circular economy in food supply chain takes the second level, while lack of cold chain, poor packaging efficiency, incorrect demand forecasting and energy limitations for running facilities are placed at middle level. The fourth level is occupied by transportation and infrastructure issues and poor harvesting planning, while at the top comes current laws of waste management not promoting circular economy practices and linkage between farmer and processing unit. A model has been developed taking into account the viewpoints of experts, developing a hierarchy of the food waste barriers and their contextual relationships, which might help the policy makers and practitioners to look at the problems in adopting circular economy practices in food industries chain management for food waste reduction and food security.

Keywords: *Modeling, Harvesting Planning, Circular Economy*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 117

A modified ant algorithm integrates real-life road constraints in vehicle routing under uncertain environments: A case study of e-commerce courier companies in India.

Krishnendu Mondal, Sandeep Mondal

*Department of Management Studies, Indian Institute of Technology (Indian School of Mines),
Dhanbad, India*

Abstract

The recent advancements in technology and rising demand indicates the need for a complex decision support framework which has directed the e-Commerce and third-party logistics industries to an extremely competitive environment. This paper focuses on such vehicle routing problems which are basically region-based and delivers mostly any types of food products. There are products in the delivery vehicle which has less shelf life than others and those products have to be delivered within their allocated time to avoid deterioration. Most of the delays in deliveries have been observed due to the ambiguous requests received from the customers. These dynamic requests may arrive at any point in time and it is irrespective of the vehicle position, whether it is at the warehouse or on its way. This uncertainty causes an interruption in the existing vehicle tour which leads to an upsurge in greenhouse emissions. The Ant System algorithm has been reformed according to specific constraints like the size of the roads and traffic congestion factors to optimize the vehicle route. The objective of this study is to minimize the emission caused by the movement of vehicles in transportation while satisfying public needs and demand.

Keywords: *Dynamic Vehicle Routing; Ant System; Online food retailers*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 118

Investigating the Vaccine Supply Chain in India

Dheeraj Chandra, Vipin B

*Department of Industrial & Management Engineering, Indian Institute of Technology
Kanpur, India*

Abstract

With several state-of-the-art manufacturing facilities, the Indian vaccine industry is recognized as one of the largest global capacity for world health organization prequalified vaccine manufacturing with the supply of vaccines to almost 150 countries. Despite being the prime vaccine-manufacturing hub, delivering quality immunization services to the children is still a major challenge in India. As of 2019, India has been able to vaccinate only 65% of the children in the first year of their life. One of the primary reasons for low immunization coverage is the poor performance of the vaccine supply chain. The objective of the vaccine supply chain is to guarantee the continuous accessibility of quality vaccines from manufacturers to delivery locations so that opportunity to vaccinate a child is not missed due to unavailability of vaccines. In this paper, we explore the current status of literature on vaccine supply chain. Further, we investigate the role of managing the supply chain of vaccines in improving the performance of immunization programme in India.

Keywords: *Supply Chain, Quality, Immunization*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 119

Implementing Block Chain Technology in Project Management

¹Gaurav Raj, ²Kuldeep Modh, ³Pankaj Maan, ¹PravinJadhav

¹*Institute of Infrastructure Technology Research and Management,*

²*Management Development Institute Murshidabad, ³PGET, Samsung Pvt. Ltd.*

Abstract

The recent advancements in technology and rising demand indicates the need for a complex decision support framework which has directed the e-Commerce and third-party logistics industries to an extremely competitive environment. This paper focuses on such vehicle routing problems which are basically region-based and delivers mostly any types of food products. There are products in the delivery vehicle which has less shelf life than others and those products have to be delivered within their allocated time to avoid deterioration. Most of the delays in deliveries have been observed due to the ambiguous requests received from the customers. These dynamic requests may arrive at any point in time and it is irrespective of the vehicle position, whether it is at the warehouse or on its way. This uncertainty causes an interruption in the existing vehicle tour which leads to an upsurge in greenhouse emissions. The Ant System algorithm has been reformed according to specific constraints like the size of the roads and traffic congestion factors to optimize the vehicle route. The objective of this study is to minimize the emission caused by the movement of vehicles in transportation while satisfying public needs and demand.

Keywords: *Dynamic Vehicle Routing; Ant System; Online food retailers*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 120

Debottlenecking the warehouse activities in a Pharmaceutical supply chain system

Shweta, Dinesh Kumar

*Department of Mechanical & Industrial Engineering, Indian Institute of Technology Roorkee,
India*

Abstract

In today period, it has been observed that healthcare industry in India suffers heavily due to insufficient and uncertain atmosphere of supply chain system of medicine. To protect and save human life it is extremely necessary to deliver all medicine to all its centre timely. Therefore, an effective and efficient pharmaceutical supply chain system must be in place for the success of any healthcare organization. Key activities of organisation are procuring, warehousing, and distribution of medicines in a controlled environment (i.e. temperature control). From field survey of medium sized pharmaceutical industry situated in northern part of India and literature survey, it is observed that the warehousing consisting of the activities namely space management, processing the orders, inventory management, packaging and shipping etc. is one of the cumbersome medicine storing process and has bottlenecks. The efforts are made to identify all the bottlenecks of the supply chain process of pharmaceutical warehouse under study through field survey in a generic medicine distributing company. Debottlenecking of warehouse activities has been performed and a novel PSC framework has been developed. These will help the organisation under study in better decision making process. Our findings highlight that quality control activities have the most unavoidable bottlenecks.

Keywords: *Debottlenecking, Warehouse activities, Decision Making Process*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 121

Connection between lean and green manufacturing: A literature review and research opportunities

Sarita Prasad, A Neelakanteswara Rao, Krishnanand Lanka

*Department of Mechanical Engineering, National Institute of Technology Warangal,
Telangana, India*

Abstract

The move towards greener activities has constrained organizations to look for choices to adjust productivity gains and ecological benevolence in their tasks and items. The investigation of the successive implementation of lean and green activities is the main focus of this study. In any case, the lean-green theme is generally new, and it requires a structured definition of lean and green manufacturing. Accordingly, this research paper's primary aim is the offering of a structural literature review of the existing articles on lean and green, revealing gaps and finding new ways for research. The author has categorized the research articles into seven different categories, which include the quantitative and qualitative research conducted among various manufacturing organizations and sectors. Critical issues for future research are then recommended as research questions for further study. The motivation behind this paper is to conduct structural literature of lean and green manufacturing. The examination included concentrate 156 research articles distributed from the year 1994 to 2019. The articles are arranged by time appropriation of articles, research methodology, research stream, industry-wise, article based on waste, an article based on the elements, and measurement of different existing structures/models. The paper's point is to likewise contribute by other researchers to additionally think about this region inside and out, which will prompt a superior understanding of the benefits obtained after the implementation of lean and green activities in organizations. The study will help other researchers to focus on growth, drivers and research development in the field of lean and green.

Keywords: *Lean manufacturing; Green manufacturing; Literature review*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 122

**Production planning and control of a hybrid MTS/MTO production network model
using asymmetric loss function**

Anirban Banerjee, Raghu Nandan Sengupta

*Department of Industrial & Management Engineering, Indian Institute of Technology
Kanpur, India*

Abstract

We model a multi-site production facility of an established firm which operates on a hybrid Make-to-Stock (MTS)/ Make-to-Order (MTO) manufacturing methodology where a share of the production line is manufactured on the forecasted demand of the products (MTS) and the remaining unfinished work-in-progress (WIP) inventory is manufactured on receiving orders (MTO). The consumer's demand for the products manufactured through MTS policy is estimated using asymmetric LINEar EXponential (LINEX) loss function. The products manufactured by MTO policy are produced based on the consumer's orders, the profitability of the products and the production capacity of the plants. A network of suppliers, who distributes the required raw material, is linked to every production facility and the finished products are delivered to a network of customers who are situated at different locations. Based on the description of the production setting, a Mixed Integer Non-Linear Programming (MINLP) model is proposed whose objective is to maximize the profitability of the manufacturing firm, considering the return on investment obtained from sales of the products, the cost associated with the production, inventory, WIPs, logistics and the corresponding holding costs. We consider the associated demand for the MTS and the MTO production plan, respectively, to be deterministic in nature and it is assumed that demand is fulfilled at the end of each period. The objective function and the constraints of the proposed MINLP model are characterized by non-linear functions, therefore we apply iteratively stochastic search procedures and metaheuristic algorithm to address the computational complexity of the proposed mathematical model.

Keywords: *Make-to-Stock, Make-to-Order, Asymmetric Loss Function, LINEX Loss Function, Mixed Integer Non-Linear Programming*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 123

Evaluation of Differing Environmental Policies on Manufacturer's Strategic Decisions

¹Vinay Ramani, ²Debabrata Ghosh, ³Mithu Rani Kuiti, ⁴Sanjeev Swami

¹*Indian Institute of Management Visakhapatnam*, ²*Malaysia Institute for Supply Chain Innovation – MIT SCALE Network*, ³*Indian Institute of Technology Jodhpur*, ⁴*Department of Management, FOSS, D.E.I. University of, India*

Abstract

This paper analyzes the impact of 3 different environmental policies namely, i) tax on aggregate emissions, ii) binding emission norms and iii) per unit environmental tax on a firm's strategic decisions. Through stylized game-theoretic models, we explore different settings where the tax decisions are endogenous and derived through social welfare maximization objective of the government whereas the manufacturing firm decides the production quantity and carbon abatement effort. The paper conducts a comparative analysis of the resulting outcomes in different settings and aims to provide directions on effectiveness of the policy tools from an environmental, consumer, firm and social welfare perspective.

Keywords: *Strategic Decision, Environmental Tax, Social Welfare Perspective*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 126

Green Supply Chain Management in Indian Petroleum Industry using: R Programming Approach

Sourabh Kumar, Mukesh Kumar Barua

Indian Institute of Technology Roorkee, India

Abstract

Petroleum industries operations have positively and negatively impacts on a range of areas covered by the sustainable developments, including on communities, economies, and ecosystems. Petroleum companies have been accused of creating disorder in global environmental issues and face the trustable issue by the side of policymakers and customers. Therefore, petroleum industries have redefined their business development strategy for achieving green sustainable goal. Therefore the objective of the paper is to identify green supply chain management practices and prioritize of these to know their level of importance in petroleum industries. Literature was scrutinized and main criteria were identified, which were filtered by the expert panel. Two criteria, basic and advanced green practices and the seven sub criteria, environmental awareness and policies, employee training related to performance, proper disposal of environment pollution, risk prevention system to cover possible environment accidents, regularly estimating cost and those activities that protecting the environment, prevention oil and methane leaks, investing into renewable energy were evolved for the final assessment of green practices indices identification. In this study, employs a multi criteria decision making techniques AHP and VIKOR using R programming to prioritize the green practices indices. The result of the analysis state that Investing into and implementing renewable energy, Risk prevention systems to cover possible environment accidents and Preventing oil and methane leaks are the top three green practices. The finding helps practitioners and policy makers of the petroleum companies to implement effective green practices to sustain the environment. We offer theoretical and empirical implication of the findings at the end of the paper.

Keywords: *Green practices; R- language; Oil and gas; Sustainability*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 128

The Value of Time of Use (ToU) pricing in a grid with significant renewable energy supply: Does it co-ordinate?

Subhasis Mishra, Balram Avittathur, Megha Sharma

Indian Institute of Management Calcutta, India

Abstract

This paper proposes a year-in-advance Time of Use (ToU) retail pricing for shaping demand. The proposed ToU algorithm attempts to achieve a higher utilization of installed renewable energy based power plants (RE). We explore the impact of the ToU retail pricing in a capacitated and deregulated electricity market, which receives supply from a mix of renewable energy based power plants (RE) and non-renewable energy based power plants (NRE). The ToU retail pricing is compared with fixed retail pricing (FT) with the objective of understanding its potential advantages in (i) managing the demand and supply variability, and (ii) better utilization of the energy resources. Based on the benefits of ToU retail pricing, we attempt to quantify the value of implementing ToU retail pricing in a grid with significant renewable energy supply. Our numerical experiments indicate that it may not always be advisable to administer ToU pricing. Our experiments also suggest that a high level of RE in the grid could discourage further investments and implementation of ToU.



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 129

Assessing relative importance and mutual influence of barriers in Business

Correspondent Model using DEMATEL approach

Richa Goyal, Sujata Kar

Indian Institute of Technology Roorkee, India

Abstract

Branchless banking is a new mantra of the banking industry and one of the initiatives taken to speed up the process of financial inclusion in India. The motive behind this regime is to increase the outreach of the banking sector in the rural areas and provide banking and financial services to the people through Business Correspondent (BC) model. It is one of the innovative ways to reach out the unreached in the rural areas, but the implementation of BC model is not an easy task and faces a lot of barriers which needs to be identified and eliminated. This research study identifies and evaluates the barriers involved in the implementation of BC model in India. Through rigorous literature review and experts' opinions, five primary barriers and twenty-one sub barriers have been identified. The study utilizes Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique to find out the priority of these barriers and then the interdependence of these barriers on each other have been identified. The result states that the technological barriers and operational barriers are the prominent barriers hindering the effective implementation of BC model in India. Further, results depict that the technological barriers as well as the knowledge and support barriers are the major causal barriers. The findings provide helpful insights and recommendations for the banking regulators and policy makers. It suggests that there is a need to create awareness among the customers about the model and special training programmes should be conducted for enhancing the technical skills of BCs.



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 130

**An Agri-business Supply Chain Contract Mechanism between a Firm and a Farmer
Producer Organization**

Ranjeet Rajput, Sri Vanamalla V

*Department of Industrial & Management Engineering, Indian Institute of Technology
Kanpur, India*

Abstract

In this study, we consider a two-echelon supply chain consisting of an agribusiness firm and a farmer producer organization (FPO). An FPO is a collective of farmers who come together to avail the benefits of economies of scale. FPO's are important in developing countries like India, where the majority of farmers are small landholders. The firm determines an optimal order quantity and a purchase price based on market demand at which it desires to enter into a contractual agreement with the FPO. On the other hand, the FPO determines its acceptable price for the specified order quantity of the firm. This price is determined as a solution of a cooperative game whose players are the members of the FPO. These respective prices determined by the firm and the FPO are often their private information, and hence we design a bargaining mechanism between the firm and the FPO through which they bargain over the transfer price. We analyze the mechanism for properties of individual rationality, incentive compatibility, and ex-post efficiency. We also determine the outside subsidy required for achieving budget balancedness. We conclude with determining the portion of outside subsidy allotted to the firm and the FPO.

Keywords: *Supply Chain Contract; Agribusiness; Game theory, Mechanism Design*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 134

Insurance design in agriculture supply chains with random yield

¹Subhasis Mishra, ²Subhankar Mukherjee

¹*Indian Institute of Management Calcutta, India,* ²*Department of Industrial & Management Engineering, Indian Institute of Technology Kanpur, India*

Abstract

Even though agricultural insurance may have a positive impact on crop yield, its demand is low, especially in emerging market economies. The extant literature discusses design of the insurance product as primary reason for this low take-up rate. In this paper we propose an innovative contract mechanism for two-tier supply chain consisting of a buyer and a farmer. There is also an insurer who provides insurance against unexpected crop losses to the farmer. Under this premise, we study the impact of the proposed contract structure in which the farmer purchases the insurance at a discount but agrees to sell the produce to the buyer at a reduced price. The buyer makes a payment to the insurer to compensate for the discount offered. We show how this can coordinate the supply chain and demonstrate the potential advantages of this contract under three conditions: farmers being risk-taker, risk-neutral and risk-averse.

Keywords: *Supply chain management (SCM), Agriculture supply chain, Yield, Insurance*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 135

Modeling a coordinated supply chain under service level constraint with price-sensitive stochastic demand and discrete transportation lead time

¹Susheel Yadav, ¹Anil Kumar Agrawal, ²Manu K Vora

¹*Department of Mechanical Engineering, Indian Institute of Technology (Banaras Hindu University), Varanasi, India,* ²*Business Excellence, Inc., USA, Naperville, IL 60567-5585,*
USA

Abstract

The study is about a single-manufacturer multiple buyers supply chain in which the manufacturer produces an item at a finite rate and sends it to the buyers who sell the item into the market. All the buyers face a price-sensitive stochastic demand. The batches are shipped from the manufacturer to the buyers with the help of a third-party logistics service provider who offers a number of types of vehicles to the buyers. Each type of vehicle has a buyer-specific transportation lead-time and a buyer-specific transportation cost per shipment. Thus a particular type of vehicle can have different transportation lead times and different transportation costs for different buyers. The transportation cost is borne to the buyers. A service level constraint has also been defined for each of the buyers. The problem is formulated as an MINLP (Mixed Integer Non-Linear Programming) model and is solved for the maximum supply chain profit. Sensitivity analysis has been conducted to illustrate the effect of the service level constraint and demand uncertainties.

Keywords: *Price-sensitive stochastic demand; Mixed Integer Non-Linear Programming; discrete transportation lead time; service level constraint*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 138

Measuring the Efficiency of individual Line of Businesses of general insurance companies in India Using Data Envelopment Analysis

Monika Mittal, Lav Ishan

Birla Institute of Management Technology, India

Abstract

Insurance sector play's a key role in country's financial services. If this crucial sector was missing, the consequences on the country's economy would have been devastating and would have also affected the perpetual business related activities. In India, earlier insurance industry is classified as Life Insurance and General Insurance. The general insurance industry is further divided among various lines of business like Fire Insurance, Marine Insurance, Engineering Insurance, Liability Insurance, Motor Insurance, Travel Insurance, Home Insurance etc. Insurance companies, their investors, stakeholders, regulators etc. are interested in the performance assessment or we can say the efficiency measurement of company. Several works in this direction had been carried out by the researchers using Data Envelopment Analysis approach, but it has been seen that the input depends on the total premium collection and the output which comes out will only give the perspective related to the total premium, because of which it is difficult to judge the individual measures of efficiency for the individual line of business of the insurance company and importantly for the major lines of business. So, it is necessary for the companies to measure the efficiency of individual lines of business of the insurance company so that it can be find out that which LOB is doing well and on which the company has to look upon for the improvement in future which will affect the company growth also.

Keywords: *Indian Insurance Industry; General Insurance; Line of Business; Data Envelopment Analysis; Efficiency Measurement*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 139

A heuristic approach to Fixed budget Tourist Trip Design Problem

A. Vashishth¹ and K. Gupta²

¹*Operations Management and Quantitative Techniques, Indian Institute of Management*

Trichy,

Tamil Nadu, India

²*Analyst, Energy Analytics Lab, Indian Institute of Technology Kanpur, India*

Abstract

Generally, tourists face difficulties to visit a destination while covering all the available attractions during the limited span. Consequently, the tourists select the most valuable points of interest (POIs) according to their preferences. Determining a route to visit the selected POIs is a challenging job as it involves a lot of constraints such as visiting time required for each POI, the distance among various POIs, the time window for a particular spot, the total time available with the tourist for sightseeing and the cost associated with each POI, as he has a limited amount of time and money to invest. This problem of designing a route plan for the tourist interested in visiting multiple POIs is known as the Tourist Trip Design Problem (TTDP). A TTDP solution gives the order in which a tourist can visit the points of his or her interest satisfying all the constraints and preferences. This article focuses on TTDP with inflexible budget where in addition to the time constraint, a budget constraint is also imposed. The problem pertains to tourists with a fixed budget to spend and have to visit the POIs with some inflexible cost associated to it such as the entrance ticket cost, photography ticket cost etc. This problem is formulated and solved as an orienteering problem where a set of vertices is given, each with a score. The proposed heuristic determines a path limited in length that visits some selected vertices maximizing the sum of the collected scores.

Keywords: *Valuable points of interest (POIs), Tourist Trip Design Problem (TTDP), Maximization*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 140

Refurbished vs Shared Markets: A perspective from Healthcare Sector

Tania Saha, Sumanta Basu

Indian Institute of Management Calcutta, India

Abstract

The inadequate access and low level of penetration of medical equipment is a serious challenge in developing countries (Mateosian, 2001). The major reasons for medical equipment unavailability are high capital cost and underutilization of medical assets. The traditional business model encourages hospitals to buy equipment at an exorbitant price. Other economic models are refurbished and shared models. Refurbished equipment is often perceived as an affordable alternative to expensive high-end equipment (Solomon, 2019). Being "remanufactured, reconditioned", the refurbished equipments are often perceived as "second hand" or "used" equipments. Because of the negative perception of such devices, most healthcare service providers are risk-averse in buying refurbished medical devices. Whereas, under the shared market, the hospitals can share underutilized medical equipment to the one in need. This sharing can lead to accessibility to advanced healthcare features, facilitate in tapping the latent capacity of the idle machines and can result in reduction in healthcare cost. We study two for-profit hospitals operating in two different markets served by a single manufacturer. One of the hospitals is budget-constrained and decides whether to buy refurbished device or take it on share from the other hospital already in possession of the new device. We study how the presence of both shared and refurbished market affects the decisions of the stakeholders involved. From the manufacturer's point of view, we study whether the manufacturer should target both the markets and sell both new and refurbished device or should target only one of the markets and sell only new device.

Keywords: *Remanufactured, Refurbished equipment, Economic Models*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 142

IMS maturity and its impact on Operational Performance

Abhishek Vashishth, Ayon Chakraborty

Indian Institute of Management Tiruchirappalli, Tamil Nadu, India

Abstract

The ever increasing customer demand for improved quality and the introduction of various industry specific management systems has given rise to the concept of Integrated Management System (IMS). The underlying proposition behind IMS is to reduce the several individual management systems into one integrated management system supporting efficient operations. Most of the research in management system implementation focuses on the large firms and the literature suggests that the implementation of larger enterprise concepts straight to SMEs might lead to failure as the small businesses are not 'little' large businesses. Thus, it becomes increasingly important to study the implementation of the Integrated Management Systems in SMEs in order to improve the operational performance of the SMEs. The objective of this study is manifold. Firstly, we aim to identify the critical success factors, motivations, benefits and the challenges for implementing IMS through a review of the extant literature on IMS. Then, we present a measurement model to measure the impact of the antecedents of IMS implementation (such as challenges and motivation) on the integration level of IMS (IMS maturity) and its subsequent impact on SMEs operational performance. Finally, our second measurement model examines the mediating role of supply chain integration moderated by environmental uncertainty on the relationship between IMS maturity level and operational performance of SMEs. In conclusion, we aim to explore how SMEs can achieve maximum benefits from IMS implementation based on environmental uncertainty, challenges and motivation.

Keywords: *Operational Performance, Integrated Management System (IMS), SME*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 143

The Shapley Value Based Compliance Table for Ambulance Repositioning

¹S Parthasarathy Parthasarathy and ²R K Amit

¹ & ² *IIT Madras*

Abstract

One of the key dilemmas for ambulance service providers is where to reposition the ambulances to improve coverage. In this paper, we propose a game theory-based methodology to quantify the importance of a base station in a network using the Shapley value. We develop a nested compliance table that maps the available ambulances to the base stations, using the Shapley value of each base station. Our simulation experiments show that the compliance table developed using the Shapley value results in better coverage than the traditional compliance table based on the criticality of the location.

Keywords: *Compliance table, Ambulance repositioning, Shapley value*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 144

A long horizon stochastic inventory routing problem for liquid nitrogen delivery

Saurabh Chandra

Indian Institute of Management Indore

Abstract

Animal husbandry department it's responsible for maintaining adequate inventory of liquid nitrogen at many livestock locations under its purview. The consumption rates for nitrogen at each location is dynamic due to variations in temperature, usage and transportation conditions. To develop a decision support system for this process, we propose two simple heuristic algorithms for planning deliveries and vehicle routing. The heuristics are compared with a hybrid ant colony optimization algorithm for quality of their solutions. Extensive computational analysis reveals that a fixed route, dynamic deployment heuristic performs better in terms of total cost in the long run in most probabilistic scenarios.

Keywords: *Inventory routing problem; ant colony optimization; animal husbandry; heuristics*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 146

A course timetabling problem

¹Ankit Rathore and ²Avijit Khanra

¹ & ²Indian Institute of Technology Kanpur

Abstract

Timetabling problem is a type of scheduling problem in which events are assigned to time-slots. Events can be any kind of activity that is to be scheduled such as courses, examinations, lab sessions, etc. This problem has a rich history. Since 1960s, researchers in the domain of operation research and artificial intelligence have studied different versions of this problem. There are two major types of timetabling problem - course timetabling problem and examination timetabling problem. In this paper, we solve the course timetabling problem of Industrial and Management Engineering Department of Indian Institute of Technology Kanpur. The problem is to assign a set of courses offered by a group of faculty members for different student groups in given time-slots, while satisfying some hard and soft constraints. We formulated the problem as a 0-1 integer linear programming problem in which soft constraints are used to model preferences of faculty members and students. We used goal programming technique to meet different goals set by the soft constraints. We employed branch and bound technique to solve the problem optimally. Our result shows improvement over the existing timetable, which is prepared manually, by meeting goals to a greater extent.



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 147

**Demand Forecasting and end to end supply chain optimization in tractor
manufacturing industry**

¹Mallikarjuna Reddy Padigapati, ²Jayendran Venkateswaran, ³Narayan Rangaraj and ⁴Rahul

Kale

^{1,2&3} IIT Bombay

⁴John Deere India

Abstract

Demand forecasting is one of the most important yet complex part in an industry of any scale. There are numerous factors which influences the demand of certain product. Some of these factors are price, product features, economic status of people, market conditions etc..One of the most common method of forecasting is to find pattern of sales by studying the historical performance in relation to many economic factors that affects the industry sales. There are many statistical models which are used to fit the historical data and then forecast the sales for future period by finding trend, seasonal and random parameters. In this project we will implement different statistical models and machine learning models to forecast the overall tractor industry sales and find the model which best fits our data. Clustering and other techniques are applied to group similar subsets of data. We then convert this industry sales into a company model wise sale by using some parameters.

Keywords: *Demand forecasting, Supply chain optimization, Clustering*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper 148

**Vehicle Routing Problem for Organized Health Care Waste Collection and
Optimization: A case study of Varanasi**

Abhishek Raj

IIT (BHU), Varanasi

Abstract

Waste disposal is one of the essential concerns for any developing country. When the disposal of health care waste comes, It also takes a significant place. Due to limited sources, proper disposal is not easy for developing countries. The waste produced from the hospitals and nursing homes are hazardous for living beings. Proper treatment of these wastes must be there before disposing them with municipal waste. The cost of disposal of waste is also crucial; cost includes the collection cost of waste from all the hospitals and store them temporary before send them to the incineration plant. The present study aims at Varanasi city which has almost two hundred hospitals. The location of collection centers has found. Vehicles which are collecting the waste have to travel to each hospital and health centers. In order to reduce the traveling cost, the Vehicle has to travel only to the collection centers. Due to this, there is a reduction in the overall traveling cost of the waste collecting vehicle, and finally, a reduction in disposal cost is possible.

Keywords: *Vehicle Routing, Healthcare Waste Management, Collection Centers*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 149

Striking the right balance between operational capabilities and dynamic capabilities for new product development excellence: An empirical study employing data envelopment analysis in the electronics sector

¹Pratap Kumar S, ²Radha Ramanan T and ³Muhammad Shafi

¹*National Institute of Electronics and Information Technology Calicut*

^{2&3}*NIT Calicut*

Abstract

Managers are always faced with the difficult choice: whether to improve core competencies or to remain flexible to adapt to changing environments. In the new product development (NPD) context, core competencies or operational capabilities describe the ability to identify customer requirements and come up with the right design. Dynamic capability, on the other hand, describes the ability to reconfigure and change the processes and routines used as part of operational capabilities in response to the changing environment. This research argues that there is a need to maintain a balance between the dynamic capabilities and operational capabilities to remain efficient and at the same time reasonably flexible to adapt to environmental turbulence. Drawing upon the dynamic capability literature we argue that too high level of either of these capabilities can actually hamper the performance. This empirical study uses the data from 30 new product development units in the electronics sector to analyze the impact of dynamic capabilities and operational capabilities on new product development performance. Firms are benchmarked based on their strategic and operational efficiencies employing data envelopment analysis (DEA). The concept of strategic and operational efficiencies along with the application of DEA for benchmarking gives a powerful tool in the hands of NPD managers to address the challenges of the competitive world.

Keywords: *Dynamic capabilities, operational capabilities, data envelopment analysis, new product development, performance measurement, benchmarking, multi-criteria decision making, empirical study*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 150

Aligning user experience design operations with agile scrum development framework

Abhijeet Shukla

Tata Consultancy Services

Abstract

Agile methodologies and frameworks are focused on development of digital application, they grew out of programmer's attempts to solve common pain points experienced during big software development projects. Surprisingly the Agile Manifesto (still the primary reference document delineating Agile principles) neither include user experience design people and their efforts in the framework, nor did it account for the time, resources, and research that user experience professionals need in order to create excellent designs first handedly required for development. This paper considers the objective of aligning the design operations to agile development operations. The paper presents the research outcomes of implementation of 'Perceive- Select- Act- Validate' (PSAV) method along with agile development practices as research study. Data and results obtained from the research study are utilized to articulate design operations alignment with Agile scrum development framework. It further utilizes PSAV Methodology and Matrix to create a framework for efficient design operations in designing human machine interaction. The paper also explores and articulates the PSAV Method for its compatibility with Agile development method for bridging the gap between user experience design process and Agile development practices.

Keywords: *Design operations, Development operations, Agile, Scrum, PSAV method, Human Machine Interaction design, Design process, Product design and development, Lean operations*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 151

Pre-requisites of Adopting Industry 4.0 Technologies in Manufacturing Plant

Sourabh Dubey, Sourabh Chandra

IIM Indore

Abstract

The stakeholders in the manufacturing plant are yet indecisive to embrace Industry 4.0 solutions. The initiatives launched by the government bodies and the investments made by the private companies who have embraced Industry 4.0 solution entice the stakeholders, but at the same time, the fear of the changes in the ways of working and the fitment of the solution in their landscape hold them back. In this paper, we have assessed the maturity level of the current state of automation systems vis –a – vis the expected new state (Industry 4.0). To accomplish this, we have conducted interviews to capture the voice (problems and expectations) of the functional heads involved directly and indirectly in the production activities. To corroborate the findings, we have gathered the responses of the experts from different functional areas within the same manufacturing plant through a survey questionnaire based on the ISA 95 framework. The result(s) of the data analysis shows that in the current state, significant gaps exist in the distribution of the right information to the right person at the right time. This information gap results in an inefficient run of the production cycle. With these findings, we conclude that one of the pre-requisites to adopt Industry 4.0 solutions is to define a structured information flow map with each stakeholder determining the minimum number of information points required to make the right decisions. An illustrative example of the information flow map is given in the paper.

Keywords: *Vertical Integration, Factory Automation Assessment, ISA 95, Information Map*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 152

Industrial Engineering Application in Production Unit

Ratnesh Srivastav, Prof. Jayendran Venkateswaran, Prof. Narayan Rangaraj

Indian Institute of Technology, Bombay

Abstract

The global market has created a tough competition among the manufacturing firms. Throughput rate, operational expense and inventory governs the profitability of the production unit thus both value added and non-value-added operations have to be managed and monitored appropriately. The concept of Assembly Line (AL) started decades ago is still aiding the manufacturing units to achieve their desired goal by yielding higher productivity. Any deviation in the assembly line from its designed or required parameters and breakdowns of machines hamper throughput rate and capacity utilization, which directly affects the profitability of organization as it burdens the operational expense. In this paper, the methodology of Assembly line balancing (ALB) has been used for the Top and the bottom line contributing value stream of Auto ancillary unit of BOSCH Limited located in Tamil Nadu, for checking the current status of its AL and proposing a new AL design by applying heuristic approach resulting in increase in its efficiency and reduction in the smoothness index. Statistical analysis of the bottleneck operation has been performed to identify the existing gap of the task time from its designed values. Breakdown analysis has been done to find out its effects on Overall Equipment Effectiveness (OEE) & potential output loss suffered by the organization, which helps in exploring the focus area for improvements. Study of capacity loss of the Oven (high power consuming) has been performed to know the root cause and implement the corrective action accordingly.

Keywords: *Assembly line, Assembly line balancing (ALB), Heuristic approach, Overall Equipment Effectiveness (OEE)*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 153

Mathematical Modelling and Simulation of sawmill operations with a view to improve occupational health and productivity

Himanshu M. Shukla, Mahendra Gupta, Mangesh P. Joshi

Shri Ramdeobaba College of Engineering & Management Nagpur

Abstract

The paper deals with the field data study using the sample survey for productivity enhancement and overall improvement of sawmill operations. The domestic and industrial use of wooden products is prevalent for decades and centuries. The wood obtained by cutting trees is irregular in shape and size. The Sawmills popularly termed as “Aara Machine” are used to cut the raw wood logs into perfectly size and shapes. The belt saw is used to cut the huge log of wood in the form of bars, beadings, blocks, etc. The activity involves a rotating belt saw and the log of wood gets cut by gradual feed and progressive depth of cut. The log of wood is fed manually by mill workers. The process involves a large number of human movements and the operating loads and conditions are at par level. Several problems are reported from the workers regarding health issues such as carpal tunnel syndrome, back pain, neck pain, breathlessness and many more. The approach is to develop the mathematical model to predict the response variables and simulation of sawmill operations to improve the productivity of sawmill operations. The mathematical modeling and simulation of the mathematical model provide the potential variables which can be improved to improve the target variables substantially. The model is validated and simulated to improve the production rate, accuracy and human energy expenditure in the traditional wood cutting activity. Various causes and inputs can be optimized further to improve the occupational health and productivity of sawmill operations.

Keywords: *Sawmill, mathematical modeling, occupational health, productivity improvement, simulation*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 154

Network Resilience in Clusters: Impact of Firm and Locational Disruptions

¹Shivane Pethe, ²Balram Avittathur, ³Anirvan Pant, ⁴Peeyush Mehta

^{1,2&4}*Operations Management, IIM Calcutta*

³*Strategic Management, IIM Calcutta*

Abstract

Industrial clusters present a unique context of cooperation within a highly networked set of geographically proximate firms. Due to proximity, firms gain benefits of agglomeration through formal and informal relationships. However, proximity also contributes to the intensification of competition as well as makes the cluster vulnerable to disturbances in the environment. Geographic clusters of firms are, thus, at risk of large-scale breakdowns due to disruptions such as natural disasters and labour strikes occurring in the area. Therefore, it is essential for clusters to develop resilient behaviour. In this paper, we posit that relationships within and between clusters may be visualised as a network, and we study the impact of location and firm disruptions on various network structures. We consider a simple scenario of two manufacturers and two suppliers in two locations with the locations of each firm giving us different structures. We model the production and pricing decisions of these firms and their impact on network output. Further, we define resilience of this network as the ability of the network to adapt in response to damage and retain its function through redundancy in capabilities and flexibility of relationships. We test the resilience of the network structures and the impact of increased adaptability on network output. We analyse firm decisions on two parameters: agglomeration benefits and probabilities of disruption for firm and location and present preliminary findings directed at policymakers focusing on resilient industry sectors and resilient clusters.

Keywords: *Geographic clusters, Resilient clusters, Network structures*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 155

Measuring Productivity of Indian Banks

Dilip Ambarkhane, Ardhendu Shekhar Singh, Bhama Venkataramani

Symbiosis International (Deemed University), Pune

Abstract

This paper measures total factor productivity of 21 public sector banks and 10 private sector banks in India; during the period 2005 to 2018 using Malmquist productivity index. The sample constitutes 86.34% and 93.61% of loan portfolio of scheduled commercial banks in 2005 and 2018 respectively. The data is obtained from annual reports of banks and Reserve Bank of India. The components of index namely technology change, efficiency change, scale efficiency change and pure efficiency change are regressed against the factors which are within the control of bank management. It is observed that the mean productivity of private sector banks was higher than that of public sector banks. The findings revealed that cash holdings, growth rate of assets, incremental gross non-performing assets and incremental cost of funds are negatively impacting total factor productivity or its components. Net interest margin is found to be positively impacting total factor productivity. It is found that banks are acquiring non remunerative assets. The findings have several policy implications such as faster digitization of economy, lowering of cash reserve ratio, statutory liquidity ratio and legal reforms for speedy recovery of loans. The study benchmarks major banks in India, which can be used as one of the inputs for deciding merger schemes for banks.

Keywords: *Malmquist productivity index, Indian banks, Total factor productivity, Technical efficiency, Scale efficiency, Pure efficiency*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 156

**Integrated Production Planning and Multi-echelon Inventory Placement for Dairy
Products**

Somu Gorai, Sanjeet Singh and Bodhibrata Nag

IIM Calcutta

Abstract

Dairy products are highly perishable in nature with some of the items having a perishable time as low as one to three days. Distribution decisions for such perishable products are therefore extremely critical and can't be separated from production, unlike non-perishable goods since doing so poses the risk of spoilage rendering it to become unusable by the end customers. In this paper, we attempt to address the integrated production and multi-echelon inventory placements of the production lines in a multi-product dairy firm having multiple processing plants. A mixed-integer linear programming model has been developed for the above-mentioned problem. Multiple perishable products have been considered with different but deterministic perishable times. The objective function aims to maximize benefits by considering costs like setup, processing, storage, ordering, and transportation cost. Key features of the model include multi products with different perishable time, shelf life dependent pricing, three echelons of inventory storage with different storage costs and the integrated decision of production and distribution. The efficiency and implementation of the model are demonstrated by a case study on a hypothetical dairy products manufacturing firm.

Keywords: *Integrated Production and distribution, Perishability, Multiple echelons Inventory, Cost optimization, Dairy industry*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 157

Modelling the Route Design in Animal Husbandry Supply Chain

Sanjay Choudhari

IIM Indore

Abstract

Our paper describes the livestock supply chain of artificial insemination in the animal husbandry department of Nagpur district. It supplies need of highly fertile frozen semen doses to livestock locations. These semen doses straws need to be stored in the cryogenic temperature and liquid nitrogen (LN₂) which maintain such temperature during freezing, storing and distribution starting from harvesting semen to endpoint consumption. The significant part of the distribution in the livestock supply chain is to ensure the availability of liquid nitrogen at each livestock location. The animal husbandry department at regular intervals supplies the liquid Nitrogen on each route on an average once a month to replenish the inventory. The department has prepared nine major routes in order to facilitate the delivery of liquid Nitrogen to each livestock location. The rationale behind planning each route was to minimize the total cost of transportation and reduce the length of trip for each visit. This judgment and rational has seen to be resulted in the pattern of all the nine routes. The contribution of our work is the use of the vehicle routing planning (VRP) concept and demonstrating the applicability of such supply chain or Operation Research (OR) model in the agriculture industry by developing the spreadsheet model to solve real-life problem at large scale. The proposed route design by model shows significant saving in supply chain cost and being extended to other districts of Maharashtra also for the possible implementation.

Keywords: *Logistics, agricultural logistics, supply chain management, vehicle routing problem*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 159

A Data Envelopment Approach for Energy Efficient Habitats

Faiz Hamid and Sri Vanamalla V

Department of IME, IIT Kanpur, Kanpur 208016

Abstract

This study develops a scientific procedure to evaluate habitat energy efficiency. Here residential buildings are considered as decision making units. A group of buildings in a residential area are analyzed using data envelopment analysis (DEA) to determine if they are operating efficiently. The most important step in carrying out this comparative assessment is the identification of the input-output variables and the exclusivity and exhaustiveness relationship between them. The result of this study will help to identify efficient and inefficient appliances used in the habitat. The inefficient habitats are further investigated to detect inefficiencies in its input and output parameter values. Through sensitivity analysis input and output parameters will be refined to make them efficient. Additionally, the coefficient of the input parameters determined through the study give insights for pricing different sources of energy. Thus, these parameters can be optimized to make green sources of energy more attractive for household use through suitable pricing policies.



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 161

A Mathematical Model for Lean-Green Supply Chain Planning

Mamta Sahare

Indian Institute of Management Indore

Abstract

Over the past few years, firms have been imposed to concentrate more on improving environmental performance along with embracing the economic performance of their supply chain. Hence firms have focused on implementing various practices such as lean, green, six sigma, agile etc to create a less detrimental impact on the environment. Even though the lean has been recognized a well know practice to reduce seven kinds of waste and improve economic performance, very few studies have been done to integrate the environmental aspect to design and plan lean-green supply chain using the operation research approach. In this paper, we consider Heijunka pillar of a lean system used for production/transportation leveling the different types and quantities of products over a fixed period to avoid inefficiencies in the supply chain. This Heijunka system forces the firm to keep the batch size low and thus creates a special case of facility decision and vehicle routing problem. This study considers a generic supply chain- supplier-manufacturer-distribution centre having different sizes of facilities, different modes of transportation for example truck, air with less/ more efficient engine type and different type of product for example, perishable and non-perishable product. This study addresses the two issue- first select the facilities to open and then select routes to transfer products in a predetermined delivery time. This study formulates a mathematical model having multiple objectives- cost, energy consumption, carbon emission, and water usage to determine the appropriate lean-green supply chain design which is more eco-efficient in nature.

Keywords: *Lean practice, Heijunka system, economic performance, Environmental performance, Facility decision, Vehicle route design*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 162

Integration of Operation and Strategy Perspectives for Successful Risk Governance

Ruchi Agarwal¹ and Sanjay Kallapur

Indian School of Business

Abstract

Globally, Enterprise Risk Management (ERM) has become a popular approach to understand the organisational risks at a holistic level to enhance strategic decision making. ERM sets the foundation for good risk governance; however, its success is dependent upon how well the operation and strategic perspective are aligned with each other. Companies faced issues in aligning the risk culture, reporting, a common understanding of enterprise risks and quality of risk governance at the operational and strategic levels. In this article, we will discuss the issues in integrating the two perspectives faced by large insurance companies. For the purpose, we have carried out field research from 2013-2019 to understand the gap and the ways to overcome them. The first part of the paper presents how ERM has been implemented from two perspectives in the large insurance companies, and the second part discusses the tussle between the two. Overall, we present a few learnings for academics and practitioners for the successful alignment of operational and strategic perspectives to enhance their current state of governance.

Keywords: *Operation and Strategy, Risk, Enterprise Risk Management (ERM)*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 163

Case Study: Manpower Productivity Improvement in Molding Section

Niraj Gupta and Tarun Kumar Verma

Shri Ramswaroop Memorial University

Abstract

Now days all company wants to be increase their output without increasing the input (manpower, cost, reduce waste and decrease idle time of machine and worker) so that their productivity will improve & profit will increase. This paper discusses time study methodology through which the work study has been successfully implemented. It provides the case study of work study methods of workplace at Mega Rubber Technology Pvt. Ltd. It focuses on the idle time of worker and idle time of machine, non-value-added activity, machine layout, skill evolution for achieving productivity improvement. From our study in moulding section shots/hour increased and there is reduction in manpower in terms of saving/month.

Keywords: *Productivity, Time study, Video picture camera methods, MMC*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 164

**Technological Innovativeness and Technological Alliances in the context of Indian
Manufacturing SMEs: A Qualitative Investigation**

Anup Chawan and Hari Vasudevan

Dwarkadas J. Sanghvi College of Engineering, Mumbai 400056, India

Abstract

Technological innovativeness and technological alliances are two important dimensions related to the performance of firms and literature show that they have not been much explored, especially in the context of Small and Medium Scale Manufacturing Enterprises (SMEs). It is also known that their nature is quite different in both the developed and developing countries. The aim of this research study has been to explore and increase the understanding about technological innovativeness and technological alliances in the context of Indian Manufacturing SMEs. A qualitative research approach was adopted in this study to understand the nature of technological alliances, as it influences the technological innovativeness of firms. It included five semi structured interviews conducted in five different manufacturing SMEs and was used for analysis. It was found that the technological alliances are in the form of long-term customer supplier partnerships in the SMEs involved in the manufacturing of molds, metallic machined components, engineering plastics, chemicals and bottling & packaging machines. The study also identified other types of technological alliances in the form of research and development contracts, joint development agreements and Public Private Partnership (PPP) in some SMEs. The study further recommends the need for measuring the innovativeness of government, industry associations and re-search institutions, especially in the context of SMEs.

Keywords: *Technological innovativeness, Technological alliances, SMEs, Manufacturing*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 165

An Optimization model for a Dairy Co-Operative for Sustainable Operations for Milk Collection

¹Shivshanker Singh Patel, ²Rajeev Pandey, ³Harekrishna Mishra

¹*Indian Institute of Management Vishakapatnam (INDIA)*

²*IHS Markit*

³*Institute of Rural Management Anand, Gujarat (INDIA)*

Abstract

This paper presents a solution to a route optimization problem for sustainable milk collection. A broad outline of the complex milk assembly process involving a Milk Union in milk cooperative set up is explained. The optimization model focusses on the development of an optimal routing for a designated fleet of milk tankers used in the collection and transportation of milk from farms to processors over a road network. The well-known Vehicle Routing Problem (VRP) across multiple constraints related to sustainable operations is discussed for the milk collection process. This model is developed to minimize GHG emissions from the milk supply chain while minimizing the total transportation cost of operations. In this paper, the large neighbourhood search (LNS) algorithm is used to compare the results for the scheduled collection routes to efficiently resolve routing problems distinctive to the dairy industry. The data of Kaira Milk Union, Anand (Gujarat, INDIA) is used in this paper while discussing the results of LNS solutions. The Kaira Milk union has close to 1100 Dairy Co-operatives (DC), 170 routes and 220 milk collection tankers with various capacities i.e. 5, 7, and 10 to 26 KL (Kilo Ltrs.). The heuristic solution was found to be the optimal solution for most of the clusters of DCs in the case of Kaira Milk Union.

Keywords: *Large Neighbourhood Search, Vehicle Routing Problem, Kaira Milk Union*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 166

Predicting sustainable supply chain performance based on GRI metrics and multilayer perceptron neural networks

Devendra Singh, Dr. L. Krishnanand, Dr. PRC Gopal,
NIT Warangal, Telangana

Abstract

The sustainable supply chain prediction model anticipates the values of key performance indicators also known as lagging metric, based on the leading metrics. The prediction system helps decision-makers to identify the performance gaps and helps to take necessary action plans to minimize the deviation between the targets set and the outputs that are estimated by the model. This study uses a worldwide accepted Global Reporting Initiative (GRI) metrics and evaluates values of level 1 metrics that are effects of level 2 metrics by artificial neural networks (ANN). The literature presents several sustainable supply chain performance evaluation models, however, a prediction model based on a combination of GRI and ANN is a fairly unexplored area. Multilayer perceptron neural network model has the ability to adjust with the environment of use with the help of past performance data unlike models present in the literature that require manual parameterization for updating & implementing them. MATLAB is used for the computational implementation of ANN models. From the results positive correlation between the targeted and predicted performance values for the GRI level 1 is obtained.

Keywords: *Sustainable supply chain management, GRI, multilayer perceptron*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 167

Introduction of store choice in India's food security program - Implications on demand distribution, replenishment policy and welfare enhancement

Maya Ganesh, Sarang Deo and Sripad Devalkar

Indian School of Business

Abstract

India's food security program has traditionally suffered from poor service levels due to local monopoly of retail stores. Advances in technology have enabled introduction of store choice to empower beneficiaries. However, absence of data before implementation makes it difficult to evaluate impact of choice on program performance. We model the decision-making behaviour of households availing benefits under a public welfare scheme, with respect to store choice. Using large scale program data from India's food security program, we estimate a discrete choice model to determine the drivers of choice and their impact. We then use the estimates to construct baseline scenario (no choice) and evaluate impact of choice. Further, we demonstrate empirically that this impact is mediated by demand variability at store level. Based on this insight, we establish the need for complementary supply side changes for an effective intervention. We further evaluate the performance of current replenishment policy with respect to beneficiary welfare and recommend alternate policies.

Keywords: *Demand distribution, Replenishment policy, Baseline scenario*



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XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 168

Supply Chain Resilience: A Systematic Literature Review

Tooba Ahmed

Aligarh Muslim University, Aligarh, India

Abstract

The scope of supply chain resilience (SCRES) is emerging and attracts the interest of the academic community around the world. Resilience is at the core of supply chain management principles and proper understanding and investment in resilience can lead to more efficient supply chains (Steven et al, 2015). Supply chain disturbances manifest both internal (e.g. a fire at a major manufacturing unit) and external risks (e.g. global economic meltdown). If these risks are not managed, they can deteriorate operational and financial performance (Hendricks and Singhal, 2003, 2005; Giunipero and Eltantawy, 2004). The global supply chains (SCs) of today are extremely complex networks that intend delivery of products and services in the right quantity, place and time in unpredictable markets. Instability in global markets exposes SCs to disruptions (Pettit et al., 2010) and traditional strategies are incapable towards problem solving when applied at each stage of the supply chain. To solve this problem of inadequacy of traditional risk management strategies, specialists now focus on building supply chain resilience (SCRES) strategies which not just recognize, monitor and reduce Supply Chain risks and disturbances, but also react rapidly and cost-effectively (Melnik et al., 2010). This study aims at presenting a focused review of the extant supply chain resilience (SCRES) literature and subsequently exploiting a solid methodology towards the preparation, collection and analysis of the information obtained. SCRES topics in peer reviewed journals are explored. Gaps in literature are identified with scope for further research being presented. The study employs the systematic literature review approach to examine relevant studies. Thorough literature review outlines the gaps in the supply chain resilience (SCRES) literature and divulges a strong need for a comprehensive SCRES definition along with a clear terminology for its building blocks. Moreover, there is a lack of quantitative studies as most of the research has been qualitative which lacks in assessing and measuring SCRES performance.

Keywords: *Systematic Literature Review, Supply Chain Resilience, Supply chain disruptions, Supply Chain Elements, Supply Chain Risk Management*



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XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 169

Industry Implementable Part Launch Sequence Optimization

¹Praneeth Akondi, ²Jayendran Venkateswaran, ³Ashutosh Mahajan

¹John Deere India, ^{2&3}IIT Bombay

Abstract

Fierce competition in the manufacturing industry and customer-centric business models resulted in higher product variants and ever decreasing product life spans to cater to different market segments. As a result, manufacturers are adapting to mixed model lines to avoid huge capital expenditure incurred for a separate line. The efficiency of an assembly line will be depending on line balance efficiency. Attaining 100%-line balance efficiency is a very rare scenario in mixed model assembly lines due to dynamic bottlenecks. So, Sequencing the models in a way that smooths the production will result in improved productivity.

In this paper, we will discuss how assembly launch sequence affects the overall productivity of the line. The assembly line up optimization problem is an NP-Hard combinatorial optimization problem. Inclusion of manufacturing constraints like space constraints, part availability, etc. and manufacturing preferences makes the problem much more complex to obtain useful and reliable results in limited computation time. An assembly line of heavy equipment manufacturing industry is considered and used for data collection. A model is developed using simulation software FlexSim and simulation-based optimization package is used for setting up the optimization problem. We study the quality and usability of results from one of the topmost proprietary simulation-based optimization packages (FlexSim + Optquest) when we run for limited amount of time, daily line up optimization vs weekly line up optimization, the effect of manufacturing constraints on line up optimization problem. Our observations and future work are then discussed.

Keywords: *FlexSim, Part Launch Sequence, Optimization, Assembly Lines, OptQuest, Simulation Based Optimization, Discrete Event Simulation, Soft OR, Metaheuristics, Manufacturing Constraints*



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XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 170

Waiting time reduction in a Hospital Outpatient clinic using Flexsim Simulation

Sumanta Roy, S. Prasanna Venkatesan and Saurabh Lalwani

NIT Trichy, Tiruchirappalli

Abstract

Healthcare industry in this era is rapidly growing albeit, with challenges to perform more effectively. Waiting time is one of the essential determinants of patient satisfaction. Waiting times arise for reasons such as the demand and supply imbalance, sub-optimal capacity management, and significant variability in demand for healthcare services. This research aims to build the “as is” model of an ophthalmology outpatient clinic in Tiruchirappalli, TamilNadu with the help of FlexSim Healthcare simulation (5.3.10). The input data is obtained from the clinic during January 2019 to February 2019 which includes the floor number, waiting times and processing times of optometry and consultation, first time/follow up patients, treatment type, day of the visit, time of visit with the name and designation of the physician on each day. The patient waiting time obtained using the simulation model is validated. Further, we proposed two scenarios namely adding an extra resource for Glaucoma consultation and implementing appointment scheduling to reduce the patient waiting time. From the results, it is observed that the average waiting time of a patient in the clinic is reduced by 27% and 57.9%, respectively for the proposed scenarios. The results of the proposed scenarios are validated using the t-test. The obtained results are communicated to the hospital for implementation.

Keywords: *Healthcare Simulation; Outpatient Clinic; Ophthalmology; Waiting time*



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XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 172

**Nuances of Managing Large Scale IT Transformation Projects in Oil & Gas Sector - A
Case Study**

Abhijit Deb Roy

Rajiv Gandhi Institute of Petroleum Technology

Abstract

One of the largest Oil and Gas Company in India had embarked upon implementation of IT Transformation Project (Software Project) with the primary objective of Customer Experience by connecting all the end customers in a single platform. The corporation benefits by understanding customer behaviour and purchase pattern and enables pitching of different products to the customers. It also benefits the customer with customer delight, single interface for diverse products etc. This is a one of its kind projects where every business groups within the Oil & Gas Company are looking upon to have a go to engage their end-customers. The Project is enormous with nearly 40K + touch points and have run into project delays and time over-runs. In this case, we study the chronological events in the project and various factors that might have contributed to the delay in the Project. We analyse various events and their impact in the project and the probable way around. We also analyse the various course corrections that the management has taken to keep the project in course even after a huge time over-run. In the Case, we also scrutinized the role of implementation partner in execution of the project and analyse the contributing factor in the delay of the project deliveries.

Keywords: *Project Plan, Project Management, SLA, COTS (Commercially available off-the-shelf Product)*



IME DEPARTMENT, INDIAN INSTITUTE OF TECHNOLOGY KANPUR, INDIA
XXIII Annual International Conference of the Society of Operations Management (SOM2019)

Paper ID 174

ENHANCEMENT FOR EASY EGRESS THROUGH EMERGENCY GATE OF BUS

Dr Vinay Kumar Singh^{a*}, Rahul Kumar^b, Rahul Varshney^c

Tata Technologies Ltd.

Abstract

Now-a-days, fire incidents are occurring very frequently in public transport system such as Luxury & tourist coaches etc. which causes loss of valuable human lives and property. There are a number of technologies available in market to avoid fire incidences and to reduce severity losses in public transport system. The damage caused is catastrophic when emergency system and rescue service could not trigger at right time due to improper communication and bugs in system. Victims have no prior knowledge of operation & in panic situation they are unable to find hammer & break emergency glass, in some cases hammer is also missing. So, we must further avoid and reduce the loss caused by fire accidents majorly in buses. Improved type emergency egress doors, windows and hatches can be further introduced for safety improvement. We have tried to come out with initial concept and have validated the same on proto vehicle and found it helpful and suitable.

Keywords: *Incidents, emergency system, communication system, fire accidents*



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XXIII Annual International Conference of the Society of Operations Management (SOM2019)

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Raghu Nandan Sengupta

IME Dept, IIT Kanpur, INDIA

Email: raghus@iitk.ac.in