THE 11TH TRIENNIAL CONFERENCE OF ASSOCIATION OF ASIA PACIFIC OPERATIONAL RESEARCH SOCIETIES

(APORS 2018, AUGUST 6-9)

Kathmandu, Nepal

THEME:

Operations Research and Development

ABSTRACT AND PROGRAM BOOK

Organized by :
OPERATIONAL RESEARCH SOCIETY OF NEPAL
(ORSN)

Supported by:
INTERNATIONAL FEDERATION OF
OPERATIONAL RESEARCH SOCITIES
(IFORS)

Message from Core Organizing Committee

Operational Research Society of Nepal (ORSN) expresses heartfelt welcome to all the delegates from around the world in the 11^{th} triennial APORS international conference 2018 at Kathmandu, Nepal with the theme of "Operations Research and Development". It is a historical event for ORSN after its establishment 11 years ago in 2007, February 01. Whole ORSN executive members, other members, OR academicians and professionals are excited to see this event happen, as this conference is one of its kind being organized in Nepal. We are taking this as the Operations Research festival in Nepal where experts from about 30 countries from all the continents of the world is joining hand together in Kathmandu. This conference with 158 abstracts submitted, 115 abstracts going to be presented with more than 200 participants is expected to have highest level of interaction among the OR experts, academicians, Ph. D. scholars and graduate students from different countries. The organizing committee is hopeful for maximum benefit to the participants and expect to be highly productive.
The conference aims to bring OR academicians and practitioners within the APORS community and throughout the world together to discuss theoretical development (hard OR) and practical applications of OR and related areas (soft OR). The conference also provides a platform for sharing not only among professionals but also for the enrichment for the students as they get golden opportunity to interact with experts.

This conference is not only for exploring new ideas, sharing previous experiences of seniors and academic exchanges, but, also exploring the natural beauty of Nepal. The half day "city tour" program during the conference will give great opportunity to the international delegates to get the overview of the beauty of Nepal. The conference is taking place in the capital city with only international airport of Nepal. Kathmandu is situated in a valley which is an open air museum of famous sites, ancient temples and shrines, golden pagodas, and inspiring deities. It is a city of inexhaustible historic artistic and cultural interest. Several beautiful and interesting villages and towns surrounding the valley offer ideal destinations for mini treks. The dazzling Himalayan peaks are visible from several points on the mountains around the valley.

The two distinct speakers supported by International Federation of Operational Research Societies (IFORS), i.e. IFORS Distinguished Lecture (IDL) and IFORS Tutorial Lecture (ITL), the keynote speeches by most senior, experienced and learned Professors are the main highlight of the conference. Great research works are being shared by the plenary speakers and invited speakers which is most awaited.

The organizing committee has put whole hearted effort for making this conference successful and to make all the national and international delegates feel comfortable during their stay.

We welcome all the delegates and wish for their wonderful time in Nepal.

Core organizing team, APORS 2018


Prof. Dr. Sunity Shrestha


Prof. Dr. Chang Won Lee


Francis Miranda


Degang Lieu

Message from Editorial Committee

It is immense pleasure and great privilege for ORSN, the host society, to present this “Abstract and Program Book” for "The 11^{th} Triennial Conference of Association of Asia Pacific Operational Research Societies (APORS 2018, August 6-9) being held in Kathmandu, Nepal, the official document of APORS. ORSN has annual publications of IJORN. This Abstract and Program Book is historical in the journey of ORSN.

In the recent world, Operational Research has been established as one of the important discipline widely used in industries ranging from petrochemicals to airlines, finance, computing and information technologies, supply chain management, policy modeling and public sector work, revenue management, logistics, and government, concentrating towards the development of mathematical models which can be extensively applied for the systematic analysis and optimization of variety of complex systems.

This book is the compendium of altogether 159 abstracts and / or extended abstracts contributed by distinguished scientists and research scholars from more than 30 countries covering wider super specialty areas of operational research to be presented in the conference as plenary talks, invited talks and technical talks. Among these contributions, abstracts and /or extended abstracts from management, Probability/Stochastic, Network Programming, Game Theory, Supply Chain Logistics, MCDM/Programming, Business, VRP/Scheduling and VRP/ Queuing. Similarly there are contributions from Programming Queuing and from the research area of Finance/Economics.

Utmost attempt has been made to maintain the uniformity in the format of the abstracts. In spite of our attempt complete uniformity could not be maintained because of diversity of the research papers to be incorporated in the book. Keeping in view to maintain the quality of the paper, all the abstracts were thoroughly reviewed by the relevant experts’ team, and tried to minimize any typographical and other errors as much as possible.

We hope that this compendium will be one of the important academic documents for learning and sharing research outcomes covering wider areas of research works in operational research. We also believe that this book will make the academicians, industry executives, researchers and students to travel from the point of known something to known everything in this area.

Finally, we on behalf of editorial team would like to thank all the paper contributors, all experts who reviewed the papers, technical team, press and well wishers who helped us to bring this document in this form.

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Prof. Dr. Sunity Shrestha Hada

Prof. Dr. Tanka Nath Dhamala

Prof. Dr. Shankar Prasad Khanal

APORS Member Countries

As APORS is a regional grouping of OR societies within IFORS, member societies of Asia-Pacific regions will automatically become part of APORS. By the end of 2011, APORS is consisted of 12 member societies:

SN	APORS Member Societies	Website
1	Australia (ASOR)	http://ifors.org/web/australia/
2	China (ORSC)	http://ifors.org/web/china/
3	Hong Kong (ORSHK)	http://ifors.org/web/hongkong/
4	India (ORSI)	http://ifors.org/web/india/
5	Iran (IORS)	http://ifors.org/web/iran/
6	Japan (ORSJ)	http://ifors.org/web/japan/
7	Korea (KORMS)	http://ifors.org/web/south-korea/
8	Malaysia (MSORMS)	http://ifors.org/web/malaysia/
9	Nepal (ORSN)	http://ifors.org/web/nepal/
10	New Zealand (ORSNZ)	http://ifors.org/web/new-zealand/
11	Philippines (ORSP)	http://ifors.org/web/philippines/
12	Singapore (ORSS)	http://ifors.org/web/singapore/

Source: $http://apors.asia/sub3/sub3_1.html$

Since its founding, APORS organizes a regular **triennial academic conference** every three years.
The past APORS meetings, locations, and hosts are:

SN	Year	Venue	Host/Chair
1	1988	Seoul, KOREA	Woong Bae Rha
2	1991	Beijing, CHINA	Guang-Hui Hsu
3	1994	Fukuoka, JAPAN	Masao Iri
4	1997	Melbourne, AUSTRALIA	Santosh Kumar
5	2000	Singapore	Kim Lin Chew
6	2003	New Delhi, INDIA	S.P. Mukherjee
7	2006	Manila, PHILIPPINES	Elise A. Del Rosario
8	2009	Jaipur, INDIA	Bani K Sinha
	2010	Penang, MALAYSIA	Illias Mamat
9	2012	Xi'an, CHINA	Yaxiang Yuan
10	2015	Kuching, MALAYSIA	Illias Mamat
11	2018	Kathmandu, NEPAL	Sunity Shrestha Hada

Source: $http://apors.asia/sub2/sub2_1.html$

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Program Schedule

The 11th Triennial Conference of Association of Asia Pacific Operational Research Societies

(APORS 2018, August 6-9)

Day 0: August 5, 2018

Welcome Tea/Coffee, Radission Hotel, 5.30-6.30 pm

Day 1: August 6, 2018					
S.No.	Time	Venue	Speaker	Paper	**Event**
1	07.00-08.30	LOBBY			Registration
	08.30-09.30	NEPADHUKU Hall			**Inauguration**
	09.30-10.30	**High Tea**			
	Plenary Session I | Chair: James MacGregor Smith				
2	10.30-11.10	NEPADHUKU Hall	Edward H. Kaplan	APORS102	Keynote
	11.10-11.50	NEPADHUKU Hall	Leo Liberti	APORS083	IFORS Distinguished Lecture
	11.50-12.00	**Break**			
	Invited Session I				
3	12.00-13.30 (4)	NEPADHUKU Hall	Thomas A. Weber	APORS057	Location
		Chair: Thomas A. Weber	Jesus M. Pinar-Perez, DRZ, MB.C.M	APORS018	Network
		Support:	Urmila Pyakurel, SD, TND	APORS 151	(**web presentation**)
		Ram Chandra Dhungana	Urmila Pyakurel, SD	APORS020	(**web presentation**)
		RARA Hall	LI Cheng, SY	APORS053	
		Chair: Francis Z. Miranda	Mohd Omar, ANK	APORS150	
		Support:	Ke Wang, ZH, SL	APORS008	Management
		Krishna Nakarmi	Susmita Mukhopadhyay, AG	APORS117	
	13.30-14.30	**Lunch Break**			
	Plenary Session II | Chair: James Cochran				
4	14.30-15.00	NEPADHUKU Hall	Chang Won Lee, HK	APORS073	
	15.00-15.30	NEPADHUKU Hall	Debdulal Dutta Roy	APORS076	
	15.30-16.00	NEPADHUKU Hall	N Ravichandran	APORS094	
	16.00-16.30	**Tea Break**			

Day I (continued): August 6, 2018					
	Technical Session I				
5	16.30-18.00 (8)	NEPADHUKU Hall Chair: Yu-Hong Dai Support: Bharat Singh Thapa	Hari Nandan Nath, UP, TND	APORS046	(**web presentation**)
			Durga Pd. Khanal, UP, TND	APORS116	
			Ram Chandra Dhungana, TND	APORS060	
			Nirmalya Kumar, MR, KN	APORS104	Network/
			Shiva Pd. Gupta, UP, TND	APORS056	Programming
			Santosh Gautam, UP	APORS028	
			Phanindra Pd. Bhandari, SRK	APORS034	
			Iswar Mani Adhikari, TND	APORS051	
		RARA Hall Chair Dilli Raj Sharma Support: Raju Manandhar	Aakasha Bajracharya	APORS115	
			Gyan Bahadur Tamang	APORS147	
			Prabin Acharya, TPU	APORS146	
			Dilasha Rana	APORS148	Management
			Phillips E. Obasohan, PG, MAM, AEU, AM	APORS092	
			Sandip Paudel	APORS149	
			Noora Shrestha	APORS089	
			Dibya Dhungana	APORS075	
		GOSAIKUND Chair: Mahananda Chalise Support: Gyan Mani Adhikari	Thakur Dhakal, DEL	APORS035	
			Samulson Neupane	APORS114	
			Supriya Chowdhary, BST	APORS120	
			Chandra Prasad Kalathoki	APORS121	Management
			Sabina Gautam	APORS156	
			Rajesh Gupta	APORS140	
			Gyan Mani Adhikari, MPA	APORS145	
			Debesh Lohani	APORS074	
6	16.30-17.30	Board Meeting Hall	**APORS Council Meeting**		Meeting

Day II: August 7, 2018					
	Plenary Session III | Chair: Tanka Nath Dhamala				
7	08.30-09.10	NEPADHUKU Hall	James MacGregor Smith	APORS081	IFORS Tutorial Lecture
	09.10-09.50	NEPADHUKU Hall	Matthias Ehrgott, JW	APORS112	Keynote
	09.50-10.20	**Tea Break**			
	Invited Session II				
8	10.20-12.05 (5)	NEPADHUKU Hall	Peter Sudhölter, PC, FL	APORS091	Game Theory
		Chair:	M. Josune Albizuri, JMZ	APORS038	
		Peter Sudhölter	Trine TornÃÿe Platz	APORS042	
		Support:	José M. Zarzuelo, MJA, SM	APORS084	
		Iswar Mani Adhikari	Petr Fiala	APORS066	
		RARA Hall	Diego Ruiz-Hernandez, MBCM	APORS019	Supply Chain/ Logistics
		Chair:	Ewout Reitsma, EJ, PH	APORS078	
		Diego Ruiz-Hernandez	BN, LC, ZZ, Ping Ji	APORS006	
		Support:	Igor Litvinchev, MM, TI	APORS063	
		Sushil Ghimire	Boualem Rabta, CW, GR	APORS068	
	12.05-13.20	**Lunch Break**			
	Plenary Session IV | Chair: Tatsuo Oyama				
9	13.20-13.50	NEPADHUKU Hall	Guochuan Zhang	APORS133	
	13.50-14.20	NEPADHUKU Hall	Tanka Nath Dhamala, UP	APORS095	
	14.20-14.50	NEPADHUKU Hall	Yu-Hong Dai	APORS132	
	14.50-15.05	**Break**			
	Invited Session III				
10	15:05-16.50 (5)	NEPADHUKU Hall	Erdem Aksakal, EB	APORS070	MCDM/ Programming
			Frantisek Zapletal, MS	APORS045	
		Chair: Ping Ji	S. Sarifah Radiah Shariff, NMH, SMD	APORS129	
		Support:	Adibah Shuib, KS, AK	APORS130	
		Phanindra Bhandari	Nezam Mahdavi-Amiri, NB	APORS010	
		RARA Hall	Indranil Ghosh, TDC	APORS001	Business
		Chair:	SR, Patrick Hosein, KBT	APORS118	
		Josef Jablonsky	Nan Zhu, SSH, GT	APORS087	
		Support:	NZ, Wasi Ul Hassan Shah	APORS086	
		Samulson Neupane	TM, BZ, Nan Zhu	APORS072	
	16.50-17.20	**Tea Break**			
	Panel Discussion				
11	17.20-18.20	NEPADHUKU Hall	Sung-Joo-Park	APORS109	
			Dipendra Purush Dhakal	Coordinator	
			Tatsuo Oyama	Discussant	
			Mahabir Pun	Discussant	

Day III: August 8, 2018					
	Plenary Session V | Chair: Chang Won Lee				
12	08.30-09.00	NEPADHUKU Hall	Niaz Wassan	APORS088	
	09.00-09.30	NEPADHUKU Hall	James J. Cochran	APORS131	
	9.30-10.00	NEPADHUKU Hall	Tiande Guo	APORS108	
	10.00-10.30	**Tea Break**			
	Invited Session IV				
13	10.30-12.15 (5)	NEPADHUKU Hall Chair: Patrick Hosein Support: Shiva Pd. Gupta	Patrick Hosein, NC, ED	APORS055	VRP/ Scheduling
			Xiwen Lu	APORS126	
			Zhaohui Liu	APORS125	
			SZ, Yuvraj Gajpal, SSA	APORS142	
			S. Sarifah Radiah Shariff, NNAH, SMZ	APORS003	
		RARA Hall Chair: Christopher Kirkbride Support: Basant Dhakal	Christopher Kirkbride, DRH	APORS017	Probability/ Stochastic
			Yuji Kawase, Tatsuo Oyama	APORS090	
			Tetsushi Yuge	APORS027	
			Monika Saini	APORS039	
			Ashish Kumar	APORS004	
	12.15-13.15	**Lunch Break**			
	Invited Session V				
14	13.15-14.45 (4)	NEPADHUKU Hall Chair: Nezam Mahdavi-Amiri Support: Bijay Lal Pradhan	Lai Soon LEE	APORS09	Programming/ Queuing
			Ather Aziz Raina	APORS023	
			Yong Yin	APORS107	
			Anju Khandelwal, AK	APORS032	
		RARA Hall Chair: Josef Jablonsky Support: Noora Shrestha	Josef Jablonsky	APORS021	Finance/ Economics
			Sara Rezaee Vessal, SS	APORS128	
			Ali Shantia, SA, HG	APORS127	
			Dakshata Rana Shah, RP	APORS159	
	14.45-15.00	**Break**			

Day III (continued): August 8, 2018					
	Technical Session II				
15	15.00-16.30 (8)	NEPADHUKU Hall Chair: Avanish Kumar Support: Bharat Singh Thapa	Sushil Ghimire, GBT, RPG	APORS071	Queuing
			M.I.G. Suranga Sampath	APORS059	
			Pradeep Kumar Tarei, PC	APORS067	
			Maziar Mahdavi Amiri	APORS062	
			AC, Taruna Kumari	APORS022	Probability/ Stochastic
			Sai Sarada Vedururu, MS, K.V.SS	APORS015	
			Bhagwati Devi, AC	APORS033	
			Bishwas Raj Aryal	APORS155	
		RARA Hall Chair: Adibah Shuib Support: Sunil Amatya	Arun Dongol	APORS005	Management
			Jagamati Pun, GT	APORS119	
			Hem Raj Lamichhane, GT	APORS123	
			Narayan Pd. Ghimire	APORS139	
			Anjay Kumar Mishra, SB	APORS152	
			Tikaram Chalise	APORS141	
			Reena Tuladhar	APORS105	
			Thakur Dhakal, MG, BJL, PKL, YSS, KDM	APORS061	
		GOSAIKUND Chair: Bhoj Raj Aryal Support: Gyan Bdr. Tamang	Atul Sharma	APORS153	Management
			Surya Prasad Poudel	APORS111	
			Sateesh Kumar Ojha	APORS110	
			Bijendra Shrestha	APORS157	
			Anish Mahato, AN, ST	APORS136	
			Janardan Ghimire	APORS138	
			Olusegun Kazeem Lekan, OLG, SEB	APORS154	
			Shrisha Prajapati	APORS158	
	16.30-17.00	**Tea Break**			
16	17.00-18.00	NEPADHUKU Hall	**Valedictory Session Program**		
17	18.00-18.30	NEPADHUKU Hall	**Cultural Program**		
18	18.30-20.30	**Farewell Dinner**			

Day IV: August 9, 2018		
19	10am - 16pm	**Organized city tours of international delegates within Kathmandu valley**

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Keynote/Plenary

Panel Discussion

Invited

Technical

Keynote/ Plenary

Operations Research and Public Health

Edward H. Kaplan

Yale School of Management
Yale School of Public Health
Yale School of Engineering and Applied Science

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Abstract

According to the US National Academy of Medicine, the mission of public health is to "... fulfill society's interest in assuring conditions in which people can be healthy." Major public health activities include disease surveillance and environmental risk assessment to identify population health problems and priorities; the design and delivery of health promotion and disease prevention services; and the evaluation of public health programs. Both the epidemiological science underlying public health interventions and the day-to-day operations of public health services present exciting opportunities for the application of operations research and management. This talk will illustrate applications of operations research to public health problems, with results to the benefit of us all.

Prof. Kaplan

Edward H. Kaplan is the William N. and Marie A. Beach Professor of Operations Research, Public Health, and Engineering at Yale. An elected member of both the US National Academies of Engineering and Medicine, his research in HIV prevention and counterterrorism has been recognized with the Lanchester Prize, the Edelman Award, and numerous other awards in operations research and public health. Kaplan was the President of the Institute for Operations Research and the Management Sciences (INFORMS) during 2016, where he preferred the title "Member in Chief."

Random Projections in Mathematical Programming

Leo Liberti

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Abstract

In the algorithmic trade-off between generality and efficiency, sometimes the only way out is to accept approximate methods. If all else fails, we can always fall back on heuristic methods. But some form of approximation guarantee is usually preferable. In this talk we shall discuss a set of approximating reformulations to various classes of mathematical programming problems involving matrices. Random projections are a dimensionality reduction methodology which projects a set of vectors into a much lower dimensional space, so that the projected vector set is approximately congruent to the original one with high probability. The probability of failure falls exponentially fast as the dimension increases, making this a truly "big data" methodology. We shall show how to apply this methodology to Conic Programming and (bounded) Quadratic Programming, and we shall show applications to Quantile Regression and Error-Correcting Codes.

Prof. Liberti

Leo Liberti obtained his Ph.D. in Global Optimization at Imperial College London, held postdoctoral fellowships at Politecnico di Milano and Ecole Polytechnique in France, where he then became professor and vice-president of his department. After two years as a Research Staff Member at IBM Research in New York, he became Research Director at CNRS and part-time professor at Ecole Polytechnique. His main research interests are mathematical programming with applications to industrial problems, optimization algorithms, and distance geometry.

Country Productivity and Development Efficiency Evaluation Using Data Envelopment Analysis

Chang Won Lee[1], Byung Won Lee[2]

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Abstract

This study is to explore the efficiency evaluation of country development (CD). Effective and efficient development of a country is significantly important. However, no proper performance measurement and evaluation are initiated. This study is to measure performance efficiency of CD using the Data Envelopment Analysis (DEA) and discuss the way to improve efficiency. The parameters for measuring efficiency are identified based on the existing studies on the DEA literatures. Evaluation are performed for the relative efficiency of CD in worldwide. Input and output factors are selected and the differences in efficiency were evaluated. t-test was conducted for exploring two types of CD groups in order to analyze mean differences between two groups. This study has contributed in analyzing the efficiency of CD and similar settings to improve service quality and productivity.

Keywords: Country Development (CD), Data Envelopment Analysis (DEA), Performance evaluation, Free Economic Index

Operation Research in Safe School Perception and School Attendance Motivation

Debdulal Dutta Roy

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Abstract

Operations research is the application of the methods of science to complex problems arising in the direction and management of large systems of men, machines, materials and money in industry, business, government and defence. The distinctive approach is to develop a scientific model of the system, incorporating measurement of factors such as chance and risk, with which to predict and compare the outcome of alternative decisions, strategies or controls. The purpose is to help management in determining policies and actions scientifically. Operations research is generally used in the industries for control of quality, risk, optimization and operations based on the distribution of the critical determinants. OR in the educational institutions like school is one of the most neglected areas though there is ample scope as school is socio-technical system and it follows the open-system model. Besides academic achievement level, perceptual level of students about the school is safe may be considered as good indicator of school quality assessment.

Current invited lecture aims to assess level of safe school perception. Perceiving school safe promotes the protection of students from violence, exposure to weapons and threats, theft, bullying, and the sale or use of illegal substances on school grounds.It can be assumed that safe school perception is linked to school attendance motivation. Operation research does not describe the variable only but also explores the strong predictor. This study aims at exploring specific domains of safe school perception that affect school attendance motivation.

Data ($N = 396$) were collected from Government schools located in rural areas of West Bengal, India, through two questionnaires measuring Safe School Perception and School Attendance Motivation. Safe School Perception questionnaire measures teacher student relation ($\alpha = 0.74$), Civility ($\alpha = 0.76$), Personal Safety ($\alpha = 0.68$), Non-Delinquency ($\alpha = 0.81$), Social Discrimination (α=0.23), Participation ($\alpha = 0.39$), Bullying ($\alpha = 0.23$) and Cleanliness ($\alpha = 0.53$). The scale is highly reliable in terms of internal consistency among the items irrespective of domain wise differences ($\alpha = 0.85$). The scale measuring school attendance motivation is moderately reliable ($\alpha = 0.51$). Results revealed that students perceived good teacher student relation, personal safety, non-delinquency and cleanliness but they perceived relatively high social discrimination, bullying, incivility and lacking participation. Step-wise multiple regression reveals that school attendance motivation is strongly predicted by the linear combination of bullying (satirical comments, nicknaming, cyber bullying) and teacher student relationship (communication, trust, sharing emotions etc.) . Finally some suggestions are given to prevent bullying and enhancing motivation for school attendance. These suggestions include value education, learning social and emotional skills, fostering emotional support between peers and staff, preventing usage of misappropriate speech, and implementing programs which aim towards conflict resolution, anger management, positive communication and enhancement of self efficacy.

Keywords: Safe school perception, school attendance motivation, protection of students

Service Quality by Using Social Media: The Experience of Indian Railways

N. Ravichandran

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Abstract

Indian railways is using a dedicated set of professionals in providing service quality support to its operations. The complaints are resolved in an admirably short duration with accountability.This document explores the features of the system, the back officearrangement ,nature of complaints received and system improvements that have been made based on the complaints/suggestions/feedback. The measures used for managing service quality is described and commented upon.The feedback system is placed in the overall context of operational excellence. The replicability of this system in other utility areas is discussed.

Keywords: Social media, Indian Railways, Operations, service quality

Evacuation Network Performance Modelling and Optimization

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Abstract

Recent catastrophic events (e.g. hurricanes, floods, earthquakes, and wildfires) in the United States and elsewhere in the world have underlined the importance of the network evacuation problem for planning, routing, and controlling the evacuation of the occupant population. Starting from first principles of modelling systems with random arrivals, service, and traffic congestion, we survey the impact of queues, queueing networks, finite blocking, and transportation systems and how to represent, analyze, and synthesize these evacuation problems. Numerous examples are illustrated throughout the tutorial to demonstrate the modelling principles and the beauty and practicality of the models for optimal resource allocation, routing, and topological network design. The examples include but are not limited to building evacuation, arena and convention center evacuation, metro train station evacuation, and regional evacuation problems. The mathematical models and algorithms underlying the modelling of the performance and optimization of these complex systems are presented together with their algorithms for solution. Figure 1 illustrates the emergency decision making framework. Shortest path and K-shortest paths in a multi-objective context including integer programming are utilized to optimize the routes for evacuation while finite queueing network performance models assess the throughputs, clearance times, and utilization of the queues.

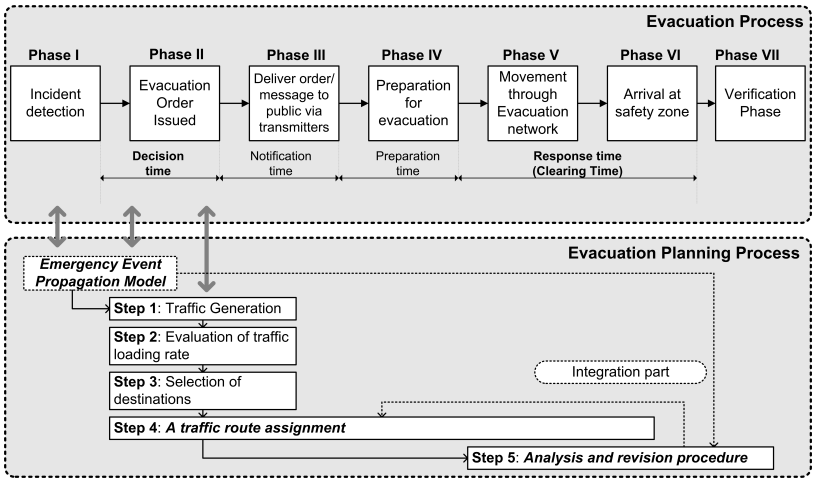

Figure 1: Emergency Evacuation Decision Making Framework

Keywords: Networks, Evacuation, Performance, Optimization

Prof. Smith

Professor at University of Massachusetts, MA. He has Ph. D. from University of Illinois at Urbana-Champaign at 1978. His research area are Topological network design; facility layout and location; stochastic network design and analysis. He has number of publications. He is honored as IE Professor of the Year Award 2005, 2006, 2007 and Best Paper Award, IIE Transactions on Manufacturing Systems (2004-2005) with Frederico Cruz.

Considerations of Sustainability in Transportation – A Case for Multi-objective Optimization

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Abstract

Traditionally, optimisation models used in transportation planning consider the optimisation of economic objectives such as minimising travel distance, travel time and monetary cost or maximising the more abstract concept of "utility". However, transportation is not a purely economic activity. It affects people and the environment in many ways, e.g., through fuel consumption and pollution. Hence decision makers at all levels – from a worker choosing a route for his commute to work to a national government aiming to reduce greenhouse gas emissions – are increasingly interested to pursue aims that fall under the wide umbrella of sustainability when making transport decisions. In this talk, we present three examples that illustrate how multi-objective optimisation can be a valuable tool to support decision making for sustainable transport.

Keywords: Transportation, Health, Reliability, Sustainability, Shortest Path, Traffic Assignment, Bi-level Optimisation, Multi-objective Optimisation

1 Healthy Route Choice for Commuter Cyclists

Commuter cyclists are often motivated by health benefits of cycling, yet they are vulnerable to exposure to traffic-related air pollution. Hence, in their route choice they face trade-offs between travel time and pollutant dose. In [1] we develop a bi-objective shortest path model, which considers the minimisation of travel time and pollutant dose. Travel time takes into account the length and slope of each link on a path as well as the average speed of the cyclist. Pollutant dose is calculated based on traffic flow, speed and vehicle fleet composition. Using a vehicle emissions prediction model these are converted to pollutant concentrations and multiplied by travel time and cyclist minute ventilation rate finally result in pollutant dose values for each link. Since both travel time and pollutant dose are additive, we can employ a bi-objective label correcting algorithm to find the set of efficient paths from which the cyclist can choose. The model is applied in a case study in Auckland, New Zealand. A set of efficient paths for a particular origin-destination pair is shown in Figure 1.

1

Prof. Ehrgott

Matthias Ehrgott studied Mathematics, Economics and Computer Science at the University of Kaiserslautern in Germany where he obtained Masters (1992), PhD (1997) and Habilitation (2001) degrees. In 2000, he moved to the Department of Engineering Science at the University of Auckland, New Zealand, as a lecturer and became full Professor and Head of Department in 2011. Since 2013, he works at Lancaster University Management School. He served as Head of the Management Science Department from 2014-2017. Matthias' research interest is in multi-objective optimisation, which he applies in a variety of areas such as medicine, transportation, and manufacturing. He has published about 100 journal papers, book chapters and proceedings contributions on theory, methodology, and applications of multi-objective optimisation. In addition, he has authored and edited about 30 books, proceedings volumes and special issues of journals on the topic. The book "Multicriteria Optimization" (Springer, 2005) is a standard monograph in the field. In total, his work has been cited more than 11,000 times (Google Scholar). He serves on the editorial board of several journals including Computers & OR and Journal of Global Optimization. Since 2002, he has been on the Executive Committee of the International Society on Multiple Criteria Decision Making, where he is president elect for the period 2019-2023. In 2011, he received the Edgeworth-Pareto award of that Society. He organized the 19th International MCDM Conference in 2008 and was on the programme committee of many other international conferences, including several MOPGP and MCDM meetings.

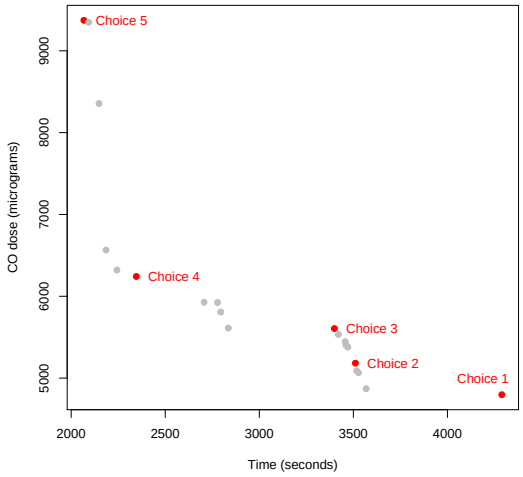

Figure 1: Efficient cycle routes in Auckland, New Zealand.

2 Bi-objective User Equilibrium Models of Travel Time Reliability

Models of route choice are also central to user equilibrium models in traffic assignment. Traffic assignment is concerned with determining how traffic flow satisfying demand for a certain number of trips between origins and destinations in a road network is distributed on the links of this network. This results in equilibrium models, where at equilibrium no user (driver) has an incentive to unilaterally switch routes, because all traffic is on "minimum cost" routes. So what does "minimum cost" mean? Empirical studies have shown that the three most important factors that influence route choice behaviour of drivers are travel time, travel time reliability and monetary cost. In many models considering these factors, a generalised cost function making use of values of time and/or values of reliability (possibly for different user classes) is considered as the route choice function, i.e., it is assumed that all drivers aim to minimise their generalised cost when choosing a route from their origin to their destination. In contrast, in [2] we introduce the following definition of bi-objective user equilibrium.

Definition 1. *Path flow vector* $\mathbf{F}$ *is a travel time reliability bi-objective user equilibrium (TTR-BUE) flow if* $\mathbf{F}$ *is feasible, i.e.* $\mathbf{F} \geq 0$, $\sum_{k \in K_p} F_k = D_p$ *for all* $p \in Z$, *and the following conditions hold.*

1. *If for any* $p \in Z$ *and any* $k, k' \in K_p$ *it holds that* $C_{k'}(\mathbf{F}) \leq C_k(\mathbf{F})$ *and* $C_{k'}(\mathbf{F}) \neq C_k(\mathbf{F})$ *then* $F_k = 0$.
2. *If for any* $p \in Z$ *and* $k \in K_p$ *it holds that* $F_k > 0$ *then there is no* $k' \in K_p$ *with* $F_{k'} > 0$ *such that* $C_{k'}(\mathbf{F}) \leq C_k(\mathbf{F})$ *and* $C_{k'}(\mathbf{F}) \neq C_k(\mathbf{F})$.

We show that the earlier concepts of travel-time-budget user equilibrium and late-arrival-penalty user equilibrium are special cases of this definition. In fact, Definition 1 gives rise to a set of TTR-BUE flows, and generalised cost user equilibrium flows are specific TTR-BUE flows as shown in Figure 2 for a three-link network.

It is important to note that the concept of bi-objective user equilibrium flow, Definition 1 can also be applied to incorporate more or other route choice factors that are related to sustainability. It is also possible to define analogous concepts for stochastic user equilibrium, see [3]

3 Road Pricing for Sustainability

Congestion pricing is a policy instrument that is used in many cities around the world, e.g., Singapore, London and Stockholm, to reduce congestion of the road network during peak hours. But it is also part of wider strategies to enhance sustainability in transport. It can improve the environment in terms of air quality and hence reduce the negative impact of vehicle emissions on health. From an optimisation point

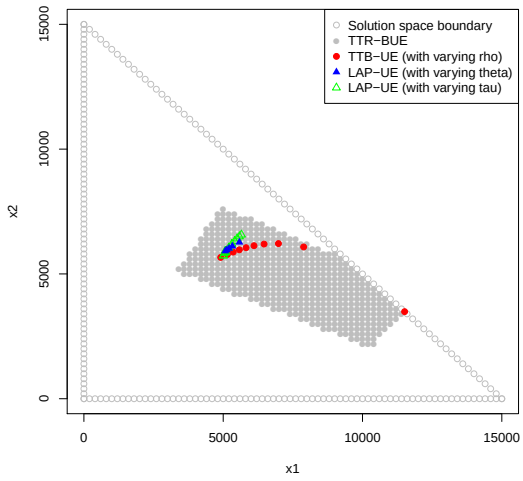

Figure 2: Bi-objective TTR-BUE flows in a three-link network.

of view, to maximise the effectiveness of congestion pricing, it is only natural to consider internalising the external costs of air pollution, including costs associated with their impact on the environment and population health, by charging road users an appropriate toll.

We consider a bi-level multi-objective model to achieve this goal. The upper level models the decision making process of the policy decision makers, which are to minimise total travel time, to minimise total vehicle emissions and to minimise negative impact on health modelled as, for example, median population CO dose. Thus at the upper level we consider a three-objective optimisation problem to determine link tolls τ_a for all links a in the network:

$$\min z_t(\mathbf{f}(\tau)) = \sum_{a \in A} f_a(\tau) t_a(f_a(\tau)), \tag{1}$$

$$\min z_e(\mathbf{f}(\tau)) = \sum_{a \in A} f_a(\tau) e_a(v_a(f_a(\tau))), \tag{2}$$

$$\min z_d(\mathbf{f}(\tau)) = \min \underset{k \in K}{\text{median}}\, d_k(\mathbf{f}(\tau)). \tag{3}$$

The lower level models the route choice behaviour of travellers given the toll values from the upper level. We assume that road users wish to minimise their travel time and their toll cost. Hence at the lower level we have a bi-objective equilibrium problem considering travel time and toll cost as route choice criteria.

In [4] we propose a game theoretical approach to this problem and develop an algorithm that combines an evolutionary multi-objective optimisation method for the upper level problem with a quasi-Newton method to handle the formulation of the equilibrium problem as a nonlinear complementarity problem at the lower level. The Pareto frontier for an example problem with a four-node network is shown in Figure 3

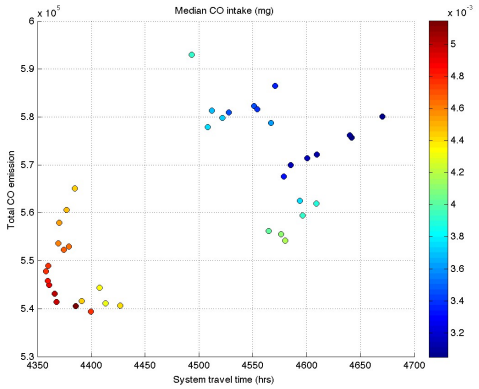

Figure 3: Pareto front for four-node network.

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Bike Rebalancing: Models and Algorithms

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Abstract

Bike sharing is an efficient way for solving the "last mile" problem in urban public transportation. In a public bike system, one can rent a bike at a station, then takes a ride to the destination, and returns the bike at a nearby station. It often arrives at a scenario that some stations have no available bikes while some other stations have no free space for returning bikes. It motivates a bike rebalancing problem, in which each station has a demand (either positive or negative) on bikes. A number of vehicles with a bounded capacity, originally located at some depots, aim to find a tour for each of them so that all demands of bike stations are met (picking up or delivering a required number of bikes for each station) and all vehicles return to the depots in a shortest time. Our approach basically consists of clustering the stations, assigning each cluster a vehicle, and routing each vehicle with a tour. It is worth mentioning that the approach is also applied to the sharing smart bike systems.

Strength and Weakness of Flow Models and Solution Strategies in Emergency Planning

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Abstract

Because of rapidly increasing number of natural and human-created disasters worldwide, researchers in the field of emergency management are highly motivated towards emergency planning and the field is being quite emerging. The operations research modeling has been the most effective approach in addressing these issues, at least partially. Although these real-life problems are modeled in diversified framework such as differential equations as fluid flow models, mathematical analysis as variational inequality optimization, optimal control and mathematical programming, none of them yield satisfactory results, being computationally challenging for large scale disasters.

In this talk, we deal with the network flow approach that has been considered more appropriate for exact or approximate results obtainable in reasonable time. Unfortunately, this macroscopic optimization approach suffers from the non-linearity (or non-convexity) of time and flow dependent attributes and the uncertainty of the scenario they appear during the emergency periods. Majority of the problems are computationally very hard because of the nonlinearity caused by traffic behavior and involved time, flow and cost dependent functions. Within this approach, we focus on lane reversal strategy that increases the flow over time values and decreases the evacuation time significantly. These models are extendable to partial contraflow reconfiguration and are also practicable for the humanitarian logistic supports and locate facilities in emergency periods. We present current status of results obtained over the last few years, discuss on the strength and weakness of the models and explore further directions on research issues for emergency planning.

Keywords: Emergency planning, network flow, contraflow, partial contraflow, variable attributes

A Family of Spectral Gradient Methods for Optimization

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Abstract

We propose a family of spectral gradient methods, whose stepsize is determined by a convex combination of the short Barzilai-Borwein (BB) stepsize and the long BB stepsize. It is shown that each member of the family shares certain quasi-Newton property in the sense of least squares. The family also includes some other gradient methods as its special cases. We prove that the family of methods is R-superlinearly convergent for two-dimensional strictly convex quadratics. Moreover, the family is R-linearly convergent in the n-dimensional case. Numerical results of the family with different settings are presented, which demonstrate that the proposed family is promising.

Changing Shapes of OR: Case of Vehicle Routing in Transport Logistics

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Abstract

The discipline of Operational Research (OR) has been continuously flourishing in a wide variety of applications; in this session, we shall keep our focus on its developments on vehicle routing in transport logistics. The presentation includes both the modelling approaches and the solution methodological developments.

In this presentation, we shall provide an overview of the changing shapes of OR in general with the growing technological developments and the varying needs of modern business and management. However the focus of the discussion will remain on how OR is making its way to cope with these changing developments and demands by exemplifying its role in the area of vehicle routing in transport logistics.

Keywords: Operational Research, Vehicle Routing, Transport Logistics

How to Discuss Big Data Intelligently in an Introductory Statistics Class

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Abstract

Discussions of big data are ubiquitous; this speaker rarely goes a day – even on weekends – without hearing or reading some reference to big data. Thus, it is natural for instructors who are teaching introductory courses in statistics, operations research, applied mathematics, and analytics to field questions from their students about this concept. Since very few textbooks written for these courses provide any meaningful discussion of the definition and ramifications of big data, instructors teaching these courses must develop a strategy for dealing with this issue in their classrooms. In this talk, the speaker will discuss the definition of big data he uses, the big data taxonomy he uses, and the ways he demonstrates simple ramifications of big data in statistics.

Optimization Models and Algorithms for Fingerprint Recognition and Its Applications in AFIS of China

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Abstract

In this talk, a general optimization model of automatic fingerprint identification system (AFIS) is proposed. To solve the general model, a serial of optimization models and algorithms are established and designed, including the modules of feature extraction and minutiae matching in AFIS. For the low-quality fingerprint images and the large database, we propose a global optimization model for orientation the field computation, a variable dimension optimization model for the singular point detection, and a bipartite graph optimization model for the minutiae matching. According to the characteristics of fingerprint image, corresponding novel algorithms are designed for these three models. These algorithms are embedded in our AFIS, which has been successfully applied to many provinces (cities) in China, and played an important role in cracking and preventing all kinds of criminal cases.

The 4^{th} Industrial Revolution and Future of OR/MS

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Abstract

The OR/MS field has been faced severe difficulties and stagnation after the booming era in the late 20^{th} Century. Academic disciplines and the number of courses taught in University had been sharply declined, the number of students and faculty members in this field were decreased, and as a result, academic departments had been closed in many top universities in advanced economies.

In this session, I will explore the reasons of the stagnation and the future directions of OR/MS. Especially, as we are facing the Fourth Industrial Revolution, I will discuss the new opportunities of OR/MS in this tectonic disruptions, i.e. OR and IoT, Robotics, Automated Vehicle, Big Data, and AI, among others. As a final thought, I will also discuss the role of APORS/IFORS in the future.

Invited

Intertemporal Fairness and the Exploitation of Nonrenewable Resources

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Abstract

The multitude of possible rules and the lack of justification for any single one of them renders the sharing of resources across generations difficult and subjective. We propose a notion of intertemporal fairness, in discrete and continuous time, which is robust, as it singles out an allocation that is 'simultaneously best' relative to all feasible Lorenz-undominated allocations. For exhaustible resources, the resulting fair allocation ensures positive consumption by all future generations. When agents have constant absolute risk aversion the unique intertemporally fair allocation is obtained in semi-closed form.

Keywords: Fairness, nonrenewable resources, optimal control, resource allocation, robust optimization.

1 Introduction

Based on an important characterization of Lorenz-dominance (Lorenz [3]; Hardy et al. [2]), Goel et al. [1] introduce a robust notion of fairness for static resource-allocation problems. In this paper, we use their fairness ratio in order to tackle the problem of robustly fair intertemporal resource allocations, which trade off among all members of a large class of (symmetric, increasing, and concave) social welfare functions. The classical utilitarian and egalitarian (Rawlsian) approaches to resource allocation are included in the possible social welfare functions. A key feature of the new approach presented here is that it avoids zero allocations for any generation, which would routinely arise in the utilitarian paradigm, as it favors present generations over sufficiently distant future generations.

2 Problem and Solution Approach

Consider the infinite-horizon optimal resource-consumption problem

$$\int_0^\infty e^{-rt}U(c(t))\,dt \;\longrightarrow\; \max,$$

subject to

$$\dot{x}(t) = -c(t), \quad x(0) = x_0, \quad x(t) \geq 0,$$

and

$$c(t) \in [0, \bar{c}], \quad t \geq 0,$$

where the positive constant $\bar{c}$ is sufficiently large, and $U : \mathbb{R} \to \mathbb{R}$ is an increasing concave utility function with nonnegative values and such that $U(0) = 0$. The initial amount of the resource $x_0 > 0$ is given. To ensure nonnegativity of the state we convert the above infinite-horizon optimal control problem into a finite-horizon optimal control problem on the interval $[0, T]$, with free endtime T and without any pure state constraints on the trajectory other than possibly at the endpoints:

$$\int_0^T e^{-rt}U(c(t))\,dt \;\longrightarrow\; \max,$$

subject to

$$\dot{x}(t) = -c(t), \quad x(0) = x_0, \quad x(T) \geq 0,$$

and

$$c(t) \in [0, \bar{c}], \quad t, T \geq 0,$$

Using the Pontryagin maximum principle it is possible to fully characterize an optimal state-control trajectory (x^*, u^*) for the resource-allocation problem (Pontryagin et al. [4]; Weber [5]). This problem can be equivalently formulated as follows:

$$P_0(y) = \int_0^T e^{-rt}y(t)\,dt \;\longrightarrow\; \max,$$

subject to

$$\dot{x}(t) = -g(y(t)), \quad x(0) = x_0, \quad x(T) \geq 0,$$

and

$$y(t) \in [0, \bar{y}], \quad t, T \geq 0,$$

where the positive constant $\bar{y}$ is sufficiently large, and $g : \mathbb{R} \to \mathbb{R}$ is an increasing convex function. From this formulation, it is possible to derive an optimized outcome for poor consumer generations (with less available resources), starting at time $t = s$, for any given $s \geq 0$, as follows:

$$P_s(y) = \int_s^T e^{-rt} y(t)\, dt \;\longrightarrow\; \max,$$

subject to

$$\dot{x} = -g(y(t)), \quad x(s) = \bar{x}(s), \quad x(T) \geq 0,$$

and

$$y(t) \in [0, \bar{y}], \quad t, T \geq s,$$

where the amount $\bar{x}(s)$ of resources left at time s is given. The solution $y^*(t, s)$ to the last problem results in the optimal "prefix" P_s^* for $\bar{x}(s)$ such that the allocation for generations in $[0, s]$ is constant. It represents the maximized discounted utility for all generations from time s onwards. Based on the notion of relative fairness introduced by Goel et al. [1], an optimal fair allocation $\hat{y}$ can be obtained by considering the "balancedness" condition (because the generations are naturally cost-ordered, later generations being always more expensive to serve than earlier ones):

$$\frac{P_s(\hat{y})}{P_s^*} = k, \quad s \geq 0.$$

At the optimum, the value k represents the optimal intertemporal fairness ratio that can be achieved relative to the class of *canonical* welfare functions, that is, all social welfare functions that are symmetric, increasing, and concave in the consumption values of time-t generations' consumption utilities.

If $V(x)$ represents the value function for the transformed resource-allocation problem with initial resource stock $x_0 = x$ (starting at time 0), then it can be shown that

$$\frac{\hat{y}(s)}{k} = rV(\bar{x}(s)) - \frac{dV(\bar{x}(s))}{ds}, \quad s \geq 0,$$

must hold for any intertemporally fair resource allocation. The missing constant k can be obtained by holding consumption constant on the interval $[0, s]$ and then optimizing the s-generation prefix P_s, which yields the "implementability" condition,

$$\bar{x}(s) + sg(\varphi(0, \bar{x}(s))) = x_0, \quad s \geq 0,$$

where the flow $\varphi(t, x) = y^*(t)$ solves the transformed allocation problem, given the initial stock $x_0 = x$. The optimal fairness ratio k is then determined by the isoperimetric constraint (referred to as "exhaustiveness" condition),

$$\int_0^\infty g(\hat{y}(t))\, dt = x_0,$$

which formalizes the notion that implementing an intertemporally fair resource allocation must be feasible and exhaust all of the available resources. A semi-explicit expression of the optimal fair allocation can be obtained for agents with constant absolute risk-aversion $\rho > 0$ with utility function $U(c) \equiv -\exp(-\rho c)$.

3 Conclusion

The three independent conditions of balancedness, implementability, and exhaustiveness pinpoint a unique fair resource-allocation trajectory $\hat{y}(t)$, for $t \geq 0$, which specifies for each generation t a consumption amount (which could be interpreted either as a the present value of an allotment or as an instantaneous consumption value). This optimal fair allocation is robust with respect to a large class of social welfare functions. In particular, the optimal fair allocation is Lorenz-undominated among all possible allocations, Pareto-optimal, and achieves the best tradeoff when evaluated with any canonical social welfare function. Most importantly, quite unlike the utilitarian approach, our optimal fair allocation avoids zero consumption of any generation because a vanishing allocation for any generation would lead to a violation of the balancedness condition.

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The K-MedianPlex Problem: Network Design When Locational Complexity Matters

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Abstract

Facility location problems are well known combinatorial problems where the objective is to minimize certain measure of the cost incurred for (or the benefit attained from) serving customers from a set of facilities. A typical location problem will either aim at maximising the demand covered by strategically locating a given number of facilities, or at finding the optimal number and location of facilities necessary for satisfying the total demand in a region.

Our aim is to bring to the field of facility location the concept of structural complexity, opening up a new research line. Broadly speaking, supply chain structural complexity refers to the negative effects of the proliferation of products, distribution channels and markets. Focusing on locational complexity, the main objective of this project is to create awareness about the need of considering complexity issues –and its impact on profitability- when deciding the location and size of a distribution network. The rationale behind our argument is that an oversized distribution network may cause hidden costs that hinder the capacity of the supply chain translating revenue into bottom-line benefits.

In this work, using a measure for structural complexity developed by the authors in previous research [1], we propose an variant of the traditional p-median problem that includes a complexity parameter in the model's formulation, the K-MedianPlex problem. Given the strongly combinatorial nature and non-convexity of the resulting objective function, we propose a constrained variant referred to as the K-Median Plex-Bounded problem, where a complexity bound is included as a constraint in a standard p-Median formulation. This constrained formulation is solved by means of an algorithm that, simulating a network's organic growth, for each possible value of the parameter p generates up to $p-1$ subordinated q-median problems seeking for a feasible solution that satisfies the complexity bound.

Our formulation is tested in networks defined over the 125 largest cities of three different countries. We also evaluate the complexity effect of different opimisation strategies and provide insights for further development and discussion.

Keywords: Structural complexity, p-Median, location, subordinated p-Median algorithm

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Network Reconfiguration with Variable Transit Times for Evacuation Planning

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Abstract

Contraflow evacuation planning is the process of shifting maximum number of evacuees from the dangerous areas to the safer places with arc reversals capability as quickly and efficiently as possible. We introduce the partial contraflow approach with the inflow dependent and load dependent transit times. In both cases, we present efficient algorithms to solve the quickest contraflow problem.

Keywords: Transportation network, evacuation planning, contraflow, quickest flow problem..

1 Introduction

After large scale disasters worldwide, an efficient, implementable and reliable evacuation planning is most essential to save life and to support humanitarian relief with optimal use and equitable distribution of available resources. An evacuation optimizer looks after a plan on evacuation network for an efficient transfer of maximum evacuees from the dangerous (sources) to safer (sinks) locations as quickly as possible. An evacuation network is defined as a dynamic network that corresponds to a region to be evacuated in which the street-intersections including sources and sinks are the nodes and the connections between these parts denote the arcs. Each arc has given limited capacity and transit time or cost. The transit time may be constant, time dependent or flow density dependent on each arc. We consider the inflow dependent and load dependent transit times in this work. The flow is defined as the group of evacuees passing through the network as a homogeneous group.

During or after disastrous situations, the evacuation planer discourage people to move towards sources from sinks because of which the corresponding road lanes are unoccupied. However, the lanes outwards from sources become more congested due to large number of evacuees and vehicles on the streets. The contraflow reconfiguration reverses the idle directions of empty lanes towards sinks satisfying the given constraints that increase the flow value, decrease the average evacuation time and save some lanes with excess capacities for an use of emergency vehicles and logistic supports needed to move towards the sources. The previous works [1, 2, 4, 3, 5] investigated the evacuation planning problem with complete contraflow configuration for constant transit time.

In this work, we investigate partial contraflow approach and solve the quickest contraflow problem with inflow dependent and load dependent transit times. In Section 2, we sketch all the necessary notations and definitions. We also introduce the partial contraflow model. In Section 3, we formulate the quickest contraflow problems with inflow dependent transit times. The quickest contraflow problems with load dependent transit times is presented in Section 4. The paper is concluded with Section 5.

2 Model of contraflow configuration

Consider an evacuation network $\mathcal{N} = (V, A, b, \tau, S, D, T)$, where V is the set of n nodes, A is the set of m arcs with sources nodes $s \in S$ and sink nodes $d \in D$, integer capacity b, transit time τ and given time horizon T within which the whole evacuation process has to be completed. Set of time horizon is denoted by $\mathbf{T} = \{0, 1, \ldots, T\}$. We assume that no arcs enter the source node and no arcs exist the sink node so that $B_s = \emptyset$ and $A_d = \emptyset$ holds, where $B_v = \{e \mid e = (u, v) \in A\}$ and $A_v = \{e \mid e = (v, u) \in A\}$.

For the constant travel time, with an amount of inflow $x_e(\theta)$ on arc $e, \theta = 0, 1, \ldots, T$, the dynamic flow

$x : A \times T \to R^+$, maximizes the flow value in objective function (1) by satisfying the constraints (2-4).

$$\max \text{val}(x,\theta) = \sum_{\sigma=0}^{\theta} \sum_{e \in A_s} x_e(\sigma) = \sum_{\sigma=\tau_e}^{\theta} \sum_{e \in B_d} x_e(\sigma - \tau_e) \quad (1)$$

$$\text{such that} \sum_{\sigma=\tau_e}^{T} \sum_{e \in B_v} x_e(\sigma - \tau_e) = \sum_{\sigma=0}^{T} \sum_{e \in A_v} x_e(\sigma),\ \forall\, v \notin \{s,d\} \quad (2)$$

$$\sum_{\sigma=\tau_e}^{\theta} \sum_{e \in B_v} x_e(\sigma - \tau_e) \geq \sum_{\sigma=0}^{\theta} \sum_{e \in A_v} x_e(\sigma),\ \forall\, v \notin \{s,d\},\ \theta \in \mathbf{T} \quad (3)$$

$$b_e(\theta) \geq x_e(\theta) \geq 0,\ \forall\, e \in A,\ \theta \in \mathbf{T} \quad (4)$$

For a given value Q_0, the quickest flow problem (QFP) looks for the minimal time $\min T = T(Q_0)$ such that the flow value is at least Q_0 satisfying the constraints (2-4) with equality in (3). The dynamic flow model is modified for the inflow dependent and load dependent transit times in [6, 7]. If transit times $\tau_e, e \in A$ is the function of inflow rate $x_e(\theta)$ on the arc e at given time point θ, then it is inflow dependent transit time and is denoted by $\tau_e(x_e(\theta))$. If the transit time depends on the total amount of flow on an arc e at a given time θ, i.e., the load $l_e(\theta)$ on e, then it is the load dependent transit times and is denoted by $\tau_e(l_e(\theta))$. With contraflow, we describe their models in Sections 3 and 4.

Let the reversal of an arc $e = (v, w)$ be $e' = (w, v)$. Then, accounting the capacities and constant transit times with reversal of arcs on given network $\mathcal{N} = (V, A, b, \tau, S, D, T)$, it creates a reconfigured network $\overline{\mathcal{N}} = (V, E, \overline{b}, \overline{\tau}, S, D, T)$ with new arc capacities $b_{\overline{e}} = b_e + b_{e'}$ and transit times $\tau_{\overline{e}} = \tau_e$ if $e \in A$ or $\tau_{e'}$ otherwise, where an edge $\overline{e} \in E$ in $\overline{\mathcal{N}}$ if $e \vee e' \in A$ in $\mathcal{N}$. The remaining graph structure and data are unaltered.

3 Contraflow with inflow dependent transit times

In this section, we investigate the quickest contraflow problem in which the transit time function depends on the current rate of inflow into that arc at any point of time. As network has two way arcs e and e', the inflow rates are $x_e(\theta)$ and $x_{e'}(\theta)$, respectively. During evacuation process, as d-s flows are not allowed, the inflow alone arc e' is zero, i.e., $x_{e'}(\theta) = 0, \theta = 0, \ldots, T$. Due to the bounded capacity b_e, the inflow $x_e(\theta)$ alone e gets congested. With contraflow configuration, the direction of the empty arc e' is changed and its capacity is added to the capacity of e so that new arc $\bar{e}$ is formed with new capacity $b_{\bar{e}}$. With increased capacity of arcs, the inflow rates may increase, i.e., $x_{\bar{e}}(\theta) \geq x_e(\theta)$, where $x_{\bar{e}}(\theta)$ is the inflow rate on the reconfigured network. Depending upon the inflow rates, the transit times also change at each point of time. As arc e' is reversed, the capacity $b_{e'}$ of the arc is used to shift flows with maximum possible inflow rate $x_{e'}(\theta)$ alone the reversed direction and its transit time is $\tau_{e'}(x_{e'}(\theta))$. As in Köhler et al. [6], we assume that the arc-wise entering flows on reconfigured network impose the pace of every unit of flow and it remains fixed throughout.

We also assume that at any moment of time, the transit time is not only integer but also a piecewise constant, non-decreasing and left-continuous function of inflow rate. The transit time of reconfigured network is $\tau_{\bar{e}}(x_{\bar{e}}(\theta))$ that may be different than the transit time $\tau_e(x_e(\theta))$ or $\tau_{e'}(x_{e'}(\theta))$ depending upon the inflow value. For example, during congestion transit time will be increased. For the constant inflow rate, the transit time is equal to the time without contraflow, i.e., $\tau_e(x_e(\theta))$ or $\tau_{e'}(x_{e'}(\theta))$. We present Algorithm 1 to solve the QCFP with inflow dependent transit times.

Algorithm 1. *QCF with inflow dependent transit times (QIFDTA)*

1. ***Input.*** *Given network $\mathcal{N} = (V, A, b, \tau, s, d)$ with given flow value Q_0.*
2. *Compute the quickest flow on reconfigured network $\overline{\mathcal{N}} = (V, E, \overline{b}, \overline{\tau}, s, d, Q_0)$ using algorithm of Köhler et al. [6] with respective capacities $b_{\overline{e}}$ and inflow dependent transit times $\tau_{\overline{e}} = \tau_{\overline{e}}(x_{\overline{e}}(\theta))$ defined as*

$$b_{\bar{e}} = b_e + b_{e'}$$

$$\tau_{\overline{e}}(x_{\overline{e}}(\theta)) = \begin{cases} \tau_e(x_e(\theta)), & \text{if } e \in A \\ \tau_{e'}(x_{e'}(\theta)), & \text{otherwise} \end{cases}$$

for all periods $\theta = 0, \ldots, T$ and edges $\overline{e} \in E$.

3. *Reverse the arc $e' \in A$ if and only if $b_e < x_e$ along the arc $e \in A$ or if $x_e > 0$ along the arc $e \notin A$.*
4. *Record the arc capacities as $\tilde{b}_{e \vee e'} = b_{\overline{e}} - x_{\overline{e}}$ for all $e \in A$.*
5. ***Output.** QCF with inflow dependent transit times and partial reversals of arc capacities for original network $\mathcal{N}$.*

Theorem 1. *An approximate solution to the QCFP with inflow dependent transit times and partial reversals of arc capacities can be computed in strongly polynomial time.*

4 Contraflow with load dependent transit times

In order to deal flows over time with the load dependent transit times, we assume as in [7] that at each moment of time, the entire flow on an arc travels with uniform speed that depends only on the current load (the amount of flow) of that arc. For the load l_e and flow rate y_e on arc e, the relation $l_e = y_e\tau_e(y_e)$ holds for a static flow. With an assumption that the function $y_e \to y_e\tau_e(y_e)$ is non-negative, strictly increasing and convex, we also denote the transit times as a function of the load $\hat{\tau}_e(l_e)$. Satisfying the former relation by the flow rate and the load, we note that $\tau_e(y_e) = \hat{\tau}_e(l_e)$. Thus the load dependent transit times model relies on the fact that the speed of flow along an arc e is proportional to the inverse of current transit time $\hat{\tau}_e(l_e(\theta))$ at any moment of time θ. For the simplicity we write the transit time $\hat{\tau}_e(l_e(\theta))$ as $\tau_e(l_e(\theta))$ for load dependent transit time in the rest of the paper. As there is also an arc e' in the network, its load dependent transit times is $\tau_{e'}(l_{e'}(\theta))$.

Here, we investigate the QCFP with load dependent transit times on each arc and with partial reversals of arc capacities. We consider *s-d* network for the investigation of the QCFP.

Recall that arc e' with load $l_{e'}(\theta)$ being empty during evacuation process, i.e., $l_{e'}(\theta)) = 0, \forall\ \theta = 0, \ldots, T$. With contraflow configuration, the empty arc e' is reversed to opposite direction and its capacity $b_{e'}$ is added to the capacity b_e of arc e, if there exits, to form new arc $\bar{e}$ with new capacity $b_{\bar{e}}$. On the reconfigured arc $\bar{e}$, the entire flow travels with uniform speed that depends only on the current load of that arc as in without contraflow. Thus let $l_{\bar{e}}(\theta)$ be the load on arc $\bar{e}$ at each point of time, i.e., $l_{\bar{e}}(\theta) \geq l_e(\theta)$. The transit time of the reconfigured arc $\bar{e}$ dependents on the current load $l_{\bar{e}}(\theta)$, i.e., $\tau_{\bar{e}}(l_{\bar{e}}(\theta)) \geq \tau_e(l_e(\theta))$, however, we assume $\tau_{\bar{e}}(l_{\bar{e}}(\theta)) = \tau_e(l_e(\theta))$ for the simplicity. If arc e' is only on the network then its reversed capacity $b_{\bar{e}}$ is equal to the original capacity $b_{e'}$ with maximum possible load $l_{e'}(\theta)$, i.e., $l_{\bar{e}}(\theta) = l_{e'}(\theta)$ and its transit time $\tau_{\bar{e}}(l_{\bar{e}}(\theta))$ is equal to $\tau_{e'}(l_{e'}(\theta))$.

We present an algorithm to solve the QCF problem with load dependent transit times, however, it is more similar to Algorithm 1. We replace the transit time in Step 3 of Algorithm 1 with $\tau_{\overline{e}}(l_{\overline{e}}(\theta)) = \tau_e(l_e(\theta))$ if $e \in A$ or $\tau_{e'}(l_{e'}(\theta))$ otherwise. Then we compute the quickest flow using algorithm of [7] on $\overline{\mathcal{N}}$.

Theorem 2. *The QCFP with load dependent transit times can be solved approximately in polynomial time by saving all unused arc capacities.*

5 Conclusions

The quickest contraflow problem with inflow dependent transit times and load dependent transit time have been investigated with partial reversals of arc capacities. Efficient algorithms have been presented for both cases that compute the approximation solutions in polynomial time.

To the best of our knowledge, these problems we introduced are for the first time in the contraflow approach. Moreover, we are interested to extend these contraflow models and algorithms to solve other dynamic network flow problems with variable transit times and make them more relevant in applications.

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Partial Lane Reversals of Transportation Network for Evacuation Planning

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Abstract

Contraflow evacuation planning increases the outward road capacities from the disastrous areas with lane reversals towards safer places. It is highly applicable for shifting maximum number of evacuees from disastrous areas to the safer places as quickly and efficiently as possible. We introduce the partial contraflow approach to solve the dynamic flow problems with constant transit times. We present an efficient algorithm that solves the earliest arrival contraflow problem with partial lane reversals. The remaining lane capacities are very useful for the logistic and emergency supports to the evacuees at disastrous areas.

Keywords: Evacuation planning, transportation network, contraflow, earliest arrival flow problem.

1 Introduction

After disasters, the process of removing residence as quickly and efficiently as possible from the disastrous areas to safer places is the evacuation planning problem. The disastrous areas and safer places are considered as sources S and sinks D, respectively and the connection between these places are lanes or arcs. There may be number of intersections of street between the connections that are considered as nodes. Each lanes have limited capacities and fixed travel times. The flow is defined as the group of evacuees passing through the network as a homogeneous group. In such transportation network, the evacuation planer discourage people to move towards sources from sinks because of which the corresponding road lanes are unoccupied. However, the lanes outwards from sources become more congested due to large number of evacuees and vehicles on the streets. The partial contraflow reconfiguration reverses the idle directions of empty lanes towards sinks satisfying the given constraints that increases the flow value, decrease the average evacuation time and save some lanes with excess capacities for an use of emergency vehicles and logistic supports needed to move towards the sources.

From the series of literature on analytical contraflow approach [5, 3, 4, 2], it is conformed that the complete contraflow configuration increases the flow value up to double for given time horizon. Similarly, evacuation time is minimized efficiently, if given flow value is to be transshipped from S to D. However, the unnecessary arc reversals are not prevented in the previous models. For example, if an arc has 3 capacities and we need to reverse only two capacity, the complete contraflow models do not care it and reverse all 3 capacities. In this work, we add a new technique in previous model that enables to reverse only necessary capacities of arcs, and it is named as partial contraflow approach. With partial contraflow configuration, we solve the earliest arrival flow problem, i.e., flow is maximized at every time point $\theta, 0 \leq \theta \leq T$ with partial reversals of arc capacities.

This work is organized as follows. Section 2 sketches all the necessary notations and definitions with the partial contraflow model. Section 3 formulates the earliest arrival contraflow problems. The paper is concluded with Section 4.

2 Model of contraflow configuration

Consider an evacuation network $\mathcal{N} = (V, A, b, \tau, S, D, T)$, where V is the set of n nodes, A is the set of m arcs with sources nodes $s \in S$ and sink nodes $d \in D$, integer capacity b, transit time τ and given time horizon T within which the whole evacuation process has to be completed. Set of time horizon is denoted by $\mathbf{T} = \{0, 1, \ldots, T\}$. We assume that no arcs enter the source node and no arcs exit the sink node so that $B_s = \emptyset$ and $A_d = \emptyset$ hold, where $B_v = \{e \mid e = (u, v) \in A\}$ and $A_v = \{e \mid e = (v, u) \in A\}$.

Let non negative function $x : A \times T \to R^+$ represent the dynamic flow. A dynamic s-d flow x for given time T satisfies the flow conservation and capacity constraints (1-3). The inequality flow conservation constraint (2) allows to wait flow at intermediate nodes, however, the equality constraint (replace the inequality in (2) by equality) forces that flow entering an intermediate node must leave it again immediately.

$$\sum_{\sigma=\tau_e}^{T}\sum_{e\in B_v} x_e(\sigma-\tau_e) \;=\; \sum_{\sigma=0}^{T}\sum_{e\in A_v} x_e(\sigma),\ \forall\, v\notin\{s,d\} \tag{1}$$

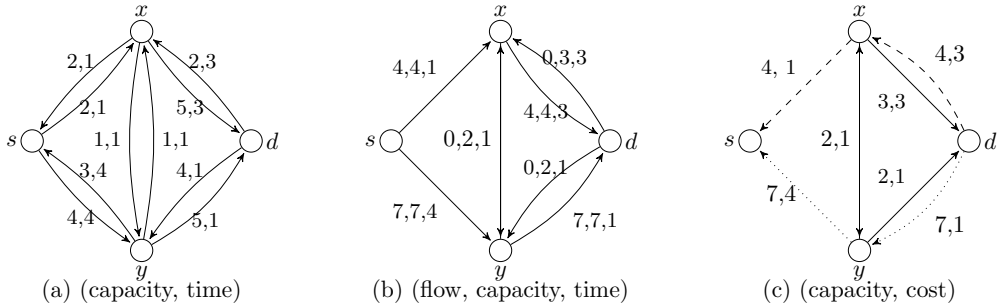
$$\sum_{\sigma=\tau_e}^{\theta}\sum_{e\in B_v} x_e(\sigma-\tau_e) \;\geq\; \sum_{\sigma=0}^{\theta}\sum_{e\in A_v} x_e(\sigma),\ \forall\, v\notin\{s,d\},\ \theta\in\mathbf{T} \tag{2}$$

$$b_e(\theta)\geq x_e(\theta) \;\geq\; 0,\ \forall\, e\in A,\ \theta\in\mathbf{T} \tag{3}$$

The earliest arrival flow problem maximizes $val(x,\theta)$ in (4) satisfying the constraints (1-3).

$$\max val(x,\theta)=\sum_{\sigma=0}^{\theta}\sum_{e\in A_s} x_e(\sigma) \;=\; \sum_{\sigma=\tau_e}^{\theta}\sum_{e\in B_d} x_e(\sigma-\tau_e) \tag{4}$$

Let the reversal of an arc $e=(v,w)$ be $e'=(w,v)$. Then, accounting the capacities and constant transit times with reversal of arcs on given network $\mathcal{N}=(V,A,b,\tau,S,D,T)$, it creates a reconfigured network $\overline{\mathcal{N}}=(V,E,\overline{b},\overline{\tau},S,D,T)$ with new arc capacities $b_{\overline{e}}=b_e+b_{e'}$ and transit times $\tau_{\overline{e}}=\tau_e$ if $e\in A$ or $\tau_{e'}$ otherwise, where an edge $\overline{e}\in E$ in $\overline{\mathcal{N}}$ if $e\vee e'\in A$ in $\mathcal{N}$. The remaining graph structure and data are unaltered. For the partial contraflow, we consider the residual network of $\overline{\mathcal{N}}$ and save the remaining residual arc capacities contained on all the augmenting s-d paths as in Figure 1(b)-(c).



(a) (capacity, time) (b) (flow, capacity, time) (c) (capacity, cost)

Figure 1: (a) Given network, (b) A maximum contraflow solution (c) Residual network

3 Earliest arrival contraflow with partial lane reversals

An efficient method to estimate the evacuation time for shifting evacuees from the sources to sinks is still demanding. So, the problem of finding maximum flow from the beginning of time point with arc reversals is important in evacuation planning. This problem is the earliest arrival contraflow problem (EACFP). The EACFP does not need estimated time period in advance.

Problem 1. *For given network $\mathcal{N}=(V,A,b,\tau,S,D,T)$ with integer input , the EACFP is to find the earliest arrival flow from S-D flow for all time θ, $0\leq\theta\leq T$ with partial reversals of arc capacities.*

In general the *S-D* EACFP is NP-hard with partial contraflow configuration. However, the EACFP can be solved efficiently in different particular networks. We modify the EACF algorithm presented by authors in [5, 3, 4, 2] by reversing only partial arc capacities and present Algorithm 1. In Step 3 of our algorithm, we use different temporally repeated flow algorithms developed for different particular networks that give the EACF solutions with partial arc reversals. For example, on two terminal series parallel and general networks, on multi-source and single sink or multi-sink and single source networks, on multi-terminal networks, the EACF problems will be investigated.

Algorithm 1. *EACF algorithm with partial lane reversals*

1. *Construct the reconfigured network $\overline{\mathcal{N}}=(V,E,\overline{b},\overline{\tau},s,d,T)$ of $\mathcal{N}$ with contraflow configuration.*
2. *Use a temporally repeated flow algorithm to obtain EAF on reconfigured network $\overline{\mathcal{N}}$*
3. *Decompose the flow into different paths and removable cycles.*

4. *Reverse arc* $e' \in A$ *if and only if* $b_e < x_e$ *along the arc* $e \in A$ *or if* $x_e > 0$ *along the arc* $e \notin A$.

5. *Record the arc capacities as* $\tilde{b}_{e \vee e'} = b_{\overline{e}} - x_{\overline{e}}$ *for all* $e \in A$.

First we apply Algorithm 1 on two terminal series parallel network. With temporally repeated flow MCCF algorithm of [7] we compute the EACF solution in strongly polynomial time with partial reversals of arc capacities. The main advantage in series-parallel graphs is that every cycle in the residual network has nonnegative cycle length.

Theorem 1. *On s-d series parallel network, the EACF solution can be computed in* $O(nm + mlogm)$ *time complexity by reversing only partial arc capacities at time zero.*

Recall that the EAFP continues the already obtained flows in earlier steps to forthcoming flows in forward steps, the final solution may change the direction of arcs and obeys the backward flow laws in its processing. Thus, with the relaxation of arc reversal time to times, the *s-d* EACF can be computed in pseudo-polynomial time by modifying the algorithm of [6] with partial arc reversals.

Theorem 2. *On s-d network, the EACFP can be solved in pseudo-polynomial time complexity by reversing only partial arc capacities at any time.*

4 Conclusions

The evacuation planning problem with complete contraflow configuration of transportation network has been studied. Partial contraflow configuration approach has been introduced by reversing only partial arc capacities. The earliest arrival contraflow problem has been solved with efficient algorithm in partial contraflow approach.

To the best of our knowledge, the problem we introduced is for the first time in the partial contraflow approach. Moreover, we are interested to extend the partial contraflow model and algorithm to solve other dynamic network flow problems with constant as well as variable transit times and make them more relevant in applications.

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An Investment Strategy for Individual Stock Based on Prediction Using ANN

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Abstract

In the business sector, it has always been a challenging task to predict the exact daily price of the stock market index. Instead, it is rather easier to forecast the direction of stock market movement. In this study, we apply artificial neural network to forecast individual stock of Japanese stock market based on data from 2007 to 2017. We choose various combinations of active functions to improve the model and get better result. Furthermore, an investment strategy is proposed based on the prediction results of individual stock.

Keywords: Artificial neural network; Individual stock; Japanese stock market; Investment strategy

1 Introduction

The issuance and trading of shares promote the development of market economy. Accurate prediction of the trends of individual stock can help investors to make right decision in trading stocks. However, the stock market is a complex system with unstable nonlinear dynamic changes. On the one hand market trend is influenced by many factors, such as political situation, financial policy, company's operating, consumer expectations, and so on. On the other hand, individual stock is highly-nonlinear and instable [[1],[2].] Therefore, it is very important to predict various kinds of financial variables to develop proper strategies and avoid the risk of potentially large losses.

2 Prediction of stock movement using ANN

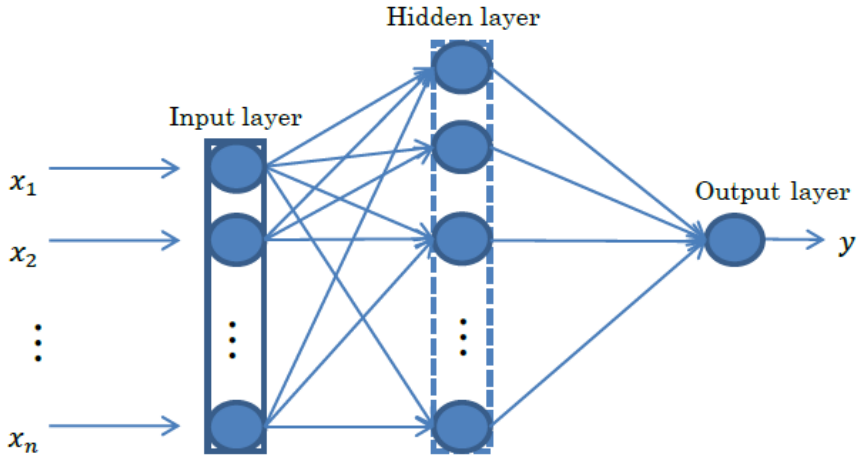

Figure 1: The architecture of a three layers model

The ANN model in this study consists of an input layer, a hidden layer and an output layer. The architecture of the ANN model is shown in Fig1. The numbers of neurons in input layer, hidden layer and output layer are 10, 20 and 1 respectively. In the light of previous researches, it is hypothesized that various technical indicators may be used as input variables in the construction of prediction models to forecast the direction of movement of individual stock. We use OBV, and the standardized closing value [3] as input variables to predict the closing value of next trading day. The output layer consists of only one neuron that represents the closing value as the output variable.

In this study, we use value of next day to subtract value of today to represent the direction of individual stock because of the detailed value can't be predicted precisely. If the result is positive, that means the stock increases in price. Otherwise, the stock declines. If predicted direction is same with true direction. That means we predict it correctly. The times of predicting correctly divided by 30 is hit ratio. The BP algorithm is a widely applied classical learning algorithm for neural networks. In the BP algorithm, we enter the sample data, and then the algorithm adjusts the weights and bias of the network by repeated training in such a way that the error between the desired output and the actual output is reduced. Previous studies showed that GA based neural network saved a lot of time for the less number of iterations and faster convergence than BP algorithm. For these reasons, GA algorithm is utilized to optimize the weights and bias of the ANN model. We set the same length of training period and testing period for the hybrid model, and then change the period to test the accuracy of the model. As shown above, the hit ratios that we have observed for individual stock is variational with different period. The average hit ratio of Sony Corporation is 85.75%. As shown in Table 1.

Training period (200 days)	Testing period (30 days)	Hit ratio
2011.1.4 - 2011.10.26	2011.10.27 - 2011.12.12	93%
2011.6.2 - 2012.3.23	2012.3.24 -2012.5.10	79%
2011.10.26 - 2012.8.16	2012.8.17 -2012.10.1	86%
2012.3.23 $\sim$ 2013.10.16	2013.1.17 $\sim$ 2013.3.1	85%
	Average ratio	85.75%

Table 1: The hit ratio of Sony Corporation stock.

3 Investment strategy

Stock investment strategy refers to methods of buying and selling stocks to avoid risk losses and gain maximum profitability. In this study, when the stock price is predicted to go down, we sell stocks at the opening price and buy at the closing price on the day. On the other hand, when the stock price is predicted to go up, we buy stocks at the opening price and sell at the closing price on the day. The profit is the different value between opening price and closing price. The simulation results showed that investment strategy is effective to get profit in Sony corporation case.

4 Conclusion

In this paper, we applied an artificial neural work that improved by genetic algorithm on predicting the direction of individual stock. As indicated above, forecasting accuracy of the neural network with weights and biases estimated by hybrid global search algorithms outperform the one that is trained by the BP algorithm. Based on the prediction result, we proposed an investment strategy. Numerical tests showed that the investment strategy is effective for more investment profit with less investment risk.

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An EPQ Model for Non-instantaneous Deteriorating Items Under Markdown Policy

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Abstract

This paper develops a non-instantaneous deteriorating inventory model with price and inventory level dependent demand that applies markdown policy. In this study, we showed that the markdown can help to sell slow moving or leftover inventory at the end of a season and increases the annual profit. Utterly deteriorated items are allowed to carry under markdown policy. The salvage value is incorporated to the deteriorated units. We develop a mathematical formulation for the model by using differential equations. Numerical examples and sensitivity analysis are used to illustrate the effectiveness of the model.

Keywords: Inventory model; Deteriorating items; Price and inventory level dependent demand; Markdown policy.

1 Introduction

Deterioration is a common scenario in our daily life. The study of deteriorating inventory started with Ghare and Schrader [1], whose presented the classical no-shortage inventory model with a constant rate of deterioration. A common characteristic of these studies is that they consider the deterioration process in the inventory takes place at the instant of their arrival. However, in reality the majority of goods have a time span for maintaining their original condition. By considering more realistic circumstances, in this paper, we establish an EPQ model in which the demand rate is a function of the inventory level and price. In order to clear the inventory and maximize the profit, particularly when demand rate is very slow, we introduce markdown policy. We develop a mathematical formulation for the problem and provide numerical examples and sensitivity analysis to highlight the theoretical results.

2 Mathematical Formulation

The behavior of inventory system at time t is illustrated in Figure 1.

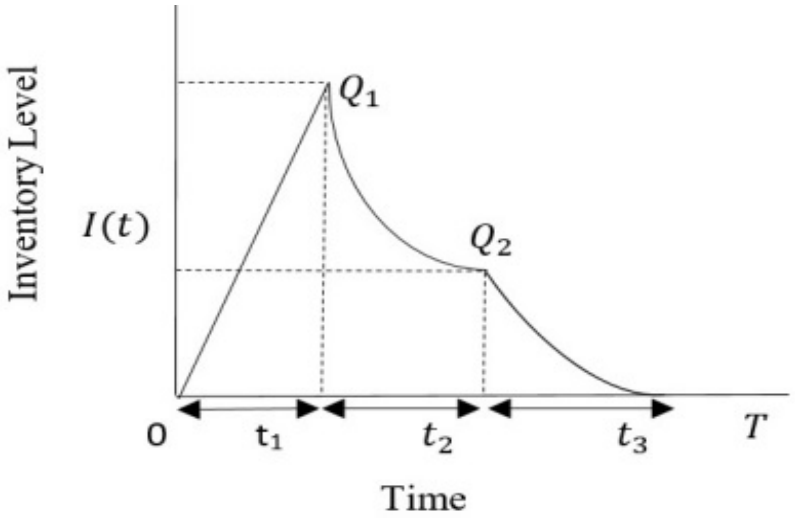

Figure 1: Graphical representation of the system

Annual profit, AP, is equal to the total revenue plus salvage value minus holding cost, deterioration cost, production cost and set up cost. Hence,

$$\begin{aligned} AP &= \frac{p}{T}\times\Big[bp^{-\epsilon}(t_1+t_2)+b(\alpha p)^{-\epsilon}t_3+\beta\big(\frac{K-bp^{-\epsilon}}{2}t_1^2+(K-bp^{-\epsilon})t_1t_2-\frac{(K-bp^{-\epsilon})(\theta+\beta)t_1t_2^2}{2}\\ &- \frac{(K-bp^{-\epsilon})\beta t_1^2t_2}{2}+\frac{(K-bp^{-\epsilon})\beta(\theta+\beta)t_1^2t_2^2}{4}-\frac{bp^{-\epsilon}t_2^2}{2}-\frac{b(\alpha p)^{-\epsilon}(\theta+\beta)^2t_3^4}{4}+\frac{b(\alpha p)^{-\epsilon}t_3^2}{2}\big)\Big]\\ &- \frac{c_h}{T}\times\Big[\frac{K-bp^{-\epsilon}}{2}t_1^2+(K-bp^{-\epsilon})t_1t_2-\frac{(K-bp^{-\epsilon})(\theta+\beta)t_1t_2^2}{2}-\frac{(K-bp^{-\epsilon})\beta t_1^2t_2}{2}\\ &+ \frac{(K-bp^{-\epsilon})\beta(\theta+\beta)t_1^2t_2^2}{4}-\frac{bp^{-\epsilon}t_2^2}{2}-\frac{b(\alpha p)^{-\epsilon}(\theta+\beta)^2t_3^4}{4}+\frac{b(\alpha p)^{-\epsilon}}{2}t_3^2\Big]\\ &- \frac{c_p(1-\lambda)\theta}{T}\times\Big[(K-bp^{-\epsilon})t_1t_2-\frac{(K-bp^{-\epsilon})(\theta+\beta)t_1t_2^2}{2}-\frac{(K-bp^{-\epsilon})\beta t_1^2t_2}{2}\\ &+ \frac{(K-bp^{-\epsilon})\beta(\theta+\beta)t_1^2t_2^2}{4}-\frac{bp^{-\epsilon}t_2^2}{2}-\frac{b(\alpha p)^{-\epsilon}(\theta+\beta)^2t_3^4}{4}+\frac{b(\alpha p)^{-\epsilon}t_3^2}{2}\Big]\\ &- \frac{Kc_pt_1}{T}-\frac{c_0}{T}. \end{aligned} \tag{1}$$

3 Numerical Example

We illustrated the model by using numerical example with the following parameter values:

Example 1: Let $c_0 = 100$, $p = 50$, $c_h = 0.05$, $c_p = 10$, $K = 200$, $\beta = 0.9$, $\theta = 0.07$, $\epsilon = 1.8$, $b = 10000$, $\lambda = 0.6$ and $\delta = 0.2$. It is assumed that the value of markdown rate, α is varying from 0.5 to 0.9. The optimal solution is solved by using excel solver.

Table 1.
Experimental result for example 1.

α	T^*	γ^*	Q_1^*	Q_2^*	AP^*
0.5	3.0	0.4195	85.8	83.2	1268.1
0.7	3.0	0.4282	88.0	46.8	1178.7
0.9	3.0	0.4284	89.5	31.0	1126.9

Table 1 shows the optimal solution for the problem. For example, when $\alpha = 0.5$ the maximum AP is 1268.1 with $Q_1^* = 85.8$ and $Q_2^* = 83.2$. We can observe that it is better to apply markdown time earlier. For example the markdown time is at time 1.6068 when alpha is equal 0.5 and at time 1.6277 when alpha is equal 0.9.

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An Environmental Efficiency Analysis in Thermal Power Industry

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Abstract

This study utilizes materials balance principle based data envelopment analysis to estimate environmental and cost efficiency of China's thermal power industry and identifies trade-offs of economic and environmental outcomes inherent in electricity generation. The estimation results show that, energy input costs and SO_2 could be reduced simultaneously through increasing technical efficiency. It is possible for this industry to adjust its energy input mix, i.e., reducing coal and oil, but increasing natural gas, to attain environmental efficient and, correspondingly, its SO_2 would be reduced. This industry would reduce unit cost by 12.1% if it attained environmental efficient and reduce unit pollution by 13.2% if attained cost efficient, which imply that, in general, there are positive environmental synergy effects associated with energy cost savings through approaching cost minimizing point and positive economic synergy effects associated with SO_2 reductions through approaching pollution minimizing point. The average shadow cost of SO_2 reduction in this industry is approximately 100 US$/kg. The high cost suggests that in short term this industry should attaint cost efficient point instead of moving forward environmental efficient point, since alternative abatement activities are less costly and in addition, some of abatement costs could be further offset by energy input cost savings.

Keywords: Cost efficiency, Data envelopment analysis, Environmental efficiency, Materials balance principle.

1 Introduction

Most of the previous studies on environmental efficiency measurements of China's electricity industry provided limited economic meanings and policy implications on the trade-offs of economic and ecological outcomes in this industry because they paid less attention on improving allocative efficiency through adjusting pollution related energy inputs, and they usually ignored to identify the economic cost and environmental impact of the energy mix adjusting strategies for improving efficiency. In this study, we propose several modified joint ecological and economic efficiency evaluation models and associated efficiency measurements which are based on the materials balance principle (MBP) and in the form of non-radial data envelopment analysis (DEA) [[1],[2], [3]] for efficiency measurement of the thermal power industry in China so as to identify both the economic and ecological trade-offs inherent in electricity generation and to further assess the impact of pollutant discharge fees and potential pollution taxes upon the levels of SO_2 emissions in China's thermal power industry.

2 Contribution

The primary contribution of this study is that it provides better understandings on the allocation efficiency of energy inputs in electricity generation, considering both the SO_2 emissions and the economic costs, which helps policy makers and managers to identify appropriate economic and ecological trade-offs, or in other words, provides them with information on how to balance the economic costs and ecological benefits of SO_2 emissions reduction in thermal power industry. Furthermore, based on the same framework, this study provides an assessment of the possible impact of the pollution taxation, which was recently released at the end of 2016 and is going to be enforced at the beginning of 2018, on the levels of SO_2 emissions and the costs of their reductions in this industry.

3 Conclusion

First, based on the current technology, both the energy input costs and the energy related SO_2 emissions in China's thermal power industry would be reduced simultaneously through eliminating the technical inefficiency of inefficient regional thermal power industry sectors. Specifically, China's thermal power

industry would reduce coal by 6.6%, oil by 36.2%, and natural gas by 8.5% annually but keep its electricity generation unchanged if it operated technically efficient. Correspondingly, its SO_2 emissions would reduce by 7.8%. Second, this industry would reduce its SO_2 emissions by 15.2% to attain ecological efficient through adjusting its energy input mix (i.e., reducing coal and oil by 15.3% and 3.1% and, as compensation, increasing natural gas by 87.9%). Actually, this is in line with China's energy development strategies for middle and long term that coal consumption in total primary energy consumption should be reduce to lower than 58%, while the proportion of natural gas consumption should be increased to higher than 10% by 2020. In addition, if this industry attained cost efficient, all three types of the energy inputs and the associated SO_2 emissions would reduce substantially. In specific, to approach the energy input cost minimizing point would result in 11.5%, 40.1% and 41.8% reductions on coal, oil and natural gas, respectively, and the corresponding SO2 emissions would decrease by 13.2%. Third, this industry would reduce per unit electricity generation cost by 9.3% if it attained ecological efficient and reduce per unit electricity generation pollution by 12.9% if attained cost efficient. This implies that it is possible for China's thermal power industry to decrease electricity generation cost by attaining the ecological efficient point, or decrease electricity generation pollution by approaching the cost efficient point. In general, there is no extra cost on pollution reduction through ecological efficiency improvement, and there is also no extra pollution on cost reduction through cost efficiency increase for China's thermal power industry as a whole. The positive ecological synergy effects associated with energy input cost savings and the positive economic synergy effects associated with SO_2 pollution reductions identified in this study provide another support to the efforts on energy conservation and emissions reduction in China's thermal power industry. Fourth, the average shadow cost of SO2 emissions reduction in China's thermal power industry is approximately 571 Yuan/kg, which is much higher than the SO_2 abatement cost in representative coal-fired power plant in China. This implies that, in general, China's thermal power industry is suggested to approach the cost minimizing point through energy input mix adjustment instead of to move further to the pollution minimizing point, since the alternative SO2 abatement activities (e.g., flue gas desulfurization) are less costly, and moreover, some of the SO_2 abatement cost could be further offset by energy input cost savings. However, we should also notice that what is true in general is not always true for specific sector. For example, there are several sectors have relative low unit shadow cost of SO2 emissions, and moving further to the pollution minimizing point is acceptable for these sectors to effectively reducing SO_2 emissions. Finally, our estimation shows that there will be no significant difference between the impacts of pollution discharge fees and pollution taxes on SO_2 emissions levels in China's thermal power industry, since even the planned upper bound of SO_2 pollution tax rate is relatively too low compared with the current energy input prices which is not likely to have significantly impact on the energy input mix adjustment and pollution abatement strategies in this industry. However, we should recognize that the planned pollution taxation mechanism has higher priority and thus will be enforced more strictly than the current pollution discharge fee mechanism. This will result in a better performance on SO_2 abatement of the pollution taxes. In summary, the findings of this study may help policy makers and managers in China's thermal power industry to identify appropriate economic and ecological trade-offs, or in another word, the estimation results provide them information on how to balance the economic costs and ecological benefits of SO_2 emissions reduction. Furthermore, the policy makers could utilize the information derived from this study as reference for setting appropriate level of pollution tax (on worse polluting energy inputs such as high-sulfur coal) or pollution reduction subsidy (on less polluting energy inputs like natural gas) so as to stimulate this industry to adjust its energy input combinations for cost-effectively reducing pollutions. Finally, we would like to point out that further analysis may additionally take into account other major air pollutions of thermal power industry, which may provide us the possibility for identifying the ecological synergistic effects of multi-pollution control strategies.

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A Study on the Safety Measure Perceptions of the Employees in ABC Steel Company

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Abstract

Introduction: In industrial context safety refers to the management of all activity within an industry aiming to reduce, control or eliminate hazards from the industrial unit to protect it from real or perceived danger. The present paper uses Classification and Predictive statisticsto study Proactive Safety Measures Effectiveness(PSME) perception of the employees in ABC Steel Company, their attitude towards safety and its relation with their Psychological Capital(PSYCAP).

Data Collection: Data is collected from primary and secondary sources.

Method: A mixed method of research is adopted where hypotheses formed from qualitative research through Unstructured Interview, FGDand Observational Research is validated through quantitative research focusing on PSYCAP of the employees and perceived PSME.

Analysis: t test, Cluster Analysis, Discriminant Analysis & Stepwise Regression Analysis

Results: Results show difference in perceived PSYCAP variables and PSMEacross two clusters; Importance of PSYCAP variables for discriminating between two clusters of perceived PSME and as predictors of PSME perception of millenials and genx.Results will be explained based on perceptual reasoning, social cognitive theory and expectancy Model of motivation.

Conclusion: An effective safety management system will be suggested for ABC Steel Company based on its employee's feedback.

Keywords: Safety, Classification and Predictive statistics

Monotonicity and Weighted Prenucleoli: A Characterization Without Consistency

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Abstract

A solution on a set of transferable utility (TU) games satisfies *strong aggregate monotonicity* (SAM) if every player can improve when the grand coalition becomes richer. It satisfies *equal surplus division* (ESD) if the solution allows the players to improve equally. We show that the set of weight systems generating weighted prenucleoli that satisfy SAM is open which implies that for weight systems close enough to any regular system the weighted prenucleolus satisfies SAM. We also provide a necessary condition for SAM for symmetrically weighted nucleoli. Moreover, we show that the per capita nucleolus on balanced games is characterized by single-valuedness (SIVA), translation and scale covariance (COV), and equal *adjusted* surplus division (EASD), a property that is comparable but stronger than ESD. These properties together with ESD characterize the per capita prenucleolus on larger sets of TU games. EASD and ESD can be transformed to *independence of (adjusted) proportional shifting* and these properties may be generalized for arbitrary weight systems p to I(A)S$_p$. We show that the p-weighted prenucleolus on the set of balanced TU games is characterized by SIVA, COV, and IAS$_p$; and on larger sets by additionally requiring IS$_p$.

Keywords: TU games, weighted prenucleolus, aggregate monotonicity, equal surplus division

1 Introduction

The core is one of the most important reference solutions for cooperative games. When restricting the attention to transferable utility (TU) games, there are widely accepted nonempty solutions like the prenucleolus, a single-valued solution that is a core selection, i.e., selects an element of the core whenever the core is nonempty. As a solution in its own right the prenucleolus may be justified by simple and intuitive axioms. Indeed, in his seminal work Sobolev [9] proved that the prenucleolus on the set of all TU games with player sets contained in an infinite universe is characterized by *single-valuedness* (SIVA), *anonymity*, *translation and scale covariance* (COV), and the *reduced game property* with respect to (w.r.t.) the Davis-Maschler [2] reduced game. It was shown that the *equal treatment property* replaces anonymity [5] and that, if the equal treatment property is used, then SIVA and the reduced game property may be replaced by *non-emptiness* and the *reconfirmation property* [6]. However, the infinity assumption of the potential universe of players is crucial in any of the aforementioned axiomatizations of the prenucleolus. It was also shown that it is impossible to suitably modify Peleg's [8] axiomatization of the prekernel that works for a finite universe of players by replacing the *converse reduced game property* by some minimality principle (see Corollary 3.8 of [6]). Up to our knowledge, there is only one characterization of the (pre)nucleolus in the literature that does not need varying player sets and consistency. Indeed, Oswald et al. [7] show that the (pre)nucleolus can be characterized with the help of an independence property and continuity. For a detailed comparison with the present characterization we refer to an explicit remark in the main part.

Our characterizations do not employ continuity and they also allow to characterize weighted prenucleoli rather than just the traditional one. For symmetrically weighted prenucleoli there are axiomatizations that are similar to Sobolev's axiomatization of the prenucleolus–only the Davis-Maschler reduced game has to be replaced by a suitable new reduced game, the definition of which depends on the weight system [4]. Hence, in the current article we present axiomatizations of the weighted prenucleoli that avoid references to any kind of reduced game and, instead, make use of the fact that all aforementioned weighted prenucleoli are core selections.

Moreover, in order to treat TU games that have an empty core (are not balanced), we employ some kind of monotonicity property in addition. Well-known monotonicity properties that are also satisfied by the core are *aggregate monotonicity* (AM), *strong aggregate monotonicity* (SAM), and *equal surplus division* (ESD). A solution satisfies AM if there is an element according to which nobody is worse off compared to any proposal of the solution of the original TU game if only the worth of the grand coalition is increased. It satisfies ESD if the additional worth of the grand coalition may be distributed equally among the players. For the formal definitions of these intuitive properties see the main part. It is well known (see, e.g., [1]) that

the per capita prenucleolus satisfies ESD (hence SAM and AM). However, when considering the class of balanced games, ESD is a rather weak property. Indeed, when diminishing the worth of the grand coalition, a balanced game may become non-balanced. Therefore, an arbitrary balanced game may never arise from another balanced game by just increasing the worth of the grand coalition. In order to receive a stronger property that is similar to ESD, satisfied by the core as well, and applicable to balanced games that do not allow to diminish exclusively the prosperity of the grand coalition, we introduce equal *adjusted* surplus division (EASD). To this end we say that a coalition is *fully exact* (called tight in [7]) if each core element assigns to this coalition precisely its worth in the game. Now, a solution satisfies equal *adjusted* surplus division (EASD) if, whenever the worth of any fully exact coalition is diminished proportionally so that the new game remains balanced, then adding equal shares to any element of the solution of the new game yields an element of the solution of the original game (see the main part for the formal definition).

We show that the per capita nucleolus on the set of balanced games with coinciding player sets N of $n \geqslant 2$ elements is axiomatized by SIVA, COV, and EASD. On all games with player sets N, ESD is needed in addition to characterize the per capita prenucleolus.

It turns out that ESD and EASD can be translated to *independence of proportional shifting* (IPS) and independence of *adjusted* proportional shifting (IAPS). A game arises from another game by proportional shifting if the worth of any proper coalition is increased proportionally to its size. Now, IPS requires that a solution element of the latter game belongs to the solution of the proportionally shifted games as well. The game arises by adjusted proportional shifting if only those coalitions that are not fully exact are shifted, and IAPS refers to the corresponding independence axiom. Hence, the per capita (pre)nucleolus on the set of balanced (all) games is axiomatized by SIVA, COV, IAPS (, and IPS).

It turns out that IPS and IAPS may be generalized to any weight system p. Instead of shifting proportionally, the shifting of a coalition has to be proportional to the inverse weight of this coalition. We prove that each weighted (pre)nucleolus is characterized by SIVA, COV, and suitably defined independence axiom(s) for the corresponding weight system. Hence, e.g., the (pre)nucleolus is axiomatized without any reference to reduced games.

We now briefly review the contents of the paper. First we offer the necessary notation, recall the relevant definitions of the considered solutions and related concepts, list properties of solutions, and provide the well-known Kohlberg criterion. Then we investigate which weighted nucleoli satisfy SAM. We generalize the inequalities characterizing symmetric weighted nucleoli that satisfy SAM in the 3-person case [3] to the n-person case. However, the conditions only remain necessary in the general n-person case. Without assuming symmetry, we show that a weighted (pre)nucleolus satisfies regular SAM as defined by [1] if and only if the weight system is *regular* (i.e., associated with a positive payoff vector). As a consequence, a weighted prenucleolus satisfies ESD if and only if it is the per capita prenucleolus. We prove the continuity of the mapping that assigns, to each weight system and game, the corresponding weighted prenucleolus and use this continuity to show that the set of weight systems generating weighted prenucleoli that satisfy SAM is open, implying, in particular, that SAM is satisfied by any weighted prenucleolus if the weights are close enough to some regular weight system. A section is devoted to the axiomatization of the per capita (pre)nucleolus without making use of any reduced game property. A further section presents the new properties IPS and IAPS, shows that these properties are equivalent to ESD and EASD, respectively, for solutions that satisfy translation covariance (TCOV), and that TCOV is crucial. Moreover, IPS and IAPS are generalized to IS_p and IAS_p, the corresponding properties depending on the weight system p. Thus, the p-weighted nucleolus on the set of balanced games is characterized by SIVA, COV, and IAS_p, whereas IS_p is needed in addition to characterize the p-weighted prenucleolus on the unrestricted set of TU games on N. The corresponding theorem, when applied to a weight system p assigning the same weight to any coalition, provides an axiomatization of the traditional (pre)nucleolus for a fixed set of n players. Moreover, it should be highlighted that non-symmetrically weighted (pre)nucleoli have not been characterized before. Finally, we offer some expansions, remarks, and comments.

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Monotonicity in Discrete Cost Sharing and Continuous Cost Sharing Problems

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Abstract

We consider here an application of cooperative game theory: cost allocation problems. Depending whether the demands of the agents are indivisible or not, these problems can be continuum or discrete problems. Here we offer alternative characterizations of the Aumann-Shapley cost sharing method for both kinds of problems. Moreover we introduce and characterize a new method for the discrete case called the Least Square cost allocation method based in the solution of the same name for cooperative games.

Keywords: continuous cost sharing, discrete cost sharing, monotonicity, Aumann-Shapley method, least square prenucleolus.

1 Introduction

Cost allocation is an area specially suitable for the application of the cooperative game theory. In this work we will consider a basic model of cost allocation problems consisting of three elements: a set of agents involved in a problem; a specification of demands requested by each agent; and finally a joint cost function. Then we will distinguish two different cases depending on the nature of the demands. More precisely, we differentiate the continuum case and the discrete case, depending wether the goods demanded by the agents are divisible or not. In both cases our attention will be focused on the Aumann-Shapley method, the cost allocation method inspired by the value of non-atomic games, that is a generalization of the Shapley value from finite games.

In the continuum case we offer a characterization of the Aumann-Shapley cost sharing method using the axiom *no merging or splitting*, already introduced by Sprumont (2005) for the discrete case. This axiom turns to be weaker than the axioms of aggregation invariance (Young, 85) or consistency (Monderer and Neyman, 1988).

Moreover, we modify slightly the axiom of *symmetric monotonicity* of Young (1985) and obtained a new characterization of the Aumann-Shapley value for the discrete case.

Finally, we define a new cost-sharing method, the least square method for discrete problems, by means of the least square prenucleolus of the transferable utility games (Ruiz et al., 1996). This new method will be characterized by several axioms, among them an average marginal monotonicity axiom.

2 Notation and Preliminaries

First we introduce the notation. Denote $\mathbf{R}$ the set of real numbers, $\mathbf{N}$ the set of non-negative integers, and $\mathcal{N}$ the set of non-empty finite subsets of $\mathbf{N}$.

If $N \in \mathcal{N}$, denote by $|N|$ the cardinality of N, and let $\mathbf{R}^N$ be the $|N|$-dimensional euclidean space with coordinates indexed by the elements of N. If $\boldsymbol{x} = (x_i)_{i\in N} \in \mathbf{R}^N$ and $M \subseteq N$ we write $x_M = (x_i)_{i\in M}$. If $\boldsymbol{x}, \boldsymbol{y} \in \mathbf{R}^N$ write $\boldsymbol{x} \leq \boldsymbol{y}$ if $x_i \leq y_i$ for all $i \in N$, and $\boldsymbol{x} * \boldsymbol{y} = (x_i \cdot y_i)_{i\in N}$. If $\boldsymbol{a}, \boldsymbol{b} \in \mathbf{R}^N$, write $[\boldsymbol{a}, \boldsymbol{b}]$ for the set $\{\boldsymbol{x} \in \mathbf{R}^N : \boldsymbol{a} \leq \boldsymbol{x} \leq \boldsymbol{b}\}$. Some distinguished vectors in $\mathbf{R}^N$ are: the origin $\mathbf{0} = (0, \ldots, 0)$; and for every $M \subseteq N$ its indicator $\mathbf{1}^M$, defined by $1^M_i = 1$ if $i \in M$ and $1^M_i = 0$ otherwise.

A *cost sharing problem* is a triple $(N, \bar{\boldsymbol{q}}, C)$, where $N \in \mathcal{N}$ represents a set of agents, $\bar{\boldsymbol{q}} = (\bar{q}_i)_{i\in N} \in \mathbf{R}^N$ is the list of their consumptions or demands, and $C(\boldsymbol{q})$ is a cost function that represents the cost of jointly producing $\boldsymbol{q} = (q_i)_{i\in N} \in [0, \bar{\boldsymbol{q}}]$. We will assume throughout $C(\mathbf{0}) = 0$.

Depending on the nature of the total demand and the cost function we have classified these problems in two different kinds: the continuum case and the discrete case.

3 The Continuum Case

We consider here cost allocation problems $(N, \bar{\boldsymbol{q}}, C)$, where $\bar{\boldsymbol{q}} \in \mathbf{R}^N_+$, and the cost function is defined on $[0, \bar{\boldsymbol{q}}] \subset \mathbf{R}^N_+$. We shall also assume that the cost function $C(q)$ has continuous first partial derivatives on its domain (one sided on the boundary). We will denote by $\mathcal{P}$ the class of these problems.

A *cost allocation method* is a mapping $\Phi : \mathcal{P} \to \mathbf{R}^N$ that specifies the price per unit that every agent has to pay in order to satisfy exactly the total cost, that is $\sum_{i\in N} \bar{q}_i \Phi_i(N, \bar{\boldsymbol{q}}, C) = C(\bar{\boldsymbol{q}})$.

Every problem $(N, \bar{\boldsymbol{q}}, C)$ can be associated with a non-atomic game. Consider the collection or set I containing together the various types of output demanded by the agents, so that I includes exactly a quantity $\bar{q}_i$ of output i. For each $S \subseteq I$, denote $c(S)$ the cost of producing S. Then (I, c) is a non-atomic game, and the Aumann-Shapley value of a unity of the output of agent i is the Aumann-Shapley price of i. That is, the Aumann-Shapley method assigns to each $i \in N$

$$AS_i(N, \bar{\boldsymbol{q}}, C) = \int_0^1 \frac{\partial C(t\bar{\boldsymbol{q}})}{\partial q_i} dt.$$

Next we describe the axioms used here to characterize the Aumann-Shapley cost allocation method

Monotonicity: Let $(N, \bar{\boldsymbol{q}}\,, f), (N, \bar{\boldsymbol{q}}\,, g) \in \mathcal{P}$. Then $\frac{\partial f}{\partial q_i} \leq \frac{\partial g}{\partial q_i}$ for all $\bar{\boldsymbol{q}} \in [0, \bar{\boldsymbol{q}}\,]$ implies $\psi_i(N, \bar{\boldsymbol{q}}\,, f) \leq \psi_i(N, \bar{\boldsymbol{q}}\,, g)$.

Rescaling Invarance: Let $(N, \bar{\boldsymbol{q}}\,, f), \in \mathcal{P}$, and $\lambda \in \mathbf{R}^N_+$. Then $\psi(N, \lambda^{-1} * \bar{\boldsymbol{q}}\,, \lambda * f) = \lambda * \psi(N, \bar{\boldsymbol{q}}\,, f)$.

No Merging or Splitting: Let $(N, \bar{\boldsymbol{q}}\,, f), \in \mathcal{P}$, and $i^0 \in N$. Let $(N \cup M, \bar{\boldsymbol{q}}\,', g) \in \mathcal{P}$, where $N \cap M = \{i^0\}$, such that $\bar{\boldsymbol{q}}\,'_{N\setminus\{i^0\}} = \bar{\boldsymbol{q}}_{\,N\setminus\{i^0\}}$ and $\sum_{j\in M} \bar{\boldsymbol{q}}\,'_j = \bar{\boldsymbol{q}}_{\,i^0}$, and $g(\bar{\boldsymbol{q}}) = g\Big(\bar{\boldsymbol{q}}_{\,N\setminus\{i^0\}}, \bar{\boldsymbol{q}}_{\,M}\Big) = f\Big(\bar{\boldsymbol{q}}_{\,N\setminus\{i^0\}}, \sum_{j\in M} \bar{\boldsymbol{q}}_{\,j}\Big)$. Then: $\sum_{j\in M} \phi_j(N \cup M, \bar{\boldsymbol{q}}\,', g) \cdot \bar{q}'_j = \phi_{i^0}(N, \bar{\boldsymbol{q}}\,, f)\bar{q}_{i^0}$.

Theorem: The Aumann-Shapley method is the unique method that satisfies monotonicity, rescaling invariance and no merging or splitting.

4 The Discrete Case

In the discrete case agents can demand several units of the good, that are indivisible. Thus in a *discrete cost allocation* problem $(N, \bar{\boldsymbol{q}}, C)$ the demands are nonnegative integer numbers, i.e. $\bar{\boldsymbol{q}} \in \mathbf{N}^N_+$, and the cost function C is defined on $[0, \bar{\boldsymbol{q}}] \cap \mathbf{N}^N_+$. We will denote by $\mathcal{P}^D$ the class of these problems. Similarly to the continuum case we have the following definition. A *discrete cost allocation method* $\psi : \mathcal{P}^D \to \mathbf{R}^N$ specifies the price per unit of every agent to balance the total cost, that is $\sum_{i\in N} \bar{q}_i \psi_i(N, \bar{\boldsymbol{q}}, C) = C(\bar{\boldsymbol{q}})$.

A cooperative game is built starting from a discrete cost allocation problem $(N, \bar{\boldsymbol{q}}, C)$. To do this the demand of each agent i is regarded as formed by $\bar{q}_i$ elements. Thus with each agent i, there is associated a set N_i with $|N_i| = \bar{q}_i$ players. The grand coalition turns to be $N^{\bar{\boldsymbol{q}}} = \bigcup_{i\in N} N_i$. Then each coalition $S \subseteq N^{\bar{\boldsymbol{q}}}$ has associated a vector of demands $\boldsymbol{q}(S) = \big(|S \cap N_i|\big)_{i\in N}$, and then the cost of producing S is

$$v^{\bar{\boldsymbol{q}},C}(S) = C\big(\boldsymbol{q}(S)\big).$$

4.1 The discrete Aumann-Shapley cost sharing method

The discrete Aumann-Shapley method, denoted $\mathcal{AS}$, assigns to every agent $i \in N$ the Shapley value of any one of its representatives in the TU game $\big(N^{\bar{\boldsymbol{q}}}, v^{\bar{\boldsymbol{q}},C}\big)$. That is, for each $i \in N$

$$\mathcal{AS}_i(N, \bar{\boldsymbol{q}}, C) = Sh_j\big(N^{\bar{\boldsymbol{q}}}, v^{\bar{\boldsymbol{q}},C}\big) \qquad \text{for every } j \in N_i.$$

We need some further notation before stating the main axiom. Let $(N, \bar{\boldsymbol{q}}, f) \in \mathcal{P}^D$, and $i \in N$. We write

a) if $\boldsymbol{q} \in [0, \bar{\boldsymbol{q}}]$ and $q_i < \bar{q}_i$, write: $\partial^+_i C(\boldsymbol{q}) = C(\boldsymbol{q} + 1^i) - C(\boldsymbol{q})$.

b) if $\boldsymbol{q} \in [0, \bar{\boldsymbol{q}}]$ and $q_i > 0$, write: $\partial^-_i C(\boldsymbol{q}) = C(\boldsymbol{q}) - C(\boldsymbol{q} - 1^i)$.

Symmetric Monotonicity: Let $(N, \bar{\boldsymbol{q}}\,, f), (N, \bar{\boldsymbol{q}}\,, g) \in \mathcal{P}^D$, $i, j \in N$. Then $\partial^+_i f(\bar{\boldsymbol{q}}) \leq \partial^+_j g(\bar{\boldsymbol{q}})$ and $\partial^-_i f(\bar{\boldsymbol{q}}) \leq \partial^-_j g(\bar{\boldsymbol{q}})$ for all $\bar{\boldsymbol{q}} \in [0, \bar{\boldsymbol{q}}\,]$ imply $\phi_i(N, \bar{\boldsymbol{q}}\,, f) \leq \phi_j(N, \bar{\boldsymbol{q}}\,, g)$.

Theorem: *The Aumann-Shapley method is the unique method that satisfies symmetric monotonicity in the discrete case.*

4.2 The Least Square cost sharing method

The *Least Square value* of a TU game (N, v), denoted $\lambda(N, v)$ is the unique solution of the problem

$$\text{minimize} \sum_{S\subset N} \big(v(S) - x(S)\big)^2 \text{ s.t. } \sum_{i\in} x_i = v(N)$$

The *Least Square cost sharing method*, denoted also λ, is defined by

$$\lambda_i(N, \bar{\boldsymbol{q}}\,, f) = \sum_{j \in N_i} \lambda_j(N^{\bar{\boldsymbol{q}}}\,, v^{\bar{\boldsymbol{q}}}\,)$$

We consider the following axioms:

Linearity: Let $(N, \bar{\boldsymbol{q}}\,, f), (N, \bar{\boldsymbol{q}}\,, g) \in \mathcal{P}^{\mathcal{D}}$, and $\alpha, \beta \in \mathbf{R}_+$. Then $\phi(N, \bar{\boldsymbol{q}}\,, \alpha \cdot f + \beta \cdot g) = \alpha \cdot \phi_j(N, \bar{\boldsymbol{q}}\,, f) + \beta \cdot \phi_j(N, \bar{\boldsymbol{q}}\,, g)$.

Inessential Problem: Let $(N, \bar{\boldsymbol{q}}\,, f) \in \mathcal{P}^{\mathcal{D}}$, such that $f(\bar{\boldsymbol{q}}) = \sum_{i \in N} a_i q_i$. Then $\phi_i(N, \bar{\boldsymbol{q}}\,, f) = a_i$.

No Merging or Splitting: Let $(N, \bar{\boldsymbol{q}}\,, f), \in \mathcal{P}^{\mathcal{D}}$, and $i^0 \in N$. Let $(N \cup M, \bar{\boldsymbol{q}}\,', g) \in \mathcal{P}^{\mathcal{D}}$, where $N \cap M = \{i^0\}$, such that (1) $\bar{\boldsymbol{q}}\,'_{N \setminus \{i^0\}} = \bar{\boldsymbol{q}}_{\,N \setminus \{i^0\}}$ and $\sum_{j \in M} \bar{\boldsymbol{q}}\,'_j = \bar{\boldsymbol{q}}_{\,i^0}$, and (2) $g(\bar{\boldsymbol{q}}) = g\Big(\bar{\boldsymbol{q}}_{\,N \setminus \{i^0\}}, \bar{\boldsymbol{q}}_{\,M}\Big) = f\Big(\bar{\boldsymbol{q}}_{\,N \setminus \{i^0\}}, \sum_{j \in M} \bar{\boldsymbol{q}}_{\,j}\Big)$. Then $\sum_{j \in M} \phi_j(N \cup M, \bar{\boldsymbol{q}}\,', g) \cdot \bar{q}'_j = \phi_{i^0}(N, \bar{\boldsymbol{q}}\,, f) \bar{q}_{i^0}$.

Denote $P(\boldsymbol{y}|\boldsymbol{x}) = \dfrac{1}{2^{\sum_{i \in N} x_i}} \displaystyle\prod_{i \in N} \binom{x_i}{y_i}$.

Average Monotonicity: Let $(N, \bar{\boldsymbol{q}}\,, f) \in \mathcal{P}^{\mathcal{D}}$, $i, j \in N$. Then $\sum_{\bar{\boldsymbol{q}} \in [0, \bar{\boldsymbol{q}}\, - 1^{ij}]} P(\bar{\boldsymbol{q}}|\bar{\boldsymbol{q}}\, - 1^{ij}) \partial_i^+ f(\bar{\boldsymbol{q}}) \leq \sum_{\bar{\boldsymbol{q}} \in [0, \bar{\boldsymbol{q}}\, - 1^{ij}]} P(\bar{\boldsymbol{q}}|\bar{\boldsymbol{q}}\, - 1^{ij}) \partial_j^+ f(\bar{\boldsymbol{q}})$ implies $\phi_i(N, \bar{\boldsymbol{q}}\,, f) \leq \phi_j(N, \bar{\boldsymbol{q}}\,, f)$.

Theorem: *The Least Square method is the unique method that satisfies linearity, inessential problem, no merging or splitting, and average monotonicity.*

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On Totally Balanced, Submodular and PMAS-admissible Weighted Minimum Colouring Games

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Abstract

In this paper, we introduce the weighted minimum colouring (WMC) games, which is a class of cooperative combinatorial optimization games. A graph $G = (N, E)$ and a positive integer weight vector w that assigns a weight to each vertex in N induce a WMC game. Our aim is to characterize classes of graphs that induce WMC games with specific properties for either any choice of weight vector or for at least one weight vector. A graph G is said to be globally (respectively, locally) WMC totally balanced, submodular, or PMAS-admissible, if for all positive integer weight vectors w (respectively, for at least one positive integer weight vector w), the corresponding WMC game is totally balanced, submodular, or admits a population monotonic allocation scheme (PMAS). We show that a graph G is globally WMC totally balanced if and only if it is perfect, and that any graph G is locally WMC totally balanced. Furthermore, G is globally (respectively, locally) WMC submodular if and only if it is complete r-partite (respectively, $(2K_2, P_4)$-free). Finally, we show that G is globally PMAS-admissible if and only if it is $(2K_2, P_4)$-free, and we provide a partial characterization of locally WMC PMAS-admissible graphs.

Keywords: Weighted minimum colouring game, totally balancedness, submodularity, population monotonic allocation scheme.

1 Introduction

The weighted minimum colouring problem is a combinatorial optimisation problem defined on a graph where there is a positive integer weight associated with each vertex of a graph representing the number of colours required to colour this vertex. The objective is to find the minimum number of colours k such that adjacent vertices are coloured with disjoint sets of colours, where k is referred to as the weighted chromatic number of the graph. An application of this problem is the channel assignment in cellular telephone networks ([1]). The problem is to assign sets of frequency bands to transmitters, each of which demands a different number of bands, and if unacceptable interference might occur between two transmitters, they should be assigned disjoint sets of bands. If a conflict graph is constructed such that each transmitter is represented by a vertex, the number of frequency bands required by a transmitter is represented by the positive integer weight of the corresponding vertex, and the interference relation between two transmitters is represented by an edge between the corresponding vertices, then the minimum number of frequency bands needed is the weighted chromatic number of this graph. Consider a scenario in which a number of mobile network operators are to provide cell phone service to a geographical area. Assume that all frequency bands have the same cost, and that the transmitters are owned by different operators. In order to provide the cell phone service with the minimum number of frequency bands, the operators should cooperate with each other. The allocation of the total cost of the minimum number of frequency bands among the operators involved can in this case be tackled using cooperative game theory. In this paper, we define a new class of cooperative games suitable for solving this type of allocation problem, and we analyze the properties of this class of games. More specifically, we introduce the class of weighted minimum colouring (WMC) games, where the cost of a subset of players is equal to the weighted chromatic number of the conflict subgraph induced by this subset.

A special case of the weighted colouring problem is when all the vertex weights are equal to 1. This problem is called a minimum colouring problem. The objective is to find the minimum number of colours k such that adjacent vertices are not assigned the same colour, and k is referred to as the chromatic number of the graph. Therefore, the minimum colouring games defined by [2] can be considered an instance of the WMC games. The cost of a subset of players in a minimum colouring game is equal to the chromatic number of the conflict subgraph induced by this subset. The class of minimum colouring games as well as the WMC games belong to the more general class of combinatorial optimisation games, which are cooperative games where the cost of each subset of players is obtained by solving a combinatorial optimisation problem.

There are numerous solution concepts in cooperative game theory defining different approaches to the allocation of cost among the players. The most prominent one among those is the core ([3]), which consists of all vectors (allocations) that distribute exactly the total cost of all players such that no subset of players can be better off by breaking away from the rest of the players. Core allocations create no disincentive for cooperation and consequently are considered to be stable. If the core of a cooperative game is not empty, then this game is said to be balanced, and if the core of any of the subgames of this game is not empty, then it is said to be totally balanced. If it is furthermore possible to find allocations in the core of every subgame, such that these allocations are monotonic in the sense that no player already present in a subgame is worse off if new players are added, then this allocation scheme is a population monotonic allocation scheme (PMAS), as introduced in [4]. The existence of a PMAS therefore implies a certain dynamic stability. A cooperative game is submodular if the incentive for other players to join a coalition increases as the coalition has more players.

In general, the core of a minimum colouring game can be empty. Nonetheless, [5] shows that a minimum colouring game is totally balanced if and only if the underlying graph is perfect. A graph is perfect if for all its subgraphs the chromatic number is equal to the clique number. Furthermore, [6] characterises the submodularity of the minimum colouring games by showing that this property is satisfied if and only if the underlying graph is complete r-partite. A graph is complete r-partite if its vertices can be partitioned into r nonempty partition classes, and two vertices are adjacent if and only if they belong to different partition classes.

In this paper, we characterise totally balancedness and submodularity of the WMC games using the properties of the underlying graph. We define a graph G to be globally (respectively, locally) WMC totally balanced if for all positive integer weight vectors w (respectively, for at least one positive integer weight vector w) the corresponding WMC game is totally balanced. We show that a graph G is globally WMC totally balanced if and only if it is perfect, and that any graph G is locally WMC totally balanced. Furthermore, we define a graph G to be globally (respectively, locally) WMC submodular if for all positive integer weight vectors w (respectively, for at least one positive integer weight vector w), the corresponding WMC game is submodular, and we show that G is globally (respectively, locally) WMC submodular if and only if it is complete r-partite (respectively, $(2K_2, P_4)$-free). A $(2K_2, P_4)$-free graph is a graph that does not have a subgraph isomorphic to the union of two complete graphs of size 2 or to a line graph of size 4.

[7] showed that a minimum colouring game has a population monotonic allocation scheme (PMAS) if and only if the underlying graph is $(2K_2, P_4)$-free. We define a graph to be globally (respectively, locally) WMC PMAS-admissible if for all positive integer weight vectors w (respectively, for at least one positive integer weight vector w), the corresponding WMC game admits a PMAS. We show that a graph G is globally WMC PMAS-admissible if and only if it is $(2K_2, P_4)$-free, and we show that if a graph admits a special kind of linear ordering, then a PMAS always exists, whereas a graph that has an induced subgraph C_n with $n \geq 5$ does not admits a PMAS for any weight vector.

Our approach to the characterisation of totally balancedness, submodularity and PMAS-admissibility of WMC games is in the same spirit as the characterisation of balancedness, totally balancedness and submodularity of Chinese postman (CP) and travelling salesman (TS) games by [8]. In this paper, the authors define a graph to be CP globally (respectively, locally) balanced (respectively, totally balanced and submodular) if for all vertices (respectively, at least one vertex) and any non-negative weight vector defined on the edges, the corresponding CP game is balanced (respectively, totally balanced and submodular), and they study the equivalence between globally and locally CP balanced (respectively, totally balanced and submodular) graphs. Similar results are obtained for the TS case

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An Extension of the Shapley Value for Partially Defined Cooperative Games

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Abstract

The classical approach to cooperative games assumes that the worth of every coalition is known. However, in the real world problems there may be situations in which the amount of information is limited and consequently the worths of some coalitions are unknown. The games corresponding to those problems are called partially defined cooperative games. In this work we propose an extension of the Shapley value for general partially defined cooperative games by following the Harsanyi's approach. That is, it is assumed that each coalition guarantees certain payments, called the Harsanyi dividends ([1]), to its members. We assume that coalitions whose worth is not known assign a dividend equal to zero. The final payoff will be the sum of these dividends. Moreover, we characterize the proposed value using four axioms. Three of them are the well known axioms of carrier, additivity and positivity. The fourth one, called essential players axiom, is in certain sense a weaker version of the anonymity axiom).

Keywords: Cooperative games, partially defined games, Shapley value, Harsanyi dividends.

1 Introduction

In the classical approach to cooperative games it is assumed that the worth of every coalition is known. However, in the real world problems there may be situations in which the amount of information is limited and consequently the worths of some coalitions are unknown. The games corresponding to those problems are called partially defined cooperative games.

Partially defined cooperative games were first studied by [2]. However, this author restricted the attention to partially defined games in which if the worth of a particular coalition is known, then it is also known the worth of all the coalitions with the same cardinality. Moreover, [2] proposed and characterized an extension of the Shapley value for partially defined cooperative games. This extended Shapley value coincides with the ordinary Shapley value of a complete game (we say that a game is complete if the worths of all the coalitions are known). In this complete game the coalitions whose worth were known in the original game maintain the same worth, but otherwise they are assigned a worth zero, that seems to be not well justified.

In this work we propose another extension of the Shapley value for general partially defined cooperative games by following the Harsanyi's approach. That is, it is assumed that each coalition guarantees certain payments, called the Harsanyi dividends ([1]), to its members. We assume that coalitions whose worth is not known assign a dividend equal to zero. The final payoff will be the sum of these dividends. Moreover, we characterize the proposed value using four axioms. Three of them are the well known axioms of *carrier*, *additivity* and *positivity*. The fourth one, called *indispensable coalition* axiom, is a weaker version of the anonymity axiom when referring to full defined games.

2 The Development of the Shapley value for Partially Defined Cooperative Games

Throughout this paper, we shall let $N = \{1, 2, \ldots, n\}$ be a set of *players*. A *coalition list* $\mathcal{K}$ is a collection of subsets of N such that $\emptyset, N \in \mathcal{K}$.

A *partially defined game*, *PD game* for short, on $\mathcal{K}$ is a function v which maps every set $S \in \mathcal{K}$ to a real number $v(S)$ such that $v(\emptyset) = 0$.

The mapping v is called the *characteristic function* of the PD game. As usual the number $v(S)$ represents what the players in S can guarantee for themselves without cooperating with the other players. Traditionally the characteristic function v is assumed to be defined on 2^N, the set of all the coalitions, but in this work it is assumed that it is defined on a subfamily $\mathcal{K}$ to describe that the worth of some coalitions is not known. Occasionally when $\mathcal{K} = 2^N$ we will refer to such a game as a *full* game. The set of all the PD games on $\mathcal{K}$ is denoted $\Gamma^{\mathcal{K}}$. It is a vector space that can be identified with $\mathbf{R}^{|\mathcal{K}|-2}$.

We define formally an *allocation rule* for the PD games defined on $\mathcal{K}$ to be any function $\phi : \Gamma^{\mathcal{K}} \to \mathbf{R}^N$.

To define the value we use the same procedure arising in the definition of the Harsanyi value for non-transferable utility games. All the members of a coalition S receives the same dividend from S. If $S \in \mathcal{K}$ the total amount of the dividends allocated by all the subcoalitions of S (as well as S) is $v(S)$. Otherwise, i.e. if $S \notin \mathcal{K}$ the dividend of S is zero.

Formally the procedure is as follows. Let $v \in \Gamma^{\mathcal{K}}$ be a PD game. We define recursively two functions $z : 2^N \to \mathbf{R}^n$ and $d : 2^N \to \mathbf{R}^n$ as follows:

$$z(v, \emptyset) = 0, \ d(v, \emptyset) = 0, \tag{1}$$

$$z(v, S) = \sum_{T \subset S} d(v, T), \tag{2}$$

$$d(v, S) = \begin{cases} 0, & \text{if } S \notin \mathcal{K}, \\ v(S) - z(v, S), & \text{if } S \in \mathcal{K}. \end{cases} \tag{3}$$

Now, we define the *PD-Shapley value* $\phi^{\mathcal{K}} : \Gamma^{\mathcal{K}} \to \mathbf{R}^n$ as follows:

$$\phi_i^{\mathcal{K}}(v) = \sum_{T \in \mathcal{K}, T \ni i} \frac{d(v, T)}{|T|}, \quad \text{for all } i \in N. \tag{4}$$

We call $\dfrac{d(v, S)}{|S|}$ the Harsanyi dividend of coalition S for the PD game v.

Throughout the paper, we weakly restrict the set of known coalitions $\mathcal{K}$ with the following

Assumption: If $S, T \in \mathcal{K}$, then $S \cap T \in \mathcal{K}$ holds.

Next, we axiomatize the Shapley value $\phi^{\mathcal{K}}$ using the axioms of the carrier, the positivity, the indispensable players and the additivity.

Let $\sigma : \Gamma^{\mathcal{K}} \to \mathbf{R}^n$.

A coalition $S \in \mathcal{K}$ is said to be a carrier in $v \in \Gamma^{\mathcal{K}}$ if the following holds:

$$v(T) = v(S \cap T) \text{ for all } T \in \mathcal{K}. \tag{5}$$

Axiom[Carrier] Let $v \in \Gamma^{\mathcal{K}}$ and $S \in \mathcal{K}$ a carrier of v. Then

$$\sum_{i \in S} \sigma_i(v) = v(N).$$

The sum of two PD games $v, w \in \Gamma^{\mathcal{K}}$ is defined by $(v + w)(S) = v(S) + w(S)$ for all $S \in \mathcal{K}$.

Axiom[Additivity] Let $v, w \in \Gamma^{\mathcal{K}}$, then

$$\sigma(v + w) = \sigma(v) + \sigma(w). \tag{6}$$

Axiom[Positivity] Let $v \in \Gamma^{\mathcal{K}}$ such that $v(S) \leq v(T)$ whenever $S, T \in \mathcal{K}$ and $S \subseteq T$. Then

$$\sigma_i(v) \geq 0 \text{ for all } i \in N. \tag{7}$$

A coalition $S \in \mathcal{K}$ is said to be *indispensable* in the PD game $v \in \Gamma^{\mathcal{K}}$ if for all $T \in \mathcal{K}$ it holds

$$S \cap T^c \neq \emptyset \Rightarrow v(T) = 0. \tag{8}$$

That is, a coalition $S \in \mathcal{K}$ is indispensable when nothing can be achieved without all of its members.

Axiom[Indispensable Coalition] Let $v \in \Gamma^{\mathcal{K}}$. If $S \in \mathcal{K}$ is an indispensable coalition in v then:

$$\sigma_i(v) = \sigma_j(v) \text{ for all } i, j \in S. \tag{9}$$

Then we obtain the following theorem.

Main Theorem: $\phi^{\mathcal{K}}$ is the unique function on $\Gamma^{\mathcal{K}}$ satisfying Axioms 1 through 4.

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Modeling of Negotiating Environmental Coalition Projects

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Abstract

The paper deals with a modeling approach of negotiating subsidies from an environmental authority to multiple polluters who offer coalition projects to reduce pollution in a region. The subjects are faced with the information asymmetry and negotiate under pressures. A biform game is defined as a combination of non-cooperative and cooperative games. A specific shape of a biform game is used as a basic model for preparing proposals of the coalition projects. The polluters prepare several projects with different coalition structures. The selection of the best coalition structure of projects is modelled as a reverse combinatorial auction. The subjects' behavior was tested in economic laboratory experiments.

Keywords: Pollution reduction, Coalition projects, Negotiation, Biform games, Combinatorial auctions

1 Introduction

The solved problem is about negotiating subsidies from an environmental authority to multiple polluters who offer coalition projects to reduce pollution in a region (Šauer et al. [5]). The negotiating subjects in the model are an environmental authority and n polluters. The process can be divided to two phases:

1. Negotiations of coalition projects proposals.
2. Selection of the best coalition structure of the proposed projects.

The first phase is based on game and negotiation theories. Traditional game theory is divided into non-cooperative and cooperative models (e.g. Kreps [4]). A biform game is defined as a combination of non-cooperative and cooperative games (see Brandenburger and Stuart [1]). We propose to divide biform games into sequential and simultaneous shapes (see Fiala [3]). The sequential biform game is a two-stage game: in the first stage, negotiating subjects choose their strategies in a non-cooperative way, thus forming the second stage of the game, in which the negotiating subjects cooperate. We propose a simultaneous shape as a one-stage model where combinations of concepts for cooperative and non-cooperative games are applied. The scope of cooperation is determined by the various constraints that result from the fact that negotiating subjects are under internal and external pressures. The scope is dynamic and changes over time. The effects of pressures will be reflected in restrictive conditions. The relationship among the polluters can be partly cooperative (to get subsidy) and partly non-cooperative (to maximize surplus for individual polluters). Polluters are under external pressures to get the subsidy for the coalition and internal pressures to get a sufficient portion of the subsidy for themselves.

The second phase is based on combinatorial auction theory (Crampton et al. [2]). The relationship between the authority and the polluters is non-cooperative. The authority wants to provide as little subsidy as possible to the required reduction of pollution. Polluters are trying to get as much subsidy but are under external pressure that if their demands are too high, do not get any subsidy.

2 Negotiations of coalition projects proposals

The simultaneous biform game is a one-stage model where combinations of concepts for cooperative and non-cooperative games are applied. The combinations will be changed according situations in the environmental problem. The first issue is a classification of situations. The situations are affected by:

- which negotiating subjects can cooperate,
- within what scope they can cooperate.

If all players can cooperate fully, a standard cooperative model can be used with subsequent distribution of the result. If no one can cooperate even in a partial content, a standard non-cooperative model is used.

Suppose n negotiating subjects (polluters). Denote X as decision space for the negotiating process (set of all possible coalition projects). Elements of this space are decisions (coalition projects) $\mathbf{x} \in X$, which

are vectors whose components represent the parameters of the decision (members, subsidy, conditions etc.). A consensus decision (selected coalition projects) $\mathbf{x}^*$ should be chosen from the decision space X. Each participant evaluates decisions by criterion and compares the decisions with the target value. The criteria (subsidies for members of coalition projects) are in the form of criteria functions, that all negotiating subjects want to maximize their values. Denote $f^1(\mathbf{x}), f^2(\mathbf{x}), \ldots, f^n(\mathbf{x})$ criteria functions that transform decision x and the criteria values are compared with aspiration levels. Own negotiations and exchanges of information among negotiating subjects happen in the decision space.

For each negotiating subject we can formulate a set of acceptable decisions, which is a set of decisions that are permissible and acceptable in terms of the required aspiration levels of criteria functions. The aspiration levels (required subsidies for individual polluters) $b^i(t), i = 1, 2, ..., n, t = 1, 2, ..., T$, of criteria functions represent opportunities for added values.

Pressures acting on the aspiration levels of criteria functions that change in time points $t = 1, 2, ..., T$, and thus change the set of acceptable decisions

$$X_i(t) = \{\mathbf{x}; \mathbf{x} \in X, f^i(\mathbf{x}) \geq b^i(t)\}, i = 1, 2, \ldots, n. \tag{1}$$

Then we can define the negotiation space as an intersection of sets of acceptable decisions of all participants in negotiations

$$X_0(t) = \bigcap_{i=1}^{r} X_i(t) \tag{2}$$

Negotiations are conducted in time periods $t = 1, 2, \ldots, T$, and should lead to a consensus decision (the selected coalition projects for subsidy), to achieve single-element negotiation space $X_0(T)$.

3 Selection of the best coalition structure of projects

We propose a model of reverse combinatorial auctions to select the best structure of subsidies from single buyer (authority) to multiple suppliers (polluters) who offer combinations of items (coalition projects) to reduce pollution in a region. The model computes the first-best solution to our problem, assuming knowledge of all information.

The buyer attempts to buy at least the needed set of items from the sellers at minimum costs. Let us assume that n potential sellers $S_1, S_2, \ldots, S_n$ are offering the set R with r items, $j = 1, 2, \ldots, r$, to the one buyer B. The bid b_h made by the seller $S_h, h = 1, 2, \ldots, n$, is defined as $b_h = \{C, c_h(C)\}$, where $C \subseteq R$ is a combination of items, $c_h(C)$ is the price offered by the seller S_h for the combination of items C. Binary variables are introduced for the model formulation: $y_h(C)$ is a binary variable specifying whether the combination C is purchased from the seller $S_h, y_h(C) = 1$.

The reverse combinatorial auction model for our problem can be formulated as follows:

$$Z = \sum_{h=1}^{m} \sum_{C \subseteq R} c_h(C) v_h(C) \to \min \tag{3}$$

$$\sum_{h=1}^{m} \sum_{C \subseteq R} v_h(C) \geq 1 \qquad \forall j \in R, \tag{4}$$

$$v_h(C) \in \{0, 1\}, \qquad \forall C \subseteq R, \forall h, h = 1, 2, \ldots, m. \tag{5}$$

The criterion function (3) expresses our objective, i.e., minimization of the buyer's costs. The restriction in the formula (4) guarantee the purchase of the needed set of items. The basic model considers only the minimization of costs, which can be complemented by restrictions on environmental standards. In the situations, where the cost information could be assessed by expert estimates, the optimal solution to the problem above can be computed with the use of solvers of binary programming.

4 Conclusions

The proposed modeling approach seems to be useful for negotiating subsidies among the authority and polluters. The approach uses a biform game model with negotiation under pressure and a reverse combinatorial auction model. The result of the reverse combinatorial auction model serves to compare with the results of real negotiation in experiments with asymmetric information. The subjects' behavior was tested in economic laboratory experiments. The procedure is flexible for extensions and modifications.

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A New Measure for Supply Chain Complexity: Consistency, Empirical Validity and Practical Relevance

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Abstract

The focus of this work is the problem of complexity in the supply chain, i.e. the complexity emanating from the firm's business strategy and materialised in the proliferation of products, channels and markets, [1]. We refer to this as *structural complexity*. In our approach, complexity is not identified with complicatedness and/or uncertainty; instead, we consider complexity as a structural factor that increases the costs of intricated managerial and/or administrative procedures, or those related with unpredictable variations in customer's behaviour.

We propose a working definition for *structural complexity* that associates complexity with the amount of information delivered to the manager by the physical flow of products and services. Based on this definition, we propose a measure for structural complexity (enrooted in the Theory of Information [4]) that is more austere in the use of business information than other alternatives available in the literature and allows the evaluation of the potential impact of certain managerial decisions before they are implemented. In [2] we provide proof for some mathematical properties of the proposed measure (we refer to this as internal consistency) which are desirable from the practical point of view. Additionally, we argue for the capability of our measure of reproducing certain empirical regularities which are observed in supply chain management (external consistency), and its utility for assessing the impact on complexity of different managerial decisions (the look-ahead property).

The empirical validity of the proposed theory is finally tested in a practical case [3], where the structural complexity measure is related to several indicators of a firm's financial performance. Finally, some general guidelines are provided that support the claim of practical relevance of our measure.

Keywords: Structural complexity, supply chain, product proliferation, information theory

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Design for Supply Chain: An Overview and Research Agenda

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Abstract

Design for Supply Chain (DfSC), which embodies the need to synchronize the new product development process (NPD) with aspects of supply chain design (SCD), is becoming an increasingly popular Design for X approach. The concept of DfSC has a long history of academic literature and practical applications. The recent literature has also well documented that the importance of managing the interface between the NPD process and SCD is driven by today's market and business environment where competitive advantage is temporary. Although it is widely accepted that decisions taken during the NPD process should be synchronized with certain aspects of SCD, research on these specific decisions is fragmented. In the same vein, the current literature on DfSC does not adequately address SCD in terms of method, tool and metric. Therefore, this paper reviews English peer-reviewed journal articles to present a clear overview of the DfSC concept, to illustrate how the interface between the NPD process and SCD can be managed, and to present avenues for future research. The aforementioned articles are gathered through conducting a structured keyword search in the following three major bibliometric databases: Web of Science, Scopus, and Business Source Premier.

Keywords: Design for Supply Chain, Design for X, New Product Development, Supply Chain Design, Literature Review

Demand Signal Transmission in a Remanufacturing Supply Chain: Rule and Incentive Analysis

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Abstract

Retailers, who sell remanufactured products, usually have accumulated big data on demand properties, and hence, hold demand signal advantages over the other supply chain parties. In practice, we observe that this signal might be voluntarily shared to a rival who sells regular products. We are therefore interested in the remanufacturing retailer's incentives of demand signal transmission and the value of an accurate signal, especially in a one-to-two supply chain comprising one manufacturer producing both regular and remanufactured products and two retailers selling the regular and remanufactured products, respectively. We formulate the two retailers' competition and demand signal properties, and find that it is of best interest for the manufacturer to produce two products, regardless of the possible downstream competition. We derive interesting demand signal transmission rules that the retailer selling remanufactured products would voluntarily transmit the signal to the retailer (the rival) selling regular products, while it will not transmit the signal to the upstream manufacturer (the business partner). Even if, the retailer selling regular products has obtained the signal, it will not transmit the signal to the manufacturer. We also discuss the resulting insights regarding the production cost reduction, the government subsidy and the effects of product quality improvement. We find that the retailers' profits may be reduced by the quality improvement of the remanufactured product.

Keywords: Manufacturing Systems; Closed-loop Supply Chain; Re-manufacturing; Information Disclose; Supply Chain Collaboration

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Lagrangian Heuristic for Multistage Location-Distribution Problem

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Abstract

Multistage location-distribution model is considered motivated by our collaboration with local production company. A large-scale linear integer programingmodel is formulated and solved using Lagrangian heuristic. Numerical results are provided to demonstrate efficiency of the proposed approach.

Keywords: Multistage location-distribution model, Large-scale mixed integer programming, Lagrangian heuristic.

1 Introduction

This research is largely motivated by our collaboration with local manufacturing company. The company is dedicated to the production of plastic parts that are assembled in Mexico and later distributed for commercialization in the US market. The material necessary for the manufacture of the product is provided by global partners located in various countries, including China. The company has nine suppliers in Asia. They provide parts and components that must be transported from China to Mexico to meet the material requirements of the plant in Nuevo Leon State, Mexico. The products are sent from suppliers to different consolidation centers, where the shipments are prepared and transported to the ports in China. Then they are shipped to the port of Long Beach in California, USA and finally the containers are sent by rail to Monterrey, Nuevo Leon, where the plant is located. Figure 1 shows how the aforementioned distribution is carried out.

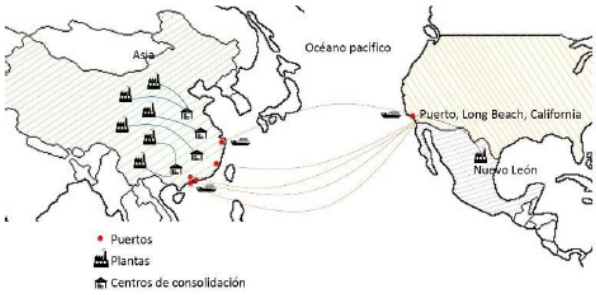

Figure 1: Distribution scheme

To send the products different size containers can be used (typically, 20 and 40 feet) depending on the volume of demand requested. However, presently the company considers that transporting in 40-feet containers is cheaper, so it is the only one used to bring the material. This results in excess inventory in the plant, shortages in some of the products, in addition to expeditions due to changes in demand. Each of the nine suppliers in Asia embarks on its own to different ports. This implies a substantial increase in total logistics costs, the amount of trips used and costs of using all ports in China each period to transport the goods. Intelligent operation policy includes selecting consolidation centers to be opened in each period, assigning suppliers to the consolidation centers, selecting container types and ports to be used. Also the frequency of shipments for each product has to be determined, minimizing total logistics costs: costs of procurement, storage and transportation of raw materials, costs for the use of ports in Asia and America, and rental costs for consolidation centers in Asia. We propose a linear mixed integer programming model of the aforementioned optimized distribution. The model has 4 stages, manages different products and types of transportation and assumes a deterministic demand in different periods of time. The corresponding solution provides a policy of sending that serves as a tool to support the decision making in the transportation of Asian materials. For more details see [[6],[7]].

2 Lagrangian Based Heuristic

Locating facilities and allocating products are the two basic design issues in a distribution system and a strategic issue within companies. The formulations of mathematical models and solution techniques in localization problems vary widely according to assumptions made. There is a large number of exact, heuristic and metaheuristic solution approaches that have been developed to find their solution (see [1],[2], [8], [9] and the references therein). Because of the large-scale nature of the model exact methods are too slow or even fail in finding a feasible solution to the problem. We focus on Lagrangian heuristic[[3],[4]] which, combining with feasibility techniques, results in a reasonable feasible solution with estimated suboptimality. Subgradient technique is used to solve the Lagrangian dual, while a number of feasible solutions is generated in each iteration of the subgradient method. Similar to [5] we noticed that the best (over all subgradient iteration) feasible solution not necessary corresponds to the best dual bound. This is the reason for running various Lagrangian bounds combining with a number of feasibility techniques.

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A Heterogeneous Drone Model with Recharge and Drop-off Stations for Emergency Humanitarian Operations

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Abstract

In this paper, we formulate a drone routing optimization model for the delivery of multiple packages of light-weight relief items (e.g. vaccine, RTUF packages, etc.) to a certain number of remote locations within a disaster prone area. The proposed drone model focuses on the implementation of realistic features related to disaster situations and drone technology limitations. In particular, extra recharge and drop-off stations are implemented to extend the operating distance of the drone and reduce the distribution cost. Time windows and priorities rules are considered to account for the urgency of the situation in each demand location.

Keywords: Drone routing, Last-mile distribution, Humanitarian operations, Priority rules

1 Introduction

A rising number of natural and man-made disasters have hit several regions all over the world recently, causing thousands of victims [1]. Sudden and slow onset disasters of recent years indicate that mostly developing countries are vulnerable to natural catastrophes [2]. Urbanization, global population growth and land-shortage in developing countries increase the amount of people living in disaster-prone areas leading to even higher numbers of victims when disasters strike [3].

Humanitarian logistics in developing countries is characterized by insufficient information flow and a lack of investments in technology and communication. A massive lack of efficient coordination and collaboration between humanitarian stakeholders in various aid activities. Those impediments are intensified by the collapse of health facilities, the disruption of health systems and the breakdown of already on-going treatments in case of emergency. Contaminated water and poor sanitation conditions combined with low vaccination coverage often leads to water-, air- and vector borne diseases, e.g. cholera, dysentery, leptospirosis, hepatitis or malaria, as it was observed in the cholera epidemic in Mozambique in 2009 [4]. In addition to these conditions, aid agencies are often confronted with poor or inexistent infrastructure that is further disrupted in case of disasters, i.e. destroyed and blocked roads, collapsed bridges and debris-covered areas which hinder medical teams in reaching remote areas.

Consequently, last-mile distribution of relief items, e.g. ready-to-use therapeutic food (RTUF) - packages, purification tablets, vaccine, etc. into these regions, proves to be extremely difficult by means of traditional transport (off-road vehicles, trucks, etc.). Air cargo via helicopters is often also not applicable due to a lack of pilots as well as helicopters and land-based personnel in developing countries. Bringing such experts from outside to disaster locations is costly and often takes too long when time pressure to provide aid is extremely high. Consequently, practitioners on the ground are seeking for alternative means of transport that offer performance improvement in last-mile distribution [5].

Unmanned aerial vehicles (UAVs), or drones, are receiving increased attention from humanitarian organizations as they can support emergency operations along the entire disaster management cycle [6]. They can be autonomous or remotely operated. Drones are primarily used for emergency response mapping, cargo delivery and search and rescue missions during the preparedness and immediate response phases. In the context of last-mile distribution, they offer great potentials to overcome the problem of inaccessibility of remote locations for providing basic emergency items to beneficiaries.

The potentials and advantages of drone use in last mile distribution has recently turn into the focus of scientific attention, as models for optimal drone routing in mapping and cargo delivery have already been developed [7, 8]. Scott and Scott [9] review the current status of innovative drone delivery with a particular emphasis on healthcare. Dorling et al. [10] present two vehicle routing problems for drone delivery, taking into consideration the energy consumption by a multirotor helicopter in hover as a function of its battery weight and payload. The objective of the first optimization model is to minimize costs subject to a delivery time window and for the second it is to minimize the overall delivery time subject to a budget constraint.

In this paper, we formulate a drone routing optimization model for the delivery of multiple packages of light-weight relief items (e.g. vaccine, RTUF packages, etc.) to a certain number of remote locations within

a disaster prone area. The proposed drone model focuses on the implementation of realistic features related to disaster situations and drone technology limitations and extends the discussion and the capabilities of the model in [5].

1.1 Model's assumpmtions

1.1.1 Heterogeneous fleet

In case of a disaster, NGOs try to intervene as quickly as possible using all available resources. We consider in our model the possibility to use various types of drones having different technological specifications and capabilities (payload, energy requirements, operating cost...) at the same time. The combination of drones with land based transport systems (possibly, with limited access to the disaster locations) is discussed.

1.1.2 Recharge stations

One of the major problems of the current drone technology is the limitation of the battery capacity which in turns limits the operating range of the drone. The maximum distance traveled by the drone is also function of its payload and flight conditions (weather, temperature,..). A fully loaded drone may not be able to reach remote locations. Therefore, intermediate recharge locations allow to extend the drone capabilities in terms of distance and to use its full capacity in terms of payload since returning to the base station for recharging will not be required. Such recharge locations can be installed in the preparedness phase within public infrastructure, e.g. schools, health centers, etc. and can be temporarily provided by NGOs via solar energy in case of total infrastructural breakdown. A discussion on how those recharge sites are implemented in practice is included. In particular, we discuss the implementation of fixed recharge stations, the use of mobile stations using SUVs and the choice of their positioning among candidate locations.

1.1.3 Drop-off locations

In the same context, the drone may be able to leave a part of its load in specific locations for energy saving purposes. The drone returns to the drop-off location to pick up those items and continue the distribution.

1.1.4 Time windows

Time is an important factor in disaster relief operations. Quick and targeted interventions may save lives. In case of epidemics, this may also help to stop or slow the spread of the disease. Hence, the model considers time windows in combination with the previously mentioned priority rules to fulfill the mission.

1.1.5 Priority rules

In a disaster situation, some locations must be treated with higher priority than others. An example of this situation is when a water-borne epidemics (say, cholera) follows the disaster. The outbreak locations must be supplied quickly with medicines, vaccines and water purification tablets while other locations connected to the affected area (e.g. downstream of watercourses) also require special attention. The remaining locations are served with lower priority.

Additionally to the main features discussed above, a discussion on partial recharge, partial delivery and asymmetric costs considering real life conditions is provided.

1.2 Results

The model is formulated as a mixed integer linear program (MILP) and solved using a commercial solver. Deriving from the criticality of fast emergency supply to remote locations, we set the objective of the model to minimize the total delivery time of relief items subject to service level. We conduct experiments using small and medium size examples to show how the specific features included in the model influence the optimal solution and the value of the objective function at optimality. In particular, it is shown how recharge and drop-off stations can extend the operating distance of the drone.

2 Conclusion

There is an increasing attention to the use of Unmanned Areal Vehicles in last-mile distribution in commercial as well as humanitarian settings. There are however numerous features that are specifically related

to humanitarian operations in the response phase. In the event of a disaster, the existing infrastructure is disrupted and the use of terrestrial means of transport might not be possible. Additionally, there is a need for quick (time pressure) and targeted (priorities) intervention to save lives and limit the impact of the disaster.

By taking into consideration the particularities of humanitarian operations as well as the limitations of the current drone technology (battery capacity, payload limitation), we can develop realistic models and derive implementable solutions.

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Research and Development Project Selection using UTA Method

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Abstract

In today's World, due to the technological change, the level of development for countries has become directly proportional to the technological transformations. Research and Development (R & D) activities are getting more important in this transformation. The important part of this transformation is to make improvement of the existing situation, having the development of new products and production methods dealing with R & D activities. As being a developing country, Turkey gives priority to R & D investments which are the most important means of economic and technological growth in the direction of becoming a self-contained country. In this sense, to encourage the R& D activities; Ministries, Universities, Technology Transfer Offices, Technocities, Development Agencies supports become more and more important. In this study, we will discuss the problem of selection of R& D projects in different sectors with a project competition which is committed in ATA Technocity. In our study, we use the UTA Method (UTilité Additives), which is a Multi-Criteria Decision-Making method, to evaluate the ranking of the alternatives for to determine the supporting project that has the best performance.

Keywords: Project Selection, UTA Method, Multi-Criteria Decision Making

1 Introduction

Selection of optimum R& D projects has become a challenging task for decision makers with having both practical and theoretical importance [1] For project selection, the decision makers have a large set of criteria for selecting projects. This selection includes a set of projects to satisfy a set of criteria with different criteria. The problem is to compare various criteria and to determine the ranking of the alternatives [2]. Among different methodologies, Multi-criteria decision making (MCDM) analysis has been widely used to deal with decision-making problems involving multiple criteria for selection of alternatives [3].

There are two sides of selecting R & D effectively-selecting the right criteria project and selecting the right project. On the other hand, after selecting the right project, moving on to support the project in right way is also critical and important. In this study, we will deal with a project competition which is committed in ATA Technocity for selection of R & D projects in different sectors. For our project selection problem, the UTA method seems to be completely adequate because it is a systematic approach based on the linear programming model and does not use criteria weights while guiding the designer in identifying the most suitable project [4].

1.1 UTA method and R& D project selection

In our study, we use utility additive (UTA) method to select the most appropriate R& D project for to support. The UTA method is a systematic approach based on the linear programming model and does not use criteria weights while identifying the most suitable result.

1.1.1 UTA method

The UTA method, proposed by Jacquet-Lagreze and Siskos [5], aims at inferring one or more additive value functions from a given ranking on reference set, A_R. In a multi-criteria decision making problem, the decision maker usually considers a set of actions (alternatives), called A, which is valued by a family of criteria, $g = (g_1, g_2, \ldots, g_n)$. A classical operational attitude of assessing a model of overall preference of the decision maker leads to the aggregation of all the criteria into a unique criterion, called a utility function, $U(g)$ [4]. $U(g) = U(g_1, g_2, \ldots, g_n)$.

Due to the strict preference relation and the indifference relation, the utility function is turned into the following form.

$U(g) = \sum_{i=1}^{n} u_i g_i$,

where $u_i g_i$ is the marginal utility of the attribute g_i for the given alternative, which is entirely determined by the attribute, g_i. Let g_i^* and $g_(i^*)$ be, respectively, the most and the least preferred value (grade) of ith criterion. With using the utility function and the step of UTA method, the set of preference

alternatives,$AR = a_1, a_2, \ldots, a_m$ is rearranged in a way that a_1 is the head of the ranking (best) and a_m is its tail (worst). After this step at last an LP model is solved to obtain the marginal utility values.

1.1.2 R& D project selection

Our study considered ten alternative projects and four selection criteria for the selection of the most appropriate R& D project for to support. The four criteria are applicability, commercial direction, technological level and innovational aspect of the project, conducting market research. These four criteria are the beneficial attributes where higher values are desirable.

The project selection criteria are first normalized as follows: For beneficial attribute: $R_{ij} = x_{ij}/max(x_{ij})$ for $i = 1, 2, \ldots, m; j = 1, 2, \ldots, n$ where x_{ij} is the performance of ith alternative with respect to jth criterion. The reference sequence of the alternatives (AR) is obtained based on the values of $\sum R_{ij}$.

Firstly, decision matrix of the project selection process formed. The values given between 1-5 in for each criteria.

Alternatives	Applicability	Commercial Direction	Technological Level and Innovational Aspect Of The Project	Conducting Market Research
A_1	3,4015	2,8958	3,9232	2,7482
A_2	2,9803	2,5778	2,9301	2,2586
A_3	2,7339	3,1404	3,2663	2,2322
A_4	2,9611	2,7921	2,8435	2,3096
A_5	3,3537	2,9265	3,0119	2,8435
A_6	2,62203	2,9301	2,1074	2,6845
A_7	2,5641	2,5778	2,5945	2,4914
A_8	2,2826	2,8619	2,2854	2,3521
A_9	3,4641	2,8435	2,8772	2,7807
A_{10}	3,0156	2,7019	2,7807	2,7305

Table 1: Decision Matrix of R & D projects

After normalized decision matrix formed according to beneficial attribute

Alternatives	Applicability	Commercial Direction	Technological Level and Innovational Aspect Of The Project	Conducting Market Research
A_1	0,9819	0,9221	1	0,9664
A_2	0,8603	0,8208	0,7468	0,7943
A_3	0,7892	1	0,8325	0,7850
A_4	0,8548	0,8890	0,7247	0,8122
A_5	0,9681	0,9318	0,7677	1
A_6	0,7569	0,9330	0,5371	0,9440
A_7	0,7402	0,8208	0,6613	0,8761
A_8	0,6589	0,9113	0, 5825	0,8271
A_9	1	0,9054	0,7333	0,7979
A_{10}	0,8705	0,8603	0,7087	0,9602

Table 2: Normalized Decision Matrix

From Table 2,the reference sequence is derived as $A_1 - A_5 - A_9 - A_3 - A_10 - A_4 - A_2 - A_6 - A_7 - A_8$. The range $[g_i^*, g_i^*]$ for each attribute is divided into equal intervals. The number of intervals and the interval difference for each attribute with their corresponding g_i^* and g_i^* values are given in Table 3.

Attribute	Applicability	Commercial Direction	Technological Level and Innovational Aspect Of The Project	Conducting Market Research
g_i^*	1	1	1	1
g_{i^*}	0,6589	0,8208	0,5371	0,785
$No.of intervals a_i - 1$	3	3	2	2
$(g_i^* - g_{i^*})/a_{ij}$	0,1137	0,0597	0,2315	0,1075

Table 3: Most and least preferred values with the interval difference for each attribute

For attribute 1:	For attribute 2:	For attribute 3:	For attribute 4:
$u_1 = 0,6589 + 0 = u_{11} = 0$	$u_2 = 0,8208 + 0 = u_{21} = 0$	$u_3 = 0,5371 + 0 = u_{31} = 0$	$u_4 = 0,785 + 0 = u_{41}$
$u_1 = 0,6589 + 0,1137 = u_{12}$	$u_2 = 0,4979 + 0,0597 = u_{22}$	$u_3 = 0,5371 + 0,2315 = u_{32}$	$u_4 = 0,8925 = u_{42}$
$u_1 = 0,7726 + 0,1137 = u_{13}$	$u_2 = 0,6653 + 0,0597 = u_{23}$	$u_3 = 0,7686 + 0,2315 = u_{33}$	$u_4 = 1 = u_{43}$
$u_1 = 0,8863 + 0,1137 = u_{14}$	$u_2 = 0,9402 + 0,0597 = u_{24}$	$u_3 = 0,5371 + 0 = u_{31} = 0$	$u_4 = 0,785 + 0 = u_{41}$

The utility values for the alternative materials are now calculated as below:

$U[g(M1)] = u_1(0,9819) + u_2(0,9221) + u_3(1) + u_4(0,9664)$,
$U[g(M2)] = u_1(0,8603) + u_2(0,8208) + u_3(0,7468) + u_4(0,7943)$
$U[g(M3)] = u_1(0,7892) + u_2(1) + u_3(0,8325) + u_4(0,7850)$,
$U[g(M4)] = u_1(0,8548) + u_2(0,8890) + u_3(0,7247) + u_4(0,8122)$
$U[g(M5)] = u_1(0,9681) + u_2(0,9318) + u_3(0,7677) + u_4(1)$,
$U[g(M6)] = u_1(0,7569) + u_2(0,9330) + u_3(0,5371) + u_4(0,9440)$
$U[g(M7)] = u_1(0,7402) + u_2(0,8208) + u_3(0,6613) + u_4(0,8761)$,
$U[g(M8)] = u_1(0,6589) + u_2(0,9113) + u_3(0,5825) + u_4(0,8271)$
$U[g(M9)] = u_1(1) + u_2(0,9054) + u_3(0,7333) + u_4(0,9779)$,
$U[g(M10)] = u_1(0,8705) + u_2(0,8603) + u_3(0,7087) + u_4(0,9602)$

After obtaining the utility values for the alternative projects dealing with the relationship holds, the mathematical model of the above-mentioned problem is formulated. In the mathematical model δ (which is used as 0.0001) is a small positive number to discriminate significantly two successive equivalence classes of R.

The mathematical model of the above-mentioned problem is formulated as given below:

Subject to $\triangle(1,5) \geq \delta$, $\triangle(5,9) \geq \delta$, $\triangle(9,3) \geq \delta$, $\triangle(3,10) \geq \delta$, $\triangle(10,4) \geq \delta$, $\triangle(4,2) \geq \delta$, $\triangle(2,6) \geq \delta$, $\triangle(6,7) \geq \delta$, $\triangle(7,8) \geq \delta$.

The LP model is solved using GAMS software which gives the results as $F = 0, u - 12 = 0.010, u_{13} = 0.149, u_{14} = 0.304, u22 = 0.007, u_{23} = 0.007, u_{24} = 0.436, u_{32} = 0, u_{33} = 0.048, u_{42} = 0, u_{43} = 0.212$. After having these results, the utility values of the alternative projects are calculated as follow: $U'[g(M1)] = 0.47991, U'[g(M2)] = 0.1172, U'[g(M3)] = 0.4795, U'[g(M4)] = 0.1174, U'[g(M5)] = 0.4794, U'[g(M6)] = 0.1171, U'[g(M7)] = 0.0715, U'[g(M8)] = 0.0699, U'[g(M9)] = 0.4793, U'[g(M10)] = 0.2678$. After arranging the utility values in descending order,the fina ranking of the alternative materials is obtained as $A_1 - A_3 - A_5 - A_9 - A_10 - A_4 - A_2 - A_6 - A_7 - A_8$

2 Conclusion

For further studies different methods will be combined to find the selection process and this study can be extended by using fuzzy logic or results of different MCDM techniques can be compared.

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Multi-stage Emissions Management of a Steel Company

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Abstract

We present a multi-stage mean-risk model for determining the optimal production and emission covering for an industrial company participating in the European emissions trading system. The model is adapted to one real-life European steel company. A mean-multiperiod CVaR criterion is used to deal with risk. The aim of the paper is to explore costs and risk of a company caused by emissions trading.

The presented multi-stage model is solved for various values of risk aversion parameters and initial price of allowance and then with and without the possibility of banking the allowances (i.e. keeping the allowances to next time periods). As a result, it is found out that the production is nearly not in uenced by the current level of emission price, nor by a risk-aversion degree. Futures on allowances are always used to hedge against risk. Moreover, the possibility of banking (i.e. transferring allowances between periods) is highly useful in risk reduction. Subsequently, a stress testing of demand is performed using a contamination technique.

Keywords: Emissions trading, EU ETS, Banking, Futures

A Dynamic Multiobjective Model for Flood Relief Centre Allocation

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Abstract

In several countries, floods are a significant threat when it could have endangered the safety and the well-being of populations. Flood relief process has become top priority in national agenda as flood remains as the most frequent and destructive natural disaster. This work presents a multi-objective location-allocation approach that identifies where to open a predefined number of shelters and how to assign evacuees to shelters when needed. The objective is to minimize the overall network distances that evacuees have to travel to reach the shelters while ensuring that the shelters are also safe, to maximize the number of evacuees moved and at the same time minimize the number of shelters open in order to optimize budget as well as ease of handling. The multi-objective optimization model takes into account that the travelled distance varies depending on the characteristics of the shelters. The number of evacuees in any flood occurrence is dynamic depending on the amount of rain, its location from water source and its height above sea level.We present a mathematical formulation for this model and solved the small problem using Excel Open for the real size problems.

Keywords: Dynamic, Multiobjective, Flood Relief Centre

1 Introduction

A natural disaster is a major adverse event resulting from the natural process of the earth. disaster has strong after effect to a lot of countries such as people losing their houses, damage of transportation, damage of agricultural and so on. Flooding remains to be the most frequent and destructive natural hazards worldwide, compared to other disasters. In Malaysia, flood remains as the most frequent and destructive natural disaster. Historically, Malaysia has faced severe floods in 1926,1931,1947, 1954, 1957, 1965, 1967,1970, 1988, 1993, 1996, 2000, 2006, 2008, 2009 and 2010 [1]. The hardest hit area were along the east coast of peninsular Malaysia in the state of Kelantan, Terengganu and Pahang. The flood event in Malaysia continues to have strong impact on human life, agricultural and economic. Malaysia's National Security Council (NSC) [2], reported that the recent flood in Malaysia considered as major catastrophe due to a large number of flood victims were evacuated to safer place. This study aims to analyze the distribution of relief centres locations in Pahang such that it maximizes the number of flood victims that can be allocated to relief centers (if needed) within a safe fixed distance. At the same the time, this study also helps to select the optimal relief centers by considering some geographical conditions such as distance from water source, amount of rainfall and its elevation.

2 Research Method

2.1 Model adaptation

The first point of concern in this study is the location analysis, the process of analyzing the topography or terrain, infrastructure, population density, elevation, facilities of an observed area. In this study, the number of flood-prone areas is referred to the number of villages that are affected by flood. The distance between the flood-prone areas and relief centres need to also be taken into account in order to determine the nearest optimal shelter to transfer the flood victims. Moreover, the capacity of relief centres need to be observed to avoid excess of the number evacuees over the capacity of the relief centres available.

Since the objective of this study is to minimize the average total travel time per person of that a flood victim would need to take between a flood-prone areas to the nearest relief center, the Capacitated p-median (CPMP) model is chosen as a suitable solution to the existing location allocation problem [3]. The second objective is to maximize the victims being transferred as previously studied by Jia et al.[4], in Los Angeles that has been hit by a major natural disaster such as hurricane. In the study, the problem has been formulated as a maximal coverage problem with multiple facility quantity-of-coverage and quality-of-coverage requirement. However, we propose to use to Location Set Covering Problem (LSCP) as it aims

at minimizing the number of facilities open while ensuring that all demand are covered within specific distance.

Hence, the model is rewritten as follows:

$$Objective function: Minimize \quad \alpha Z_1 + \beta Z_2 \tag{1}$$

$$Subject \quad to: \sum_{j=1}^{J} z_{ij} = a_i, \quad \forall i \tag{2}$$

$$z_{ij} \geq 0, \quad \forall i, \forall j \tag{3}$$

$$z_{ij} \leq c_j y_j \quad \forall i, \forall j \tag{4}$$

$$\sum_{j=1}^{J} a_{ij} y_j \geq 1 \quad \forall i \tag{5}$$

$$x_i = \{0, 1\} \tag{6}$$

$$y_j = \{0, 1\} \tag{7}$$

$$Where, \quad Z_1 = \sum_{i=1}^{I} \sum_{j=1}^{J} d_{ij} z_{ij} \tag{8}$$

$$Z_2 = \sum_{j=1}^{J} y_j \tag{9}$$

$$For, \qquad x_{ij} = \begin{cases} 1, & \text{if site j cover demand i} \\ 0, & \text{if otherwise;} \end{cases} \tag{10}$$

$$y_j = \begin{cases} 1, & \text{if site j is selected to be opened} \\ 0, & \text{if otherwise;} \end{cases} \tag{11}$$

2.2 Setting of Pilot Study

In our study area, Kuala Kuantan, there are 29 number of existing relief center to serve total of 27088 evacuees from 24 prone areas. The overall capacity for the existing relief center is 25410 people which is lower than the number of evacuees. Through this situation, it is has been concluded that not all evacuees can be transferred to the safe place due to capacity constraint. Thus details capacities analysis should be conducted in order to make sure the allocation process can be conducted with 100 percent of evacuees can be transferred to the closest center. Meanwhile, the area can be classified into 3 categories: inland, river and coastal. The criteria for safe relief centre at inland area is at the average elevation are 16.31m, the rainfall amount is 65mm and the distance from river is 6.00m. For river area, the average elevation for relief center recorded is 10.51m, the average rainfall amount is 55m and the distance from river is 0.57km. For coastal area, the average elevation is 7.0m, the average rainfall amount is 45mm and the distance from coastal is 0.67km.

3 Results and Discussion

We explore the results of each objective before combining them. There are two ways to assign the flood victims from a flood-prone area to a relief centre, which are split is not allowed and split is allowed.

Model	Method of assignment	Average dist. travelled (km)	Pop^n covered(%)	Facilities opened
CPMP	Split allowed	3.78	93.81	29
	Split not allowed	2.36	54.08	29
LSCP	Split allowed(within 3km)		68.48	14
	Split not allowed(within 3km)		34.93	14
	Split allowed(within 5km)		75.88	24
	Split not allowed(within 5km)		53.50	19

Table 1: Allocation of Evacuees using both CPMP and LSCP Model

Based on the results, it can be concluded that the existing relief center is not adequate to allocate all the flood victims from the prone area. The results showed that the existing capacity unable to allocated 100 percent of flood victims even the distance has been extended to 5km. Therefore, the capacity of relief center need to be upgraded to fulfil the demand.

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Multiple-Choice Knapsack based Integer Programming Model for Diet Planning with Energy Balance Requirements

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Abstract

In general, physically active people are more capable to both lose weight and maintain their weight than are sedentary persons. Thus, studies on energy intake and expenditure is crucial in acquiring information related to energy balance requirements. Most diet planning problems in past studies have been modelled by assuming that a person is moderately active, thus, variations in energy requirements have not been considered. Many of these studies also have been solved using Linear Programming (LP) models. In our study, the diet planning problem is solved using a knapsack problem based Integer Programming (IP) model that incorporates nutrients constraints that can realize energy balance. Two-stage modelling is implemented. The first stage is to determine the prescription of dietary energy intakes that are compatible with long-term good health where LP is used to find the range of macronutrients that are associated with energy. This involves finding the range for three major macronutrients, carbohydrate, protein, and fat, for the energy intake. The second stage is to determine the minimum cost daily meal combinations based on the proposed model. The results indicate that as the physical activity of an individual increases, the total price of healthy balanced diet per day also increases.

Keywords: Diet planning, two stage modelling, energy intake, Linear programming Integer Programming, Knapsack problem

1 Introduction

According to the World Health Organization (WHO)(2017) [1], obesity or overweight can be defined as the abnormality o excess fat accumulation that risk health. Overweight is commonly defined as a body mass index (BMI) greater than or equal to 25, while obesity starts when the BMI exceeds 30 (WHO 2016)[2]. Overweight and obesity are growing health problems both worldwide and in Malaysia. Currently, Malaysia has the highest obesity prevalence in Southeast Asia in which the prevalence of obesity was at 13.3 per cent, while overweight was at 38.5 per cent [3].

Throughout the world, it has been known that obesity was the underlying factor for many non-communicable chronic diseases such as heart disease, diabetes, stroke and certain types of cancers. Obesity should be recognized as a disease and should be highlighted to underline the gravity of the condition. Although obesity can be caused by genetic or medical reasons, most cases of obesity are caused by excessive eating, sedentary life styles. and unhealthy diets. Adult obesity can also be due to unhealthy eating habits since childhood, which turns into childhood obesity and this learned unhealthy lifestyle choices continue into adulthood. Obesity does not just happen overnight. Often, it develops gradually from poor diet and lifestyle choices. In this case, overweight and obesity happen over time when a person take in more calories (energy) than used. This is known as lack of energy balance as according to National Heart, Lung, and Blood Institute (NIH) [4], energy balance is the balance of calories consumed through eating and drinking (energy IN) compared to calories burned through physical activity (energy OUT). Consuming high amounts of energy in diet but failing to burn off the energy through exercise and physical activity results in the surplus energy, i.e., a lot of the calories consumed end up being "wasted" and converted into fat cells, that leads to obesity.

Diet planning problems have been widely studied (refer to [4]; [**?**]; [6]; [7]; [8];[9].) Most of the past studies assumed that a person is moderately active and the mathematical models were formulated based on this assumption. Thus far, studies that involved mathematical models for diet planning which addressed diet plan for individuals with different physical activity levels, which lead to varied energy requirements are still lacking. By taking into consideration that information related to energy balance requirements could be in incorporated diet planning model which can be useful as means to prevent and treat most cases of human overweight and obesity, our study aims at solving a diet planning problem by formulating models that incorporate nutrients constraints that can promote towards the achievement of energy balance. The objectives include to determine macronutrients requirements for sufficient energy intake according to physical activity level using proposed Linear Programming (LP) models, to formulate an Integer Programming

(IP) model for diet planning based on Knapsack problem approach and to obtain minimum cost daily diet based on the solution of the model. The main ideas are to obtain optimal realistic diet planning solution that takes account the physical activity of an individual and to propose alternative solution approach by considering the implementation of Knapsack problem based in the IP model. Malaysian young adult aged 18-30 years old.

2 Methodology

The study involves two stages. The first stage (Stage I) is to determine the new range of energy requirement and macronutrients needed by human body according to physical activity level. This involves finding the new lower and upper bounds of macronutrients for three major macronutrients, which are carbohydrate, protein, and fat, for the energy intake. Two Linear Programming (LP) models are developed. The first LP model is to find the lower bound of macronutrients while the second LP model is to find the upper bound of macronutrients. The second stage is to determine optimal cost diet for diet planning formulated using knapsack problem approach and Integer Programming (IP) model

2.1 Data

Three types of input data are used. Information concerning prices of foods are based on data collected from the Ministry of Domestic Trade, Cooperative and Consumerism (MDTCC). The data on energy and nutrient requirements: are obtained from the Malaysian Recommended Nutrient Intakes (RNI) from National Coordinating Committee on Food and Nutrition of Malaysia (NCCFNM) [10], published by the Ministry of Health Malaysia (MOH). Nutrients data are also collected from Malaysian Food Composition Database (MyFCD) [11] Other references include information provided in the Malaysian Dietary Guidelines [12]. A combination of 146 raw, processed and cooked food were chosen from the Malaysian Food Composition Database and 11 basic nutrients were selected for the models in this study. Three meal times being considered in the minimum cost diet model are chosen based on expert consultation. Meanwhile, the model focuses on the Malaysian young adults aged 19-29 years old as the age-gender group for modelling the diet problem. Aside from that Infant, pregnant lady and lactating women are not being considered. No fast food is considered in the choices of foods. All foods listed can be found at most local restaurants. The price used for each food is the average price of prepared food. In this study, 11 nutrients namely energy, carbohydrate, protein, fat, calcium, iron, vitamin A, vitamin B1, vitamin B2, vitamin B3, and vitamin C, are chosen based on expert consultation to be included in the models.

2.2 Mathematical Models

LP Model for the Determination of Macronutrients' Lower Bound (n=1)	LP Model for the Determination of Macronutrients' Upper Bound (n=2)
$Minimize \quad Z = \sum_{m=2}^{4} c_{mn}$	$Maximize \quad Z = \sum_{m=2}^{4} c_{mn}$
(lower bound of macronutrients)	(upper bound of micronutrients)
Subject to:	Subject to :
$c_{2n} \geq 0.55c_{1n}$ (lower bound of carbohydrate)	$c_{2n} \geq 0.55c_{1n}$ (lower bound of carbohydrate)
$c_{2n} \leq 0.70c_{1n}$ (upper bound of carbohydrate)	$c_{2n} \leq 0.55c_{1n}$ (upper bound of carbohydrate)
$c_{3n} \geq 0.20c_{1n}$ (lower bound of fat)	$c_{3n} \geq 0.20c_{1n}$ (lower bound of fat)
$c_{3n} \leq 0.30c_{1n}$ (upper bound of fat)	$c_{3n} \leq 0.30c_{1n}$ (upper bound of fat)
$c_{4n} \geq 0.10c_{1n}$ (lower bound of protein)	$c_{4n} \geq 0.10c_{1n}$ (lower bound of protein)
$c_{4n} \leq 0.15c_{1n}$ (upper bound of protein)	$c_{4n} \leq 0.15c_{1n}$ (upper bound of protein)
$\sum_{m=2}^{4} c_{mn} \geq c_{1n}$	$\sum_{m=2}^{4} c_{mn} \leq c_{1n}$
(total amount of micronutrients <l.b. of ER)	(total amount of micronutrients <u.b. of ER)
$c_{1n}, c_{2n}, c_{3n}, c_{4n} \geq 0$	$c_{1n}, c_{2n}, c_{3n}, c_{4n} \geq 0$
non-negativity constraint	non-negativity constraint

Table 1: LP Model for the Determination of Macronutrients' Lower and Upper Bound

Note: c_{mn} =lower bound ($n = 1$) or upper bound ($n = 2$) of the amount of micronutrient $m = 1, 2, 3, 4$ (m=1 represents energy, m=2 carbohydrate, m=3 fat and m=4 protein). ER denotes energy requirement and consists of three major macronutrients, which are fat, carbohydrate and protein.

Stage I concerns with the determination of the lower and upper bounds of the energy requirement and macronutrients needed by human body according to Physical Activity Level (PAL) and the energy requirement (ER) varies since PAL varies, as the following: $ER = PALXBMR$. BMR deotes Basal Metabolic Rate and $1.40 \leq PAL \leq 1.69$ for individual with sedentary or light activity lifestyle, $1.70 \leq PAL \leq 1.99$ for individual with active or moderately active lifestyle, and $2.00 \leq PAL \leq 2.44$ for individual with vigorous or vigorously active lifestyle.

Stage II consists of two phases. The first phase is the formulation of mathematical model using Knapsack based problem approach while the second phase is development of the Integer Programming model to solve the Knapsack problem formulated. The multi-Choice Knapsack constraint is used to determine the best combination of products in each class so that the chosen product will fit in a knapsack. It can also be illustrated as a diet problem as a set of food chosen from different class (appetizer, main dish, drinks) to fit in into a knapsack of calorie intake prescribe in the diet of an individual. The Knapsack based Integer Programming model is formulated as follows:

$$Minimize \sum_{h=1}^{3} \sum_{N_{hi} \in K_h} \sum_{j \in N_{hj}} p_{hi} x_{hij} \tag{1}$$

$$Subjectto: \sum_{h=1}^{3} \sum_{N_{hi} \in K_h} \sum_{j \in N_{hi}} w_{hijm} x_{hij} \geq c_{m1} \tag{2}$$

$$\sum_{h=1}^{3} \sum_{N_{hi} \in K_h} \sum_{j \in N_{hi}} w_{hijm} x_{hij} \leq c_{m2} \tag{3}$$

$$\sum_{j \in N_{hi}} x_{hij} \leq 2 \quad \forall h, \forall i \tag{4}$$

$$\sum_{j \in N_{hi}} x_{hij} \geq 1 \quad \forall h, \forall i \tag{5}$$

$$x_{hij} \geq 0, integer \tag{6}$$

where, h is the index for meal ($h = 1, 2, 3$ (breakfast, lunch and dinner, respectively), i index for the class of food (drink, side dish, rice, etc.), j is the index for food, p_{hij} is price of food j, in class i of meal h, x_{hij} is the quantity of serving of food j, in class i of meal h, w_{hijm} is the amount of nutrient m of food j, in class iof meal$h$, c_{m1} is the macronutrients lower bound, and c_{m2} is the macronutrients upper bound.

The objective function of the model is given in (1), which is to minimize the cost of the daily diet. The energy and nutrient content will be used as the knapsacks in the knapsack problem approach. Hence, we have a multiple choice - multiple constraint Knapsack problem approach. Constraint (2) is the minimum nutrients intake while Constraint (3) is the maximum allowable nutrients intake. The constraint for lower bound and upper bound for the number of food chosen, constraints (4) and (5), are developed so that in each class of food, a minimum of one food need to be chosen and the maximum number of food that taken by an individual in every class cannot exceed two foods. Constraint (6) is the nonnegativity and integer constraint.

3 Results and Conclusion

The proposed model was solved using Excel Adds-In Solver and an Excel VB interface has also been developed to enable the model to be solved based on certain input and the solution (output) to be displayed in the form that is easy for user to understand. Four main input data are weight, gender, and physical activity level. Results varies according to input entered. The minimum daily diet cost ranges from RM10 to RM20 per day. This amount is affordable as the data are for Klang Valley, an urban area. From the results obtained, it can also be concluded that as the individual physical activity increases, the total cost of daily diet also increases. The increase in total cost is due to the quantity of food need to be taken while the quantity of food taken is subjected to the individual physical activity, as the amount of energy requirement (ER) needed increases.

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Solving Positive Definite Total Least Squares Problems by Orthogonal Decompositions

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Abstract

We consider solving an overdetermined linear system of equations with multiple right hand sides, where the unknown matrix is to be symmetric and positive definite. Several algorithms exist for solving such problems when the data matrix and the right hand sides are assumed to be free of error. Here, we consider the more realistic case considering error in data and present a new approach using an error function to solve the resulting positive definite constrained total least squares problem. The proposed approach makes use of orthogonal decomposition of the data matrix. We implement our method and present a comparison of our approach with the interior point method and a method based on quadratic programming. Using the Dolan-More performance profiles, the experimental results show that the new approach is not only more efficient but also leads to smaller standard deviation of the error entries and smaller effective rank, as features being desirable for control problems.

Keywords: Total least squares, Positive definite constraints, Correlation matrix

A Deep Learning Framework for Predicting the Exchange Rate Using Relative Returns, Volatility Measures and Technical Indicators

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Abstract

Foreign currency is bought and sold in the financial markets, every minute, every day, on trading days, like any commodity or stocks of companies. The players in this market are (a) people with underlying interest in foreign currency such as exporters and importers who are continuously hedging in futures or options markets, (b) speculators and (c) arbitrageurs. This paper presents a multivariate deep learning based research framework for predictive modelling of Indian Rupee – US Dollar exchange rate using a series of macroeconomic and technical variables. Deep Belief Network and Recurrent Neural Network models as tools of deep learning have been used here. Performance of deep learning models has been compared with some well-known machine leaning models. Results justify the efficiency of the research framework.

Keywords: Exchange Rate, Technical Indicator, Random Walk, Deep Learning, Machine Learning, Deep Belief Network, Recurrent Neural Network, Random Forest.

Optimizing Car Imports in Small Island States

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Abstract

In most Small Island Developing States (SIDS), automobile dealers must import vehicles for sale on a periodic basis. The period should be large enough so that a sufficiently large number of vehicles is imported to achieve bulk purchase benefits (such as supplier discounts, shipment costs, port costs, etc.). On the other hand the period should be small enough to allow for an acceptable matching with the demands of users which change with time. Note that such a problem only holds for Small Island States (SIDS) for which the total demand is limited and the importation costs can be high since the only delivery option is by ship. We consider this problem for a single dealer in which the importation period is fixed and we use historical data to predict which brands/models should be purchased as well as the quantities of each to purchase. We demonstrate the potential increase in profit (for a given purchasing budget) using a realistic dataset.

Keywords: Optimization, Machine Learning, Auto Imports, Business Intelligence

1 Introduction and Contributions

We consider the problem in which an automobile dealer must import cars for sale ([1]). The orders are done on a periodic basis which is large enough so that a sufficiently large number of cars is imported to achieve bulk discounts. However, for such large periods one must be able to accurately predict the purchasing needs of customers. If too many cars are ordered then several may remain on the lot for months while if too few are ordered then once those particular models run out customers will have to go to competitors to make their purchases. We develop a predictive model that ensures that errors in over-ordering or under-ordering are sufficiently small. Once one determines the number of cars of each model that should be ordered then, given a limited budget, one must then determine which of these cars should actually be ordered to maximize profit. We provide the solution of this optimization problem.

2 Predicting Number of Cars to be Imported

Let us first focus on a single brand/model and determine how many should be ordered. We assume that when the ith order for this model was made, O_i cars were purchased. When this order is placed it may take several months for the order to be processed, shipped and then cleared from the arrival port. When this shipment of cars arrives on the sales lot there may be cars of this type from a previous shipment on the lot or the car may have been sold out before the new shipment. If there are leftover cars we denote the number of these by E_i. However if the car is sold out before arrival of the new shipment and customers have placed orders for such cars then we define E_i to be the negative of the number of orders (i.e, negative excess cars). In the ideal situation, when the new shipment arrives there should be no left over cars and no orders for them in which case $E_i = 0$.

This model is illustrated in Figure 2. Here we assume a period of T months and so a new shipment of cars arrives on the lot every T months. At time zero, cars arrive from the last placed order. The next order or cars would arrive at time T. The black line represents the case in which the number of cars ordered was perfect since the inventory is sold out exactly at the end of the period. The solid red line corresponds to the case where too few cars were ordered (and so customers would have instead had to place orders between time τ to time T) and the solid blue line to the case in which too many cars were purchased. The dashed red line corresponds to what would have happened if the correct order was placed for the case of too few cars and the dashed blue line corresponds to the optimal order for the case in which too many cars were purchased. We therefore would like to use historical data to estimate and correct this error so that the optimal number of each model is ordered in the future.

We use the following approach to this problem. First we keep an exponentially smoothed estimate of two metrics. We monitor the number of cars ordered, $\bar{O}_i$ to use when estimating new orders. Secondly we

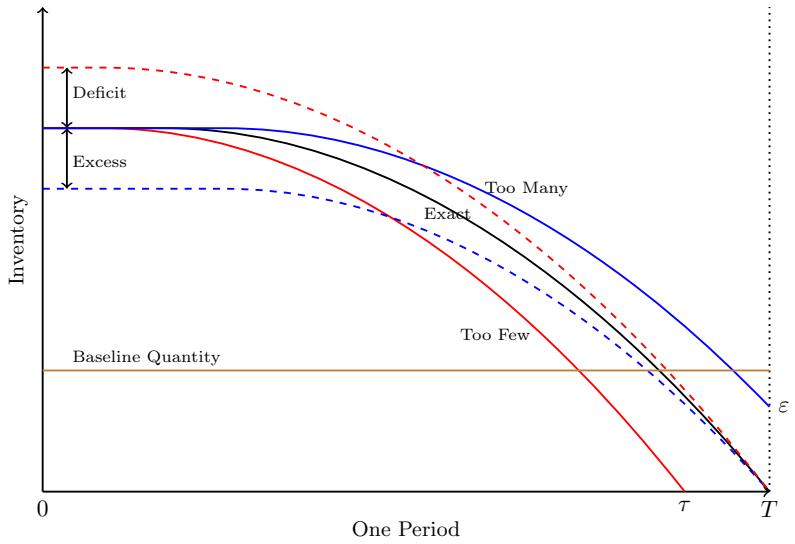

Figure 1: Depletion of Inventory over a Single Period

compute an exponentially smoothed estimate of E_i and denote this by $\bar{E}_i$.

$$\bar{O}_i = \alpha O_i + (1-\alpha)\bar{O}_{i-1} \tag{1}$$

$$\bar{E}_i = \alpha E_i + (1-\alpha)\bar{E}_{i-1} \tag{2}$$

where $0 < \alpha < 1$ is the smoothing factor. We use these values and errors to determine the jth order to be made by

$$O_j = \bar{O}_{j-1} - \bar{E}_j \tag{3}$$

This means that the present order is the smoothed average of past orders minus the present smoothed error (so the smoothed error is updated at the present point in time before being applied). If $\bar{E}_j > 0$ then there are excess cars so the order is reduced by this amount and if $\bar{E}_j < 0$ then insufficient cars had been previously ordered and so more cars are ordered to take into account the pre-orders.

3 Optimizing Profit

Once we estimate the number of cars of each model that should be ordered we next have to determine if the budget allows for such an order and, if not, what models should in fact be ordered. Let $O_j(i)$ denote the computed number of cars of model i for the jth order. Let x_i denote the number of cars of model i that should be ordered, let p_i denote the profit per car for model i, let c_i be the unit cost to the dealer for model i and let B denote the total budget. Since we want to optimize the total profit given the allocated budget then the optimization problem can be stated as:

$$\max_{\vec{x}\in\mathbf{Z}^N} P(\vec{x}) \equiv \sum_{i=1}^{N} x_i p_i \tag{4}$$

$$\text{s.t.} \quad \sum_{i=1}^{N} x_i c_i = B$$

$$\text{with} \quad 0 \le x_i \le O_j(i) \quad \forall i$$

where we assume N types of models. Note that we have assumed that the budget constraint is binding (i.e. that the total cost is exactly equal to the budget) since if this were not the case then additional cars could be purchased resulting in additional profit.

This problem can be solved using Lagrange Multiplier methods by introducing $\lambda, \vec{\mu}$ and $\vec{\gamma}$. The Lagrangian is given by,

$$\mathcal{L}(\vec{x}, \lambda, \vec{\mu}, \vec{\gamma}) = \lambda B + \sum_{i=1}^{N} x_i p_i - \lambda x_i c_i + \mu_i x_i + \gamma_i (O_j(i) - x_i) \tag{5}$$

$$\text{s.t } \mu_i x_i = 0, \ \ \gamma_i (O_j(i) - x_i) = 0, \ \ \mu_i \geq 0, \ \ \gamma_i \geq 0 \quad \forall i$$

Taking partial derivatives and setting to zero we obtain:

$$\frac{\partial \mathcal{L}}{\partial x_i} = p_i - \lambda c_i + \mu_i - \gamma_i = 0 \tag{6}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = B - \sum_{i=1}^{N} c_i x_i = 0 \tag{7}$$

Let us consider the various cases:

$$\begin{aligned}
\mu_i > 0, \ \gamma_i > 0 \quad &\Rightarrow \quad x_i = 0, \ \ x_i = O_j(i) \ \text{ not possible} \\
\mu_i > 0, \ \gamma_i = 0 \quad &\Rightarrow \quad x_i = 0, \ \ \lambda > \frac{p_i}{c_i} \\
\mu_i = 0, \ \gamma_i > 0 \quad &\Rightarrow \quad x_i = O_j(i), \ \ \lambda < \frac{p_i}{c_i} \\
\mu_i = 0, \ \gamma_i = 0 \quad &\Rightarrow \quad 0 \leq x_i \leq O_j(i), \ \ \lambda = \frac{p_i}{c_i}
\end{aligned}$$

Therefore, we just need to find $\lambda = \lambda^*$ that satisfies these conditions. This can be accomplished by starting with the model with the largest ratio $\frac{p_i}{c_i}$ and purchasing the maximum number of cars of that model. We then go to the model with the next largest ratio and repeat. We keep track of the total cost and stop when this total reaches B.

4 Numerical Results

In the final submission we will provide numerical results using data from an actual automobile dealer. Performance benefits will be demonstrated as follows. We simulate car purchases for a fixed number of models. We then apply the approach described above and compare it with the traditional approach of using a constant number of orders at each ordering point. The proposed approach to making purchasing decisions has three benefits, (a) Increased profits, (b) reduced average time on lot and (c) increased probability of a customer finding their desired car. We monitor and compare these metrics.

4.1 Description of Dataset

The dataset was obtained from a large automotive retailer in Trinidad and Tobago. The first portion of the dataset contained a unique identifier for each vehicle accompanied by the following date information:

- Ship - Date at which the vehicle was shipped from the country of manufacture.
- Entry - Date at which the vehicle entered the stock of the company.
- Sold - Date at which the vehicle was sold.

We used the various dates to compute the number of vehicles sold, ordered and currently in stock by the company for each month.

The other portion of the dataset contained detailed information about each vehicle such as its the profit and cost. This information was aggregated and used in conjunction with the forecasts made previously in determining which vehicles (along with their respective quantities) should be purchased via utilization of the Lagrange Multiplier.

4.2 Algorithm

This section mentions the following algorithms that were used in determining how much of a particular vehicle should be ordered. The smooth function applies simple exponential smoothing to a series of values (quantity for sales and purchases for each month).

Algorithm 1 Smooth Function

Input numMonths - The number of months.
monthInfo - An array containing the quantity for each month.
alpha - The value for smoothing parameter.
Output smoothValues - An array containing the smooth values for each month.

1: $smoothValues = []$
2: **for** $i = 1;\ i < numMonths;\ i = i + 1$ **do**
3: $\quad smoothValues[i] \leftarrow -1$
4: $i \leftarrow 2$
5: $smoothValues[i] \leftarrow monthInfo[i - 1]$
6: **while** $i \neq numMonths$ **do**
7: $\quad smoothValues[i] \leftarrow (alpha * monthInfo[i]) + ((1 - alpha) * smoothValues[i - 1])$
8: $\quad i \leftarrow i + 1$
9: **return** $smoothValues$

5 Conclusions

Future work will include the deployment of this solution for an automobile dealer. The solution will also include the reporting of Key Performance Metrics such as the average time spent on the lot, the probability of a customer not finding their preferred car on the lot and the achieved profit.

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Frontier Analysis of Chinese and Nepalese Commercial Bank: DEA Approach

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Abstract

In this paper, we make frontier analysis of DEA efficiencies (including technical, cost and allocation efficiencies) between Chinese and Nepalese commercial banks by using data envelopment analysis (DEA) approach. The corresponding Malmquist indices are also analyzed.

Keywords: Data envelopment analysis, Malmquist index, Bankig industry, China, Nepal

A Comparative Study of DEA Efficiency between Chinese and Pakistan Commercial Banks

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Abstract

In this paper, we make frontier analysis of DEA efficiency (including cost, technical efficiencies) between Chinese and Pakistan commercial banks by using data Envelopment analysis (DEA) approach. The results are discussed.

Keywords: Data envelopment analysis, Banking industry, China, Pakistan

Internet Business Simulation Competition and Education – China's Experience

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Abstract

Business simulation competitions can be structured to model a realistic business operation of the company through Internet. We shall give that internet business simulation competition and learning, including production, R & D, Marketing, Human Resource Management and Finance, are conducted in the business administration department and MBA program of higher educational institutions of China. So far an educational software has been devised and wildly used in China, the experience and future development direction will be discussed.

Keywords: Internet, Business simulation competition, Software, China

Spatio-Temporal Clustering for Optimizing Time-Sensitive Product Deliveries

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Abstract

We consider the problem of optimizing the near-periodic delivery of a product to customers with the additional constraint that there is an estimated deadline for delivery of the product. Delivery after the deadline is unacceptable while early delivery increases the frequency of deliveries which is also not desirable. While satisfying these customer constraints we wish to minimize the resources required by the delivery company to provide this service. In particular, we wish to minimize the total travel distance for delivery of products to customers since this reflects the associated costs of the service.

Keywords: Clustering, Optimal Routing, Rate Prediction, Delivery Optimization

1 Introduction and Contributions

Several papers have been published on delivery truck routing (e.g., see [1], [2], [3], [4] and [5]). However these focus on route optimization and some take into account constraints due to delivery of perishable items. We focus on a different type of problem. We assume that customers purchase a product that must be refilled (or replaced periodically). One example could be different types of gas products (oxygen, nitrogen, helium etc.) that must be refilled. In many cases the usage rate of the product could be used to estimate when next a refill is required. Given this information one can therefore better plan the routing of trucks to customers since the time of delivery constraint is more flexible than in the traditional approach (i.e., make a delivery when the customer makes a request). Since the model under investigation is different to those used in the past we have developed a unique solution approach using clustering.

2 Problem Description

We assume that some consumable product is to be provided to customers. In particular, we focus on the delivery of refillable gas to customers. Each customer has one or more refillable gas tanks which must be refilled on a near-periodic basis. The refill period will depend on several factors such as the number of tanks, size of the tanks, usage rate of the gas, etc. Ideally the tanks should be refilled just when they are about to become empty since this will minimize the frequency of refills which minimizes the trips to the customer (saving on delivery resources) and this is also beneficial to the customer (since each visit can be inconvenient). However, because the gas exhaustion date has to be estimated then one must be conservative and make a visit prior to the estimated exhaustion date. The accuracy of the prediction and how fast a vehicle could be dispatched will determine how conservative one must be. Given these constraints, the problem is to minimize the travel distance of the delivery trucks in order to save on fuel cost, truck maintenance costs and costs for the drivers. In the next section we describe the approach used to estimate the stochastic refill period of a customer. We then describe how deliveries are scheduled.

3 Predicting Time Left before Refill

We assume that we are provided with historical data that contains, for the ith visit, the tank level v_i before refilling (as a fraction of capacity) and the date of the visit d_i (in number of days from the initial visit). In the case of multiple tanks we add the fraction left in the last tank with the total number of remaining full tanks and divide by the total number of tanks. For each consecutive pair of such readings we compute a smoothed estimate of the period as follows:

$$T_i = \alpha T_{i-1} + (1-\alpha)\frac{d_i - d_{i-1}}{1 - v_i} \quad (1)$$

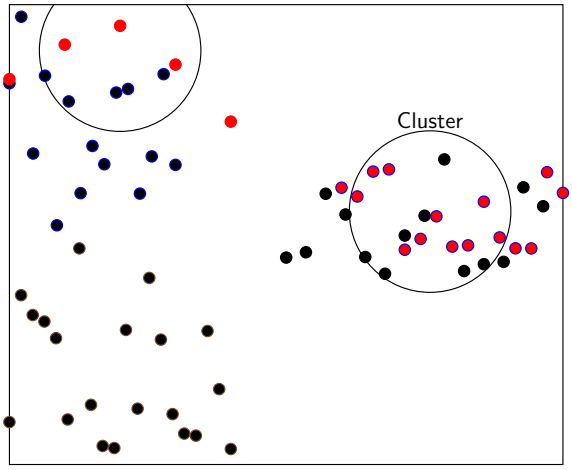

Figure 1: Customer Locations with urgent deliveries represented in red

where $0 \leq \alpha \leq 1$ is the smoothing factor and T_i is the estimate of the period at the ith visit. The last fraction corresponds to the expected value of the last period (i.e the time it would have taken if the tanks were allowed to become empty). Finally we use this to estimate the next time for a refill $\hat{d}_{i+1}$ as

$$\hat{d}_{i+1} = d_i + T_i \tag{2}$$

This estimate of the next time for refill is used in the clustering approach.

4 Spatio-Temporal Clustering

In order to reduce travel distance, once a truck visits a customer it should also visit as many nearby customers as possible. On the other hand, consider the case where all customers have the same number and size of tanks and the same gas usage rate. All customers served on a particular day will all need to be refilled at about the same time in the future. Therefore it is useful to cluster customers by expected exhaust date and serve all those with similar exhaust dates at about the same time and preferably do so near exhaustion. Hence we need to cluster in both space (serve all customers in the same neighborhood at the same time) and time (serve all customers who have similar exhaust dates together). We therefore cluster using the following 3 attributes, customer latitude, customer longitude and customer expected exhaust date. Note that, due to the nature of the data points, we use the K-Medoids algorithm for determining clusters. We determine the number of clusters K as follows. Assume we have N customers and the average time between refills (over all customers) is T days. This means, on average, N/T customers must be served per day. Suppose that we have M trucks then they must each serve about $N/(TM)$ customers per day and hence this should be the average size of our clusters. Therefore we choose $K = TM$. Once clusters are formed we order them by the average exhaust time of its members. We then choose clusters, starting from the cluster with the lowest average time before exhaustion, until all trucks are allocated. Note that if a cluster has too many members then we remove those furthest away until a suitable number is obtained. If a cluster has too few members then we add the closest ones first (ignoring those that have already been assigned to a cluster that is being served) until a suitable number is obtained. In Figure 1 we provide a simple illustrative example. In this example the dots are customer locations and the lighter colored dots have more immediate exhaustion dates and hence are more likely to be chosen.

On a daily basis all information is updated based on the prior day's deliveries and then K-Medoids clustering is used to determine which clusters of customers are to be served today. The attribute vector for each sample point (customer) consists of Longitude and Latitude values of the customer's location and the predicted exhaustion date of the customer (i.e., $\hat{d}$). Note that a scaling factor will have to be used when combining distance metrics for location and time. For example, if we have two customer vectors (x_1, y_1, d_1) and $x_2, y_2, d_2)$ then the distance between them is given by

$$D_{12} = |x_1 - x_2| + |y_1 - y_2| + \theta|d_1 - d_2| \tag{3}$$

where we have used the Manhattan Norm for the location separation and the factor θ is used to scale the time metric depending on the specific units used. If we denote the members of a particular cluster by $\mathcal{C}$ then the priority metric we use in deciding which clusters to serve is given by

$$P_{\mathcal{C}} = \frac{1}{|\mathcal{C}|} \sum_{j \in \mathcal{C}} d_j \tag{4}$$

where smaller values of the metric (i.e., closer exhaustion date) have higher priority.

5 Numerical Results

In order to illustrate the benefits of the proposed approach we provide numerical results for the case of an actual gas delivery company. In addition, we generate an artificial scenario with realistic assumptions so that we could do a sensitivity analysis of the proposed approach. We compare the proposed approach with the present mode of operation. In the present mode of operation the customer informs the delivery company when their gas supply has dropped to 30% and the company attempts to deliver gas to such customers on the following day. Therefore no exhaust prediction is performed and the scheduling does not take into account the exhaustion date. Note that a value of 30% has to be used to ensure that a delivery could be made to the customer before they run out of gas. For example, during busy periods, it may not be possible to dispatch soon after receipt of a customer request. We compute the total distance traveled for both approaches. Since the major cost for the supplier is the distance traveled (which reflects fuel cost, maintenance cost and driver costs) then the percentage reduction in travel distance represents the percentage reduction in delivery cost. We show that significant savings that can be achieved by the proposed approach. Detailed numerical results will be provided in the final paper.

6 Conclusions

We investigated a problem that has not been fully addressed in the past but one that is of interest to many companies, namely the delivery of some refillable product to a set of customers. We combine predictive analytics with clustering analytics and propose a simple, yet effective, solution to the problem. We show that the proposed approach can result in significant savings to the delivery company. In future work we plan to develop a commercial grade application for the company that will include additional features.

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Position-dependent Processing Time Scheduling

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Abstract

The position-dependent processing time scheduling problems are studied. The problems to minimize make span or total completion time on single machine with release time are firstly considered. An integer linear programming is proposed for the arbitrary variable processing time. Then 2-approximation algorithms and PTAS are provided for problems under the learning constraint. For deteriorating scheduling problem on parallel machines to minimize make span, a 2-approximation algorithm is designed after the NP-hardness is proved.

Keywords: Scheduling, Position-dependent, PTAS, NP-hardness, Approximation algorithm.

Online Fractional Hierarchical Scheduling on Uniform Machines

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Abstract

We discuss the fractional version of online hierarchical scheduling problem on m uniform machines. In the problem, the jobs and machines have l different hierarchies, and each job can be arbitrarily split between the machines, but can be processed only on the machines with hierarchies not above its hierarchy. The objective is to determine the assignment scheme of the jobs so as to minimize the makespan. We present several lower bounds and an online algorithm for arbitrary $l \geq 2$. Furthermore, the algorithm is proved optimal for $l = 2$, 3 and 4.

Keywords: Online scheduling, Hierarchical scheduling, Fractional scheduling, Uniform machine

Minimizing Energy Consumption for Routing Electric Vehicles

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Abstract

Driven by the growing concerns about greenhouse gas (GHG) emissions, people are commencing to adopt electric vehicles in distribution service. In this paper, the Electric Vehicle Routing Problem (EVRP) is introduced and the corresponding mathematical model is formulated. The EVRP seeks to minimize the energy consumptions of electric vehicles. The comprehensive calculation of energy consumption used by electric vehicles is provided in the EVRP model. A two-phase based heuristic and an ant colony (AC) algorithm based meta-heuristics are proposed as the solution methods of the EVRP. The effectiveness of proposed algorithms is evaluated through extensive numerical experiments on newly generated instances.

Keywords: Vehicle routing; Electric vehicle operations; Capacitated vehicle; Greenhouse gas emissions

1 Introduction

Global warming is becoming a worldwide concern of human beings, because of its negative impacts on nature, economics and society. The global warming is considered as a threat to the life of future generation [5]. The concern of global warming is evident from the Paris Agreement signed by different countries in the climate change conference of United Nations in December 2015. The Agreement emphasized the global efforts for rapid reductions of global carbon dioxide emissions. The use of fossil energy represents the largest source of carbon dioxide emissions [2], so non-fossil energy is gradually grabbing the attentions of people. The innovation of green vehicles, such as hydrogen vehicles and electric vehicles, is a good example of people's attempt to utilize non-fossil energy. However, the scheduling and routing of green vehicles in distribution system is complicated. Due to technology bottleneck, green vehicles usually have short driving range which is 100-150 miles [4], and have to visit refueling or recharging stations during service. Furthermore, the number of refueling or recharging stations is limited. For an instance, there are only 1626 recharging points across Canada[1]. Thus, the routing schemes for traditional vehicles are not suitable for routing green vehicles.

To properly design the routing plans for green vehicles, the Green Vehicle Routing Problem (GVRP) was introduced in operations research literature. Like the classical Vehicle Routing Problem (VRP), the GVRP seeks to minimize traveling distance, traveling time etc., underestimating the negative environmental effects of the vehicles' pollutions. Even though the green vehicles use cleaner energy resources, they are not completely pollution-free. The electric vehicles use electricity as power resource and 73% of electricity generation in 2012 came from the burning of fossil fuel, such as coal, natural gas and petroleum [3]. In 2015, the carbon dioxide emissions from electricity generation was 1,925 million metric tons[3]. In this context, how to design a routing plan, which is low in carbon dioxide emissions, for electric vehicles is important, from both economic and environmental perspective.

The main contributions of this paper are twofold. Firstly, it introduces a new model in literature for minimizing energy consumption of electric vehicles which requires recharging operations time to time. The model in this paper considers actual energy consumption of electric vehicles, unlike other existing models where energy consumption is dependent on distance only. Furthermore, the electric vehicles are considered as pollution-free vehicles by most people. In fact, such vehicles consume electricity and the generation type of electricity in many places is coal-fired generation which emit huge quantity of carbon dioxide emissions. Therefore, the carbon dioxide emissions for operating electric vehicles can be mapped through the energy consumptions of electric vehicles. To authors' best knowledge, this model is not available in literature yet and the motivation of this research is to fill this gap. Secondly, although the model is proposed for routing electric vehicles, it is also applicable for alternative fuel vehicles (AFSs) which requires refueling due to low tank capacity of vehicles.

2 Solution Methodology

In this paper, the Electric Vehoicles Routing Problem (EVRP) is considerd and the corresponding model is formulated. The proposed model is derived from the combination of GVRP and PRP, and aims to minimize

the energy consumption while designing the routing plans for the electric vehicles. Furthermore, the energy consumption can be converted to the carbon dioxide emissions. As solution methods, a two-phase based heuristic and an ant colony (AC) algorithm based meta-heuristics are proposed.

3 Computational Results

The construction of algorithm will be coded in C programming language. The effectiveness of the proposed algorithm will be tested creating new problem instances. The problem instances will be created either randomly or by modifying the existing VRP problem instances from literature. The problem instances will be used to examine the viability and feasibility of the proposed algorithms, i.e. Saving algorithm and Ant Colony System algorithm.

4 Conclusions

The main contributions of this paper are twofold. Firstly, it introduces a new model in literature for minimizing energy consumption of electric vehicles which requires recharging operations time to time. The model in this paper considers actual energy consumption of electric vehicles, unlike other existing models where energy consumption is dependent on distance only. Furthermore, the electric vehicles are considered as pollution-free vehicles by most people. In fact, such vehicles consume electricity and the generation type of electricity in many places is coal-fired generation which emit huge quantity of carbon dioxide emissions. Therefore, the carbon dioxide emissions for operating electric vehicles can be mapped through the energy consumptions of electric vehicles. To authors' best knowledge, this model is not available in literature yet and the motivation of this research is to fill this gap. Secondly, although the model is proposed for routing electric vehicles, it is also applicable for alternative fuel vehicles (AFSs) which requires refueling due to low tank capacity of vehicles.

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An Integrated Production and Preventive Maintenance Schedule for Seasonal Food Manufacturer

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Abstract

Small Medium Enterprises (SMEs) played a major role in supporting the Malaysian's economic growth as they contribute 36.3% to the national economy in 2015 compared to 35.9% or RM385.6 billion in 2014. Thus, they need to continue enhancing competitiveness by improving its productivity by continuously converting raw materials into value-added products that meet the customers' needs. Most SMEs tend to fail due to the lack of expertise in technology management as well as in production scheduling. Improper planning and scheduling the production gives negative impacts to the company such as higher operating costs, wastes of resources and energy, and fail to meet customers' need. This study proposes an integrated schedule that considers the production and its preventive maintenance of the machinery. This schedule aims to minimize the overall production costs of food manufacturer, the shutdown costs, while at the same time maximizing the utilization of manpower and machine capacity. The demand for food and its raw materials vary according to season, hence we assume it becomes available in different time periods and have limited capacity. The efficiency of the schedule is tested on small data sets solved using Excel Solver and compared with a random instance.

Keywords: Integrated Schedule, Cost Optimization, Dynamic Multiobjective Model

Dynamic Policies for Equipment Replacement in Response to Technological Innovation

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Abstract

We consider the problem of replacing or upgrading aging equipment when new or improved technologies enter the market. Technological innovations can be modelled as planned or randomly arriving upgrade releases. The scale of technological advance may be a constant or a random improvement over the previous state of the art for the equipment type. We assume that the cost for purchasing improved technology decreases over time. With each new technological improvement arriving to the market the efficiency or usage of the currently utilised equipment will lag behind the state of the art or become obsolete over time. The manager must plan if, when and how to upgrade or replace the equipment so that it is suitable for its required purpose. When upgrading the manager can choose amongst all co-existing improved technologies available for purchase in the market. The goal of this work is to provide a dynamic policy for upgrading or replacing equipment where, at each decision epoch, the planning actions available are whether to upgrade to an improved technology (or wait for further improvements); and, if so, at what future date (or cost threshold) to upgrade.

Keywords: Equipment replacement, Markov decision processes, Dynamic programming

Statistical Data Analyses for Investigating Recent Major Earthquakes and Mitigating their Damages in Japan

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Abstract

Natural disasters are unpredictable regarding when, where and how they occur, causing serious damages. Every time we have such serious damages due to large scale earthquake, public utilities such as electricity, gas, and water have been cut off temporarily, then many refugees are brought to the refugee sites. In this paper we take four major earthquakes, which occurred recently in Japan, with damages data such as deaths and missing people, refugees, and refugee sites, water supply suspension and its recovery. Statistical data regarding those four major earthquakes are investigated in detail with their corresponding mathematical modeling analyses to derive mitigation policies for preparing natural disasters in Japan.

1 Introduction

Japan has experienced many serious natural disasters including earthquakes, typhoon, floods, landslides, and so on. Every time we have such serious damages due to major natural disaster earthquake, public utilities such as electricity, gas, and water have been cut off, then a lot of refugees are brought to the refugee sites such as public schools and public halls. In this paper we take four major earthquakes, which occurred recently in Japan, with serious damages data such as deaths and missing people, refugees, and refugee sites, water supply suspension and its recovery, and so on. Statistical data regarding those four major earthquakes are investigated in detail with their corresponding mathematical modeling analyses to derive mitigation policies for preparing natural disasters in Japan.

2 Recent major earthquakes in Japan

We take four major earthquakes, which occurred recently with serious damages including a lot of deaths and missing people: Hanshin-Awaji earthquake (1995/01/17) denoted by Hanshin-A, Niigata-Chubu earthquake (2004/10/23) denoted by Niigata-C, Great East Japan earthquake (2011/03/11) denoted by GEJE, and Kumamoto earthquake denoted by KMMT, The relationship between refugees and refugee sites indicating how they have been converging to the origin, i.e., corresponding to no refugee and no refugee site with their numbers both 0 can be expressed by a mathematical model with a quadratic function type. Number of refugees (y) with respect to the number of refugee sites (x) accurately is given as follows. Fig. 1 shows approximating estimates and actual values for refugees and refugee sites $y = 1.0890x^2$ where y : number of refugees, x : number of refugees sites.

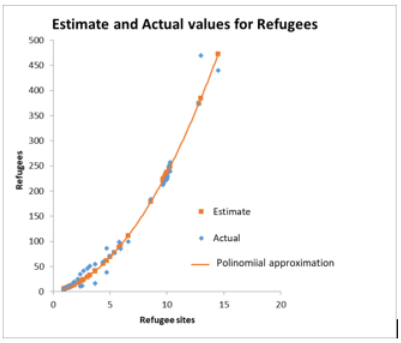

Figure 1: Estimates and actual values for refugees and refugee sites

3 Suspension of water supply and its recovery

In Hanshin-A earthquake number of households for which water supply was cut off just after the incident amounted to 1.265,730 in 10 cities and 7 towns. This corresponds to almost 90% of the total number of households in those areas, moreover in 5 cities and 4 towns all households were cut off with their water supply. However, their recovery has been very quick: 1 town on the day; 1 city and 1 town next day; 2 cities and 4 towns in a week. After a week, percentage of households with suspended water supply became 45.1%, almost half of the total on the first incident day. Furthermore, after two weeks, it became 3.2%, which means almost all households were provided with water supply. In the whole Hyogo prefecture the percentage of households with suspended water supply was 33.7%. Using those statistical data for households with suspended water supply, we show various types of mathematical models expressing their data, relationships and proceeding processes.

4 Measuring robustness of the water supply system

We aim at measuring the robustness of the water supply network system by applying network flow optimization techniques, investigating the emergent situations, and obtaining efficient countermeasures strategy for the risk management of the water supply system in Tokyo. The network flow optimization approach used in this study is mathematically called multi-source multi-sink maximum flow model, wherein sources correspond to water intake sites, while sinks are demand sites. We formulate the network flow optimization problem maximizing the total flow, under the conditions that each source node corresponding to water intake site has upper bound, each edge corresponding to the water pipeline has capacity, and each sink node has an upper bound of its each water demand. We solve the network flow optimization problem for each case such that several edges are "broken" randomly, thus arbitrary number of edges are "disrupted", thus try to measure quantitatively, indicating how much of the total demand can be met. Fig. 2 illustrate the water supply network. In order to estimate the approximation of the coverage rate rk iteratively with respect to k (ranging from 0 to m), we apply Monte Carlo method. Given the conditional distribution function defined by: $F_k(z) = P\{Z \leq z | \sum A_{ij} = m–k\}$, the conditional expected maximum flow of this network defined as: $z_k = E[Z \sum A_{ij} = m–k]$, and the reliability of this network computed by: $r_k = \frac{z_k}{\sum_{i \in T} t_i}$; thus this research is conducted in three steps (iterating the following steps 10,000 times):

Step 1. Determining the set of k "broken" edges out of m edges obtaining a network G_k.
Step 2. Solving the network flow optimization problem for the $G_k = (V_k, E_k)$.
Step 3. Calculating the coverage rate (r_k).

We solve the above network flow optimization problem for each k, ranging from 0 to m, thus obtain the estimation of r_k.

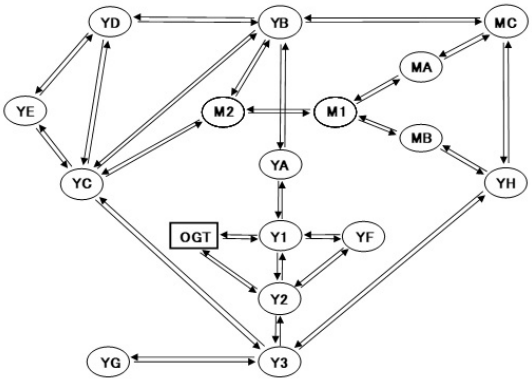

Figure 2: Water supply network

5 Summary and conclusion

Based upon the statistical data analyses regarding those four major earthquakes and using mathematical modeling analyses we derive mitigation policies for preparing natural disasters in Japan.

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Common-cause Failure by External Shock Following Weibull Distribution

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Abstract

In reliability analysis and in probabilistic risk analysis, the treatment of common-cause failure is very important. Common-cause failures are mainly analyzed by using parametric model which assumes the constant failure rate as the component failure. We try to deal with increasing failure rate components in common-cause failure analysis. Marshall-Olkin type shock model is applied for the purpose. In recent years, numerous papers dealing with extensions of Marshall-Olkin distributions have appeared. However, the Marshall-Olkin model is not yet a commonly used mathematical model in the field of risk analysis, even though it has been considered to be suitable for common cause analysis in the field of statistics. We consider the reliability of a k-out-of-n system subjected to Marshall-Olkin type shocks following Weibull distributions. All combinations of components in the system are assumed as the shock sources in the analysis. The reliability is derived by using signed domination theory.

Keywords: multivariate Weibull distribution, common cause failure, shock model, domination

1 Introduction

In this paper we incorporate common-cause failure (CCF) into system analysis. The representative CCF modeling methods are β-factor model, α-factor model and MGL (Multiple Greek Letter) model. These are referred to as parametric models. In such methods, the ratio of CCF to entire component failure is estimated under the assumption that the entire component failure rate is constant with respect to time, i.e., constant failure rate (CFR). The assumption of CFR makes the analysis simple, but it is very important to handle components without the assumption. Because the existence of components with increasing failure rate (IFR) rapidly increases the risk of system failure and result in the occurrence of severe accident. However, CCF analysis with IFR component failures has not been used in PRA. Although applying the conventional parametric models to IFR systems is an influential approach, it is difficult to build a reasonable mathematical models for IFR systems because of increasing parameters. This paper tries to deals CCF analysis with IFR components by using a shock model.

Marshall and Olkin [1] considered the independent exponential shock model called Marshall-Olkin type shocks [2]. They derived the survival function as a multivariate exponential distribution (MVE) and some of its properties [1]. In an earlier study, Bayramoglu and Ozkut [3] considered the system reliability of a k-out-of-n system subjected to Marshall-Olkin type exponential shocks. They assumed two types of shocks, one destroying only one component and the other destroying all components simultaneously. They formulated the system reliability by using the exchangeability of random variables. Yuge et al,. [4] generalized the Bayramoglu and Ozkut model and considered all combinations of components in a system as shocks, i.e., $2^n - 1$ shocks which follow homogeneous multivariate exponential distribution (HME).

In this paper, the reliability of a k-out-of-n system composed with identical components is considered. Component failures including CCFs are assumed to occur as the result of the occurrence of external shocks. The distribution of the shock occurrence is extended to multivariate Weibull distribution to deal with IFR phenomenon. The Marshall-Olkin type shocks following homogeneous multivariate Weibull distribution (HMW) are assumed. The reliability of a system is obtained by using the result in Behr et al.[5]. They derived the reliability of k-out-of-n system by using signed domination proposed in Satyanarayana and Prabhakar[6]. This study enables us to quantify the reliability and the influence of CCF in a system, not only for CFR distribution but also for IFR cases. This is greatly meaningful in PRA and in industrial engineering.

2 HMW Model

2.1 Homogeneous Multivariate Weibull Distribution

Assuming the homogeneous model of multivariate Weibull distribution (HMW), where the distributions of shock sources j destroying arbitrary i components follow the same Weibull distribution with parameters a_i

and b_i in (1).

$$P[U_j > t] = \exp\left(-a_i t^{b_i}\right) \tag{1}$$

The random variable of the failure time of component k is denoted as X_k and satisfies

$$X_k = \min\left(U_j | k \in I_j\right) \tag{2}$$

Then the joint survival function for an n-component system is

$$\begin{aligned}\bar{F}(t_1, t_2, \ldots, t_n) &= \exp\left[-a_1 \sum_{i=1}^{n} t_i^{b_1} - a_2 \sum_{i<j} \max(t_i^{b_2}, t_j^{b_2})\right. \\ &\left. -a_3 \sum_{i<j<k} \max(t_i^{b_3}, t_j^{b_3}, t_k^{b_3}) - \cdots - a_n \max(t_1^{b_n}, t_2^{b_n}, \ldots, t_n^{b_n})\right]. \end{aligned} \tag{3}$$

Furthermore, the probability that none of the component has failed at time t for an n-component system, $\bar{F}_n(t)$, is

$$\bar{F}_n(t) = \exp\left[-\sum_{k=1}^{n} \binom{n}{k} a_k t^{b_k}\right]. \tag{4}$$

2.2 Marginal Distribution of HMW model

As the $(n-j)$-dimensional marginal is given by $\bar{F}(t_{j+1}, \cdots, t_n) = \bar{F}(0, 0, \cdots, 0, t_{j+1}, \cdots, t_n)$, the terms involving only $t_1, t_2, \ldots, t_j$ in eq.(3) become 0 and the other terms remain in the marginal. Setting $t_{j+1} = t_{j+2} = \cdots = t_n = t$, we obtain the $(n-j)$-dimensional marginal of joint survival function in eq.(3) as follows,

$$\bar{F}_{n-j}(t) = \exp\left[-\sum_{k=1}^{n} \left\{\binom{n}{k} - \binom{j}{k}\right\} a_k \, t^{b_k}\right]. \tag{5}$$

Therefore, all the marginal distributions of the HMW are also Weibull distributions. Eq.(5) gives a probability that more than or equal to $n-j$ components including some $n-j$ components are functioning at time t.

2.3 System Reliability

The reliability of a k-out-of-n:G system at time t, $R_{k/n}(t)$, which is subjected to shocks following the HMW model is

$$R_{k/n}(t) = \sum_{i=k}^{n} \binom{n}{i} (-1)^{i-k} \binom{i-1}{k-1} \bar{F}_i(t) \tag{6}$$

where $\bar{F}_i(t)$ is i-dimensional marginal in eq.(5). Eq.(6) is given by using signed domination proposed by Satyanarayana and Prabhakar[6] and Behr et al.[5].

3 Conclusion

This paper deals with common-cause failure analysis for a k-out-of-n system composed of components with non-constant failure rate. The system reliability is formulated by using Marshall-Olkin type shock model and signed domination theory. We will show some numerical examples in order to show the influence of common-cause failure in the presentation.

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New Ratio Estimators using Stratified Random Sampling and Stratified Ranked Set Sampling

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Abstract

The aim of this paper to proposes ratio estimators for the population mean by using auxiliary information efficiently under stratified random sampling (SRS) and stratified ranked set sampling ($SRSS$). We obtain the bias and mean square error (MSE) for the proposed estimators and show that the proposed estimator under SRSS is more efficient than the estimator under SRS. The results have been illustrated numerically through simulation study.

Keywords: Finite population, Stratified Random Sampling, Stratified Ranked Set Sampling, Auxiliary Variable Ratio, Estimator efficiency

Stochastic Modeling of Redundant Systems with Priority and Preventive Maintenance

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Abstract

The ever increasing demand of automation in appliances and economic constraints in purchasing capacity of consumers motivate to analyse the non-identical redundant system. For this analysis, a stochastic model has been designed for a non-identical redundant system having two units one operative and other cold standby. Each unit has two possible states either operative or failure. Original unit gets priority for repair over repair and preventive maintenance of duplicate unit. The repairs, preventive maintenance and switches used to shift standby unit into operation are perfect. All failure and repair time random variables are arbitrary distributed. The system is observed using SMP and RPT to obtain various characteristics of interest to system designers. At last some numerical results have been obtained by considering exponential, Rayleigh and Weibull distributions and compared with the results obtained by Kumar et al. (2016) and Kumar et al. (2016).

Keywords: Stochastic Modeling, Weibull Failure and Repair Distribution, Priority, Semi-Markov Process and Regenerative Point Technique.

A Differential Evolution for Simultaneous Transit Network Design and Frequency Setting Problem

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Abstract

The urban transit network design problem (UTNDP) is concerned with the development of a set of transit routes and corresponding schedules on an existing road network with known demand points and travel time. It is an NP-hard combinatorial optimization problem characterized by high computational intractability, leading to utilization of a wide variety of heuristics and metaheuristics in an attempt to find near-optimal solutions. This paper proposes a differential evolution approach to address the UTNDP by simultaneously determining the set of transit routes and their associated service frequency with the objective to minimize the passenger cost, as well as the unmet demand. In addition, a combined repair mechanism is employed to deal with the infeasible route sets generated from the route construction heuristic and the operators of the differential evolution. The proposed algorithm is evaluated on a well-known Mandl's Swiss network reported in the literature. Computational experiments show that the proposed algorithm is competitive according to the performance metrics with other approaches.

Keywords: differential evolution, transit network, frequency setting, urban transit network design.

1 Introduction

Transit planners and city authorities have been making significant effort to address the heavy traffic and congestion on urban roads owing to the rapidly growing population and urbanization particularly in developing and emerging countries. These have led to the development of a variety of tools or approaches for the urban transit network design problem (UTNDP) that ideally reflects the interests of the transit users, operators, and social factors. These approaches span from manual, analytical, to heuristics and metaheuristics for both theoretical and realistic transportation networks.

The transportation planning process consists of five broad activities, namely: network design, frequency setting, timetable development, bus scheduling, and driver scheduling. The first two stages of the transportation planning processes represent a long-term planning that seeks to balance the competing objectives of minimizing both passenger and operator costs [1]. In most studies, the development of routes and frequencies setting of vehicles is performed separately to avoid extreme complications and computational intractability. In practice, both should be handled simultaneously for interaction and feedback so that the routes constructed will provide support to the defined schedule [2].

Previous efforts focused more on the well-known metaheuristics such as simulated annealing, genetic algorithm, and tabu search to solve more practical problems of the UTNDP. However, it is desirable to explore the viability of the more recent population-based metaheuristics. In recent times, differential evolution (DE) has emerged as a simple, flexible, and efficient scheme for continuous optimization problems with considerable success. However, not much attention is given to the applicability of DE to discrete optimization problems [3].

We [4] recently developed an efficient algorithm for urban transit routing problem based on the DE metaheuristic. This paper presents the extension of the research done. The UTNDP is considered in a way that we simultaneously determine the edges to be included in the transit network, assemble the chosen edges into bus route, and determine bus service frequency on each of the developed routes. In the proposed algorithm, the heuristic in [5] is used to generate the initial population of vectors for the DE to determine the optimal set of routes and the corresponding service frequency. The genetic operators of DE, namely, mutation and crossover are modified from the standard DE for exchanging solution's routes. To the best of our knowledge, there is no work on UTNDP based on DE approach reported in the literature. By adopting a design approach analogous to the one proposed by [6], and [7], the candidate route sets are evaluated from the perspective of service quality.

2 Differential Evolution Framework

The proposed solution framework of the DE for solving the UTNDP consists of two stages. The construction heuristic algorithm proposed by [5] is used to generate the initial population of vectors in the first stage,

followed by a DE algorithm to determine the optimal route networks and their corresponding frequencies in the second stage. While executing the construction heuristic, as well as the genetic operators of the DE, it is likely that some infeasible vectors could be generated. Some studies in the literature considered such vectors to be rejected and the whole initialization procedure together with feasibility checks are repeated in order to construct new feasible vectors (see [5], [8], and [9]). In this study, an effective repair mechanism which combines the make-small-change [10], terminal repair [5] and sub-route reversal [4] sequentially is used to deal with the infeasible vectors. Detailed descriptions of the combined repair mechanism can be found in [4]. The framework of the proposed DE for solving the UTNDP is shown in Algorithm 1:

Algorithm 1: Differentail Evolution for UTNDP

Generate N_p candidate route set based on heuristic in [5] with combined repair mechanism
for $i := 1$ to N_p
    fitness evaluation using passenger assignment model
end for
for $n := 1$ to G
    for $i := 1$ to N_p
        set *Target* vector = $X_{i,n}$
        select randomly a vector (except the selected *Target* vector, $X_{i,n}$) in the population
        apply **identical point mutation** to generate a *Noisy Random* vector, $V_{i,n}$ (repair if infeasible)
        apply **uniform crossover** between $X_{i,n}$ and $V_{i,n}$ to generate a pair of *Trial* vectors, $U_{i,n}$ (repair if infeasible)
        fitness evaluation of $U_{i,n}$ using passenger assignment model
        elitism selection
        if *Trial* vector fitness $\leq$ *Target* vector fitness
            new_population[i] = *Trial* vector, $U_{i,n}$
        else
            new_population[i] = *Target* vector, $X_{i,n}$
    end for
    N_p = new_population
end for
Return BEST

3 Results and Discussions

The proposed algorithm is evaluated on a well-known Mandl's Swiss network reported in the literature [11]. The network comprises of 15 nodes and 21 undirected edges with 15570 total passengers demand for service. The highest node per demand is 880 transit trips with 82% of the demand node pairs have non-zero demands. The road network data includes link connectivity, link lengths, link travel times, feasible bus stop locations, and others. The network will be tested in five cases with route set sizes of 4, 6, 7, 8, and 12 bus lines, respectively.

Computational experiments show that the proposed algorithm is competitive according to the performance metrics with other approaches in the literature. From the perspective of service quality, the proposed DE algorithm produces a higher percentage of direct trips (i.e. zero transfer) compared to other approaches considered in the literature in most cases. The results also show that as the bus line increases, the total travel time improved initially because more transit demand is assigned to the network. However, after the lowest total travel time is achieved with 7 bus lines, the total travel time become less stable. It is also interesting to observe that the proposed algorithm indicate that all travel demand can be covered with a maximum of one transfer. The best values of the percentage demand satisfied with zero transfer and the total travel time is produced in the case of a network that contains 8 bus lines.

4 Conclusion

A DE algorithm is proposed to optimize the UTNDP by simultaneously determining the set of transit routes and their associated service frequency with the objective to minimize the passenger cost, as well as the unmet demand. The proposed algorithm is applied together with the passenger assignment model based on widely accepted frequency share rule and a non-equilibrium assignment method for the UTNDP. The passenger assignment model embedded in the UTNDP model is based on the assumption that passengers have perfect knowledge about the transit system and exercise rational behavior in their transit path (route) choice. Computational experiments on the benchmark Mandl's Swiss network instances show that the proposed algorithm is competitive with other approaches in the literature. For practical purposes, an interesting issue concerning the effect of route length is analyzed and discussed.

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Performance Analysis of (m, M) Machining System with Threshold Policies and Geometric Reneging

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Abstract

In this investigation, we deal with machine repair problem having multi identical primary units and warm standby units under care of an unreliable repairman who follows threshold-based policies in service and being repaired. Waiting failed units may renege and decide sequentially whether to leave the queue or not from service station. Besides various performance characteristics viz expected number of failed units in the system, throughput of the system etc., we compute some reliability measures also like reliability of the system, MTTF, failure frequency etc. Cost function is also made to assist system analyst to work with various deciding parameter for optimal policies. Sensitivity and performance analysis are also presented in this paper in the form of graphs and tables.

Keywords: Threshold-based policies, Geometric reneging, (m, M) machining system, Reliability, MTTF, Throughput

A Production System with Uncertain Demands

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Abstract

In this presentation, we introduce a relatively new production system, called *seru* production system, which emerges recently in the academic papers. A characteristic of *seru* production systems is that *serus* can be reconfigured quickly and efficiently to deal with uncertain market demands. In this presentation, optimal tools are introduced to control a *seru* production system to satisfy customers uncertain demands.

Keywords: Assembly systems, operations-markting interface.

A Study on Recruitment and Selection Process with Reference to Current Scenario in Organizations

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Abstract

The success of organizations in this modern business environment depends on the performance / strength / caliber of the manpower that steers the day to day affairs of the organizations. The process of recruiting and selecting all categories of employees into both private and public organization has been a matter of concern to many and needs attention. It is the wish of every organization to attract the best human resource in order to fulfill organization needs and got excellent performance by appropriate candidate. There are various methods available regarding the recruitment of candidates in the field. The research paper "An Amalgamated Approach of Fuzzy Logic and Genetic Algorithm for Better Recruitment Process" (Ref. no. 1) proposed a method of recruitment with the use of fuzzy triangular number and genetic algorithm (using Robust Ranking and Linguistic variable) and successfully proved the mathematical solution of the problem. Further it is extended with an objective to understand the relationship between recruitment and selection process of an organization and also its link to the organization growth and effectiveness. For this research we assume that there is a strong impact of recruitment on selection of right candidate with desired set of skills, knowledge and ability leading to cost effectiveness. Also, for evaluation researcher take measure for evaluation as (i) Competency (ii) recruitment process (iii) Organizational climate.

Keywords: Recruitment process, Selection process, Competency, Employees, Recruitment rule, Organization climate, Ethical values

Methods for Deriving Priorities in the Analytic Hierarchy Process: A Comparative Study

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Abstract

Analytic Hierarchy Process (AHP) is a general tool for solving complex decision making problems that structures decision making problems into several hierarchical levels. The method itself is based on pairwise comparisons of elements on each level of a hierarchy with respect to the elements of the preceding level. In order to derive priorities from pairwise comparison matrices the author of the method proposes to solve the eigenvector problem. This paper compares this commonly used practice with alternative approaches. They are based on goal programming methodology which allows minimization of the maximum absolute or relative deviations, and minimization of the sum of absolute and relative deviations. The results of computational experiments are illustrated on the set of randomly generated matrices of different sizes and consistency levels.

Keywords: Analytic Hierarchy Process, Pairwise comparison matrix, Priorities, Optimization

1 Introduction

AHP is a tool for solving decision making problems that was proposed in seventies of the last century by T. Saaty. AHP organizes the decision problem into a hierarchical structure containing always several levels. The topmost level of the hierarchy defines the main goal of the problem and the lowest level usually describes the decision alternatives or scenarios. The levels in between can contain secondary goals, criteria and sub-criteria of the decision problem. The method itself is based on pairwise comparisons of elements on each level of the hierarchy with respect to the elements of the preceding level. The comparisons are estimates of the preference between two elements of the lower level with respect to the element of the level above. They can be formed into pairwise comparison matrix $\mathbf{A} = \{a_{ij} | a_{ji} = 1/a_{ij}, a_{ij} > 0, i, j = 1, 2, \ldots, k\}$, where k is the number of elements of the lower level. Saaty [4] proposes to use numerical scale from 1 to 9 to express preference of the decision maker, where 1 means that the i-th and the j-th element are equally important and 9 means that the i-th element is absolutely more important than the j-th element. By Saaty [4] and later by other researches several methods for deriving priorities from pairwise comparison matrices have been proposed. The aim of this paper is to compare and discuss some of them and suggest their modifications. This research is a continuation of the research published in Jablonsky [3] and the rest of the paper is organized as follows. Section 2 contains short introduction to the theory of the AHP. The next section describes computational experiments in deriving priorities from pairwise comparison matrices using conventional approaches and goal programming based models. The last section of the paper summarizes and discusses the results.

2 Deriving priorities in the AHP

One of the most important issues in the AHP modelling is using the evaluation scale (Saaty's scale from 1 to 9 or its modifications) and deriving priorities from pairwise comparison matrices. These issues have been and still are discussed by many researchers – e.g. Ishizaka et al. [2] or Srdjevic [5]. The original Saaty's procedure computes the prioritization vector as the right eigenvector $\mathbf{w}$ assigned to the largest eigenvalue $\lambda_{\max}$ of the pairwise comparison matrix $\mathbf{A}$. This "eigenvector method" consists in solving the following linear problem:

$$\mathbf{A}\mathbf{w} = \lambda_{\max}\mathbf{w} \tag{1}$$

A successful application of the AHP assumes a certain level of consistency of pairwise comparison matrices. This level is measured by consistency ratio CR defined as the ratio of consistency index $CI = (\lambda_{\max} - k)/(k-1)$ and random index RI (see Saaty [4] for more details). A matrix is considered as sufficiently consistent if $CR < 0.1$. Due to computational problems with solving the eigenvector problem some other prioritization methods have been formulated by Saaty and later by other researchers. All of them are based on minimization of a metric (a deviation function) between elements of pairwise comparison matrices a_{ij} on one hand and the ratios of estimated priorities w_i/w_j on the other hand.

3 Computational experiments

The aim of this study is to test whether using selected alternative approaches for deriving priorities influence the prioritization vector and how much. For this purpose we have worked with several sets of randomly generated pairwise comparison matrices (rank of the matrices from 4 to 8) with various consistency ratios from almost fully consistent matrices to matrices with borderline values of consistency ratios. The following alternative methods have been used in our experiments:

- Logarithmic least square method (LLSM) which is a popular alternative to eigenvector method easy to solve.
- Least square method (LSM) is hardly possible to use due to serious computational problems. Bozoki [1] proposed a modification of this method that overcomes main computational problems. This modification is used in our numerical experiments.
- An interesting possibility how to derive priorities is to apply the methodology of goal programming which is a general approach for solving optimization problems that instead of minimization of a objective function minimizes a metric measuring deviations from the given goals. In this case it is possible to measure positive and negative deviations of estimated priorities w_i/w_j from the elements of the pairwise comparison matrix a_{ij}. We suggest to minimize the sum of absolute or relative deviations on one hand, and maximum absolute or relative deviation on the other hand. These problems can be solved easily as linear programming problems.

The results of the experiments are quite surprising. It is clear that the results for fully consistent matrices or for matrices with a very low consistency ratio are almost identical. In the contrary there are very high differences in derived prioritization vectors by using above mentioned approaches when the level of consistency is higher which is common in applications of the AHP. The quality of all results is measured by the sum of absolute or relative deviations and by maximum absolute and relative deviation. The results given by eigenvector problem, especially for matrices with a higher consistency ratio, belongs to the worse ones. Deriving priorities from particular pairwise comparison matrices is important task but the decision problem analyzed using AHP contains always certain number of matrices depending on the number of alternatives, criteria, decision-makers, etc. The priorities derived from particular matrices are synthesized and final priorities of alternatives are obtained. Our aim was to find out not only how the priorities in one pairwise comparison matrix are influenced by the prioritization methods applied but how the final priorities are affected by these methods.

4 Conclusions

AHP belongs to one of the most popular methods for structuring and analysis of complex decision making problems. This method is based on deriving priorities for the elements on each level of hierarchy by pairwise comparisons. The paper presents a survey of possible methods for deriving priorities. Traditional methods as eigenvector method or LLSM are both computationally relatively simple but they do not reach acceptable values in optimization of maximum deviations, sum of deviations, etc. The alternative procedures seem to be better with respect to all optimization criteria but they are computationally more demanding and their wider using is questionable for users without advanced background in optimization. Future research can be focused on analysis of rank reversals in case different prioritization methods are used or are combined in solving a decision problem.

Acknowledgements

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Going CO-located or Dispersed in Product Development Projects

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Abstract

We consider a company choosing the composition of a development team, in particular, whether to co-locate or disperse team members. While the latter are less effective at collaboration, they potentially have better skills related to their specific tasks. We show that both the team composition and the optimal incentives differ dramatically for three types of collaboration: "helping", cost-reducing "knowledge sharing" and "information sharing" which allows for better coordination and more compatible design decisions. We find that for information sharing, collaboration should not even always be encouraged, and that incentives must be adjusted differently when dispersing teams depending on the type of collaboration. Finally, for uncertain projects, the firm might be better off choosing co-located team members for information sharing, dispersed team members for helping if these team members have significantly improved abilities, and dispersed team members for knowledge sharing, even with only low levels of improvement in team member abilities.

Keywords: Product Development; Incentives for Collaboration; Team Composition

1 Introduction

Competing on an international scale, companies increasingly turn towards dispersed product development teams to access technical or market know-how or to lower costs. Some companies do so very successfully. A well-documented success story of a dispersed development project involves the design of the SLICE rocket engine by Boeing Rocketdyne [1]. The engine design team included members from three different companies, each in a different location and each contributing a different expertise and skill set. They developed the rocket engine in just ten months without any face-to-face meetings (the typical duration is six years) and succeeded in lowering the manufacturing costs for this rocket engine to one fortieth the cost of earlier engines.

Other experiences with dispersed product development teams have been less successful. Consider, for example, Elecompt's Apcantes project, which targeted the development of a smart technical block to allow for flexible control of machines in automated production. The project was split between two of the company's sites to take advantage of idle (and hence low-cost) personnel in one of the locations. However, the project ran into major communication and coordination problems, and the company finally had to hire a consultant to finish the project—with a delay of two years and a huge cost overrun.

These two examples raise the question of when firms should use co-located development teams and when they should use dispersed development teams. Clearly, there is a tradeoff between including more skilled (or lower-cost) individuals and the difficulty of collaborating and communicating important information if these individuals are not located in the same place [2, 3]. This paper contributes to this discussion in two ways. First, it explores the impact of project and team characteristics on this tradeoff, and second, it adds an important topic to the discussion: the impact of incentives provided for collaboration. While incentives for collaboration have received some attention in the literature [4, 5], their importance in relation to the team composition decision has been ignored. In addition, we examine a common form of collaboration in product development teams that, to the best of our knowledge, has not been explored in the incentive literature: information sharing, which allows for coordinated decisions about design choices.

2 Model

In this paper, we consider a company that has development centers in several locations. Hence, the company needs to decide how to leverage its dispersed network in the development process and how to encourage the selected development team to collaborate and transfer necessary technological or market knowledge between team members. We use an incentive model to explore the impact of project and team characteristics on the optimal incentives for collaboration and ultimately on the optimal composition of the development team. In particular, we consider the impact of novelty (project uncertainty) and the type of collaboration required

for the project. We consider three types of collaboration, comparing information sharing to two forms of collaboration that are more commonly considered in the literature: "helping" in which a team member's collaborative effort directly impacts the performance of other team members, and "knowledge sharing" in which the collaborative effort makes other team members' tasks easier and hence less costly. Our goal is to provide managers with guidelines for when dispersed teams (with the right incentives) are most useful as well as when co-location (despite possible lower abilities of team members) might be preferable.

To analyze whether the team members should be co-located or dispersed, we need to capture the impact of the team composition decision on the characteristics of the team members. Companies disperse their development teams to access talent, market or technological knowledge, or cheaper labor. Hence, dispersed teams should have members whose effort towards their own performance measure is more effective.

On the other hand, it is well known that the dispersion of product development teams results in obstacles to collaboration, which are not easily overcome even by today's online collaboration tools. We capture the ability to collaborate effectively in our model to compare teams' composition.

3 Conclusion

Our analysis shows that the form of collaboration has an important impact on the optimal incentives. In fact, in case of collaboration in the form of information sharing, collaboration should not always be encouraged. Even so, there are dramatic differences between the three settings regarding the optimal adjustment of incentives when moving from co-located teams to dispersed teams, and the adjustments can go in opposite directions. Finally, a correctly adjusted incentive scheme can justify the choice of dispersed product development teams even when this entails little improvement in team members' abilities or a loss of collaboration effectiveness. Ultimately, the differences between the types of collaboration and associated optimal incentive plans result in very different optimal team compositions. For example, for projects with high uncertainty, the firm might be better off keeping the team members co-located in the case of information sharing collaboration; for helping collaboration, the firm can be better off dispersing team members but only if this allows it to include team members with very high levels of ability; while for knowledge-sharing collaboration, the firm will be better off dispersing team members, even with low levels of improvement in team members' abilities.

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Input-price Risk Management: Technology Improvement and Financial Hedging

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Abstract

We study firms' motivation for investing in risk management measures through technology improvement (TI): activities that reduce consumption of an input commodity, leading to fewer waste products and emissions, lower production costs, and more sustainable operations. Investing in TI is not a trivial decision because even though it clearly reduces cost and risk, firms may actually benefit from input-price uncertainty—which, when combined with production flexibility, creates an "option value" that firms are understandably reluctant to forgo. We use a stylized mathematical model to explore and generalize this claim and to specify its implications, under a variety of scenarios, for firms' decisions to invest in cost reduction and risk management. We derive a closed-form expression that explicitly quantifies a firm's attitude toward input-price risk by considering the firm's positive or negative *certainty premium* (i.e., what the firm would pay to "lock in" the unit input price); we then link that premium to various firm- and industry- level characteristics. In addition, we compare the risk management advantages of technology improvement versus financial hedging (FH) and characterize conditions under which these strategies are complements or substitutes.

Keywords: risk management, risk exposure, technology improvement, sustainable operations, financial hedging

Motivated by the business case of the airline industry (and several others), this paper explores the incentives of firms to use *technology improvement* (TI)—technical changes that reduces the consumption of an input commodity—for the purpose of managing risk. Previous research has noted the use of TI as a risk management strategy. Technology improvement, such as follows from investing in fleet fuel efficiency, is thus viewed as another strategy for airlines to incorporate into their "overall risk-management program".

Should all firms invest in technology improvement to manage input (i.e., jet fuel) price risks? To answer this question, we highlight the trade-offs involved when adopting TI initiatives. On the one hand, an extensive academic literature argues that the firm actually benefits from uncertainty, including uncertainty about the input price, provided its profit function is convex with respect to the uncertain parameter [1]. On the other hand, of course, many firms are risk-averse and so prefer to invest in risk-reducing measures irrespective of any option value that uncertainty may yield.

Our main contribution is to study the trade-off between two forces: convexity of the profit function, which results in risk-seeking preferences and higher option values; and the firm's aversion to risky profit, which results in risk avoidance and lower option values. In this regard, we explicitly derive the (positive or negative) certainty premium that firms are willing to pay for a *constant* input price as a function of the following factors: the extent of uncertainty, the profit function's curvature, the risk aversion parameter, and the total amount of commodity inputs that are used in the firm's operations. The derived mechanism makes it clear why some firms prefer not to pursue TI: they prefer to continue benefitting from the uncertainty's option value.

When it comes to input-price risk management, technology improvement is not the only option. Companies in different industries deploy an array of conventional risk-hedging strategies—including financial hedges (FH) and long-term contracts—to shield themselves from input-price volatility. Yet FH instruments do have several drawbacks and they are not always the best solution. A key difference between FH and TI is that using the latter to reduce the rate at which input commodities are consumed can affect a firm's profit in two ways. First, TI reduces the firm's average unit operational cost; this is the "average price" effect. However, it also changes how input-price uncertainty affects the firm's "profit risk" by reducing the *intensity* of commodity use in both the production process and the total cost function. So in terms of risk management, the key difference between FH and TI is that FH reduces the volatility of price but not its mean, whereas TI affects both volatility and the mean. We also identify another contrast between technology improvement and financial hedging: TI directly changes the profit function's curvature

Table 1: Interaction between industry and firm type (RA↑, high risk aversion; RA↓, low risk aversion).

		Flexible	Committed
Noncompetitive	RA↑	National oil and copper companies, large mining companies	Large specialized agriculture companies (e.g., monopolist coffee producers)
	RA↓	Highly leveraged special commodity processors (e.g., Nestlé)	Nondiversified regional electricity producers
Competitive	RA↑	Diversified freight and shipping companies	Diversified large agriculture companies producing normal crops, diversified hotel companies
	RA↓	Refineries, solar panel producers, cement producers chemical industry, metal smelters	Airlines, small farmers, electricity companies with long-term contracts, small hotels, construction companies

and also the option value of uncertainty, whereas FH does not affect the certainty premium of a flexible firm.

Technology improvement consists of implementing measures that increase the efficiency of a firm's operations, thereby reducing the amount of input needed for the same amount of output. It follows that TI not only serves as a strategy for managing risk and reducing cost but also has direct implications for the sustainability of firms' operations from the environmental perspective. For example, an airline that adopts a more energy-efficient engine reduces the quantity of jet fuel burned for each kilometer of flight. Our goal is therefore to develop a framework useful for characterizing instances when risk management and TI are aligned with the organization's sustainability goals, which provides still more reasons for investing in cleaner production.

Given the literature's previous results on the option value of uncertainty, should firms increase or rather decrease their investment in TI in response to higher input-price volatility? We respond to this question by explaining the dynamic through which the total amount of TI investment changes as a function of input-price risk; for that purpose, we use an explicitly characterized input-price certainty premium (and its sign). We show that, when investment reduces the certainty premium, firms tend to respond by increasing (resp. decreasing) TI investment in the presence of more (resp. less) uncertainty. This approach has the additional advantage of allowing us to isolate the risk management properties of TI while *ignoring* the average price effect (which is instead driven by the focal technology's cost effectiveness).

The risk management strategies of TI and FH can affect risk as well as the profit function's curvature and hence the option value discussed previously. However, there are various mechanisms through which a firm's profit function is affected also by industry characteristics (e.g., product/service type or level of competition). In some industries, firms are "flexible" and can adjust their production plan or price *after* observing the realizations of uncertain input costs; the shipping industry is a prime example, with companies adjusting their freight rates in response to realized fuel costs. In other industries, the market is "committed" and so firms must decide on a production or price plan *before* observing the realization of input-price shocks. For instance, airlines offer tickets months before the flight even though the price of jet fuel changes almost daily. In this paper we delineate the circumstances under which a firm's profit function is convex in the input price—connecting that convexity to firms' pricing flexibility and specifying the conditions under which a firm does (or does not) benefit from input-price uncertainty. Table 1 gives a summary and examples of the scenarios we examine for firms characterized by low versus high risk aversion.

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A Study of Entrepreneurial Ecosystems of Kathmandu: Value Chain Analysis to Explore the Roles of Business Support Mechanisms for Competencies

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Abstract

The Entrepreneurial Ecosystems (EE) has taken the centre stage of debate among policy makers and practitioners alike recently. Systematic review of literatures indicates that the root of the concept Entrepreneurial Ecosystems takes into account from many branches of school of thoughts, thus informing the pattern of evolution and operationalisation of the concept. Plethora of research from the developed nations indicates Entrepreneurial Ecosystem has been considered as a tool for regional economic development to enhance innovation in start ups. In this research a multi-stage research design is developed to explore the roles and relationship of Business Support Mechanisms (BSM) for competencies in entrepreneurial ecosystem. The main aim is to identify the missing links within the entrepreneurial ecosystem development process and BSM in the developing context. The findings indicated that support activities through local stakeholders are implemented mainly through six forms of implementation networks. These are creating enterprise and growing business, formulating ideas, facilitating international trade, mobilising resource efficiency, financial resources and human capacity management, to enhance high value competencies within the ecosystem.

Keywords: Entrepreneurial Ecosystem, Value Chain Analysis, Networks, Business Support Mechanisms, Case studies

Technical

Facility Location on Arcs for Quickest Evacuation Planning

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Abstract

When facilities are to be placed on the arcs of an evacuation network, it is imperative to find the appropriate arcs to place the facilities to minimize the effect of the reduction in arc capacities in the efficiency of evacuation. In this work, we introduce quickest FlowLoc problem to identify the optimal arcs to place emergency facilities so that the quickest time of evacuation is increased the least, and present efficient algorithms to solve single facility quickest FlowLoc. We also solve the problem using contraflow strategy which has been found instrumental in reducing the quickest evacuation time significantly.

Keywords: Quickest FlowLoc, quickest flow, contraflow, evacuation network, emergency facilities

1 Introduction

In evacuation planning, an important objective is to send a given number of evacuees from danger areas to safe areas as quickly as possible. Providing emergency facilities is also equally important in such cases. A recent trend in evacuation planning research is to amalgamate network flow models which have been widely used in modeling evacuation planning and facility location models which have been used for finding the optimal location of facilities to fulfill a given objective. Authors in [1] introduced FlowLoc problem and designed algorithms to solve such a problem to minimize the reduction of the maximum flow value after placing the facilities on arcs of the evacuation network. Recent studies also focus on reversing lanes of the roads in an appropriate direction (contraflow) for the effectiveness of evacuation, [2, 3].

Placing facilities on arcs reduces the capacity of the arc and hence, it may increase the time of the quickest evacuation. In this work, we introduce quickest FlowLoc problem to combine quickest flow and location modeling to find the optimal arcs for placing facilities during emergency evacuation with and without contraflow. We present efficient algorithms so the increase in the quickest time, because of the placement of facilities on arcs, is minimized.

The outline of this extended abstract is as follows. Section 2 describes the mathematical modeling, Section 3 introduces the quickest FlowLoc problem and solution algorithms for single facility case, and Section 4 concludes the paper.

2 Mathematical Modeling

2.1 Quickest flow

In evacuation planning models, the region to be evacuated is represented by a network in which nodes represent the intersection of the roads and and arcs represent the section of the road between the nodes. The direction of the arcs is the direction of the traffic flow.

Let $G = (V, A)$ be a directed network with $|V| = n$ and $|A| = m$ with two special nodes $s, d \in V$ known as a source and a sink respectively. For a node $w \in V$, we denote the set of outgoing arcs from w by $A_w^{\text{out}} = \{(w, u) \in A\}$, and the set of incoming arcs to w by $A_w^{\text{in}} = \{(u, w) \in A\}$. For each $e \in A$, $b(e), \tau(e)$ denote the constant upper capacity, and constant travel time on e. The lower capacity of each arc is assumed to be zero. The initial occupancy at vertex $v \in V$, if any, is denoted by $o(v)$. We denote this single source, single sink network by $N = (V, A, b, \tau, o, s, d)$, in general.

The quickest flow problem seeks to find the minimum time T^* needed to send a given amount of flow

$o(s) = F$ from the source s to the sink d. The problem can be formulated, mathematically, as, [4]:

$$T^* = \min \frac{F + \sum_{e \in A} \tau(e) \cdot x^{\text{stat}}(e)}{v}$$
$$s.t. \sum_{e \in A_w^{\text{out}}} x^{\text{stat}}(e) - \sum_{e \in A_w^{\text{in}}} x^{\text{stat}}(e) = \begin{cases} v, & \text{if } w = s \\ -v, & \text{if } w = d \\ 0, & \text{otherwise} \end{cases} \tag{1}$$
$$0 \leq x^{\text{stat}}(e) \leq b(e) \ \forall e \in A$$

where $x^{\text{stat}}(e)$ is the static flow with value v, for details, see [5].

2.2 Contraflow strategy

Contraflow strategy refers to finding the ideal directions of arcs so as to optimize a given objective (e.g. maximizing the flow value or minimizing the time to send a given flow from source(s) to sink(s)). The core step in this strategy is solving the problem by constructing an undirected network (referred to as the auxiliary network) by adding the capacities of two reverse arcs between each pair of nodes keeping the travel time same. This strategy can also be used for quickest evacuation planning with contraflow, [6].

3 Quickest FlowLoc problem

There are situations in which facilities are to be placed on arcs so that the capacity of the arc is reduced resulting into the increase of the quickest time to reach the shelter. Analogous to a definition given by [1], we give the following definition.

Definition 3.1. Given an evacuation network $N = (V, A, b, \tau, o, s, d)$ and $o(s) = F$, set of feasible locations $\mathbb{L} \subseteq A$, the set of all facilities $\mathbb{P}$, the size of the facilities $r : \mathbb{P} \to \mathbb{N}$, the number of facilities that can be placed on the possible locations $nol : \mathbb{L} \to \mathbb{N}$, the quickest FlowLoc problem seeks for an allocation $loc : \mathbb{P} \to \mathbb{L}$ of the facilities to the arcs, such that the quickest time on the network $N^{loc} = (V, A, b', \tau, o, s, d)$ is minimized with $b'(e) = b(e) - \max\{r(p) : loc(p) = e\}$.

3.1 Single facility quickest FlowLoc

If the facility with size r_p is placed on an arc, its capacity (per unit time) is reduced by r_p (per unit time). In this section, we study the single facility quickest FlowLoc, a special case with $p = 1$.

Algorithm 1 iterates through all possible locations $l \in \mathbb{L}$, determines the quickest time if location l hosts the facility and finds the optimal location for the single facility by comparing all those quickest times.

Algorithm 1: Single facility quickest FlowLoc

Input : directed network $N = (V, A, b, \tau, o, s, d)$, the set of possible locations $\mathbb{L}$, $o(s) = F$, size r of the facility
Output: location loc of the facility

```
curr_min_time = ∞
for l ∈ 𝕃 do
    if b(l) ≥ r then
        b(l) = b(l) − r
        q_time_temp = the quickest time in the modified network
        b(l) = b(l) + r (to regain the capacity of l for the next iteration)
        if curr_min_time > q_time_temp then
            curr_min_time = q_time_temp
            loc(p) = l
        end
    end
end
return loc
```

If we allow lane reversals in case of emergency evacuation planning, we can make much room for the facilities to be placed on the arcs, and may reduce the quickest time significantly. Problem 3.2 is set to address such a situation.

Problem 3.2. *Let $N = (V, A, b, \tau, o, s, d)$ be an evacuation network. Find the location of loc of a single facility so that the quickest time is minimum allowing lane reversals in appropriate directions.*

To solve Problem 3.2, we present Algorithm 2 which makes use of auxiliary network to locate the facility.

Algorithm 2: Single facility quickest FlowLoc with contraflow

Input : directed network $N = (V, A, b, \tau, o, s, d)$, the set of possible locations $\mathbb{L}$, $o(s) = F$, size r of the facility

Output: location *loc* of the facility

1 Construct the auxiliary network $\bar{N} = (V, \bar{A}, \bar{b}, \bar{\tau}, o, s, d)$
2 Use Algorithm 1 on $\bar{N}$ to find the quickest sink location *loc*
3 **return** *loc*

With the use of the algorithm, with the best known complexity, to solve quickest flow problem, [7], we come to the following theorem.

Theorem 3.3. *The single facility quickest FlowLoc problem (with or without contraflow) can be solved in $O(|(L)|nm^2(\log n)^2)$ time.*

4 Conclusion

In this study, we considered the problem of minimizing the increase in the quickest time after placing emergency facilities in the arcs in evacuation planning. This is very useful in evacuation plannig because there is always a need of emergency facilities, like medical support, etc. to save life during various types of disasters. We presented efficient algorithms for choosing a single arc from among a given number of arcs, for facilities to be placed in. Choosing more than one arc from among a given number of arcs is a difficult problem and is one of our next concentration area.

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Non-existence of EAF Inflow-dependent Transit Times

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Abstract

Network flow over time is an important area for the researcher relating to the traffic assignment problem. Transmission time of the vehicles directly depends on the number of vehicles entering the road. Flow over time with fixed transit times can be solved by using classical (static) flow algorithms in a corresponding time expanded network which is not exactly applicable for flow over time with inflow dependent transit times. In this paper we discuss the time expanded graph for inflow-dependent transit times and non existence of earliest arrival flow on it.

Keywords: Inflow-dependent transit times, inflow-preserving flow, quickest flow, earliest arrival flow

1 Introduction

Due to increasing population and the economic activities day by day, number of vehicles are increasing rapidly. But limited capacity of roads causes major traffic problem in most of the cities. To solve this problem a better traffic management system and route guidance is essential. Dynamic network flow theory, traffic simulation, models based on fluid dynamics, control theory and variational inequalities are common approaches to study the problems. Actually, time is an essential component for the flow of vehicles that travel through a network of road and it directly depend on the inflow rate of vehicles on the road. In inflow-dependent transit times, described by Köhler et al.[4], transit time on arc only depends on the current rate of inflow into that arc.

An important application of flow over time problem is evacuation planning problem. In continuous time setting, different dynamic network flow problems have been solved for evacuation planning problems. Pyakurel and Dhamala [7], Dhamala and Pyakurel [6] studied the continuous dynamic flow and introduce the continuous contraflow model. They present efficient algorithms to solve maximum dynamic, quickest, earliest arrival contraflow problems with natural transformation of Fleischer and Tardos [1] by traversing the direction of arcs at time zero.

2 Basic Denotations

Inflow-dependent transit times. Network flow problems are related with directed graphs G = (N,A), where N denotes for nodes and A for arcs. Each arc $a \in A$ has positive capacity denoted by u_a and a non negative, left-continuous and non-decreasing transit time function $\tau_a : [0, u_a] \to \mathbf{R}^+$. The main objective of this section is to focus on the models of flow over time with inflow-dependent transit times, which is an extension of the flow over time with fixed transit times. Transit times are fixed in flow over time with fixed transit time so that flow on arc a progresses at constant speed. Here in inflow-dependent transit times, described by Köhler et al.[4], transit time experienced by an infinitesimal unit of flow on an arc is determined when entering this arc and only depends on the inflow rate at that moment of time. In the flow over time with inflow-dependent transit times, flow entering arc a at time θ arrives at head(a) at time $\theta + \tau_a(f_a(\theta))$ and all arc must be empty from time T on, so for all arcs $a \in A$ and $\theta \in \mathbf{R}^+$ we have $\theta + \tau_a(f_a(\theta)) < T$ whenever $f_a(\theta) > 0$.

Flow conservation, in this case, is modeled as

$$\sum_{a\in\delta^+(v)} \int_{0\le\theta<\zeta} f_a(\theta)d\theta - \sum_{a\in\delta^-(v)} \int_{\theta\ge 0:\theta+\tau_a(f_a(\theta))\le\zeta} f_a(\theta)d\theta \le 0.$$

for all $\zeta \in [0, T)$ and $v \in N \setminus \{s, t\}$ and equality holds for $v \in N \setminus \{s, t\}$ at time $\zeta = T$.

The flow over time f satisfies the supply and demands if

$$\sum_{a\in\delta^+(v)} \int_{0\le\theta<\zeta} f_a(\theta)d\theta - \sum_{a\in\delta^-(v)} \int_{\theta\ge 0:\theta+\tau_a(f_a(\theta))\le\zeta} f_a(\theta)d\theta = D.$$

for $v \in \{s, t\}$.

The value of s-t flow over time f is given by

$$|f| := \sum_{a\in\delta^+(s)} \int_0^T f_a(\theta)d\theta - \sum_{a\in\delta^-(s)} \int_{\tau_a}^T f_a(\theta)d\theta.$$

The value of a temporally repeated flow f with flow-dependent transit times $(\tau_a)_{a\in A}$ and underlying path decomposition $(x_p)_{p\in\mathbf{P}}$ is given by

$$|f| = \sum_{p\in\mathbf{P}} (T - \tau_p(x_p))x_p = T|x| - \sum_{a\in A} \tau_a(x_a)x_a.$$

2.1 The Bow Graph

As described in [4], the bow graph, denoted by $G^B = (N^B, A^B)$, arises from the original graph by expanding arc $a \in A$ according to its transit time function. In bow graph G^B, every arc $e \in A^B$ has capacity u_e and a constant transit time $\tau_e \in \mathbf{R}$. For the definition, let us consider an arc $a \in A$ with capacity u_a with breakpoints $0 = u_0 < u_1, ... < u_m = u_a$ and corresponding transit times $\tau_1 < \tau_2 < ... < \tau_m$, where $\tau_a^s(x) := \tau_i$ for $x \in (u_{i-1}, u_i]$. This means that flow entering the arc a at the rate $x \in (u_{i-1}, u_i]$ needs τ_i time unit to traverse arc. To construct bow graph of an arc a we replace it by arcs of two types: bow arcs denoted by $b_1, b_2, ..., b_m$ and regulating arcs denoted by $r_1, r_2, ..., r_m$. The bow arcs are uncapacited, they represent all possible transit times of arc a. The transit times of bow arc b_i is given by $\tau_i; i = 1, 2, ..., m$. The regulating arcs have zero transit time and they limit the amount of flow entering the bow arcs. Their capacities are chosen according to the breakpoints of transit time function $\tau_a^s(x_a)$, more precisely , the capacity of arc r_i is set to $u_i, i = 1, 2, ..., m$. The set of regulating arcs and bow arcs of an arc $a \in A$ is denoted by A_a^B. For every arc $e \in A_a^B$, we denote $a(e)$ as the corresponding arc a in A. The size of A_a^B is linear in the number of breakpoints of τ_a^s. In bow graph nodes in N^B corresponding to nodes in N are original nodes and the remaining nodes are artificial.
According to the transit time function, flow entering the arc a at time θ in the original graph G with flow rate $f_a(\theta)$ reaches head(a) at time $\theta + \tau_a^s(f_a(\theta))$. We use the similar behavior in the bow graph by sending flow onto the arc $e \in A_a^B$ with transit time $\tau_a^s(f_a(\theta))$. To be more precise, let $b_1, ..., b_m$ be the bow arcs in A_a^B and let $i \in \{1, 2, ..., m\}$ be chosen such that $\tau_a^s(f_a(\theta)) = \tau_i$. We define a flow over time f^B on the expansion of arc a by setting $f_e^B(\theta) := f_a(\theta)$ if e is either a bow arc b_i or a regulating arcs r_j with $j \geq i$. For all other arcs we set $f_e^b(\theta) = 0$.

Definition(Inflow-preserving flow): Let f^B be a flow over time in G^B. Then flow f^B is inflow-preserving if for every original arc $a \in A$ and at every point in time θ, the flow f^B sends flow into at most one bow arc $e \in A_a^B$.

Theorem 2.1: For an single arc instance, the class of inflow-preserving flow over time in G^B contains quickest and maximum flow over time but this may not hold in general.
Proof: Let G consist of a path P of length 2 denoted by a_1 *and* a_2 with respective capacities $u_{a_1} = 2$ *and* $u_{a_2} = 2$. The first arc on P has transit time function

$$\tau_{a_1}^s(x) := \begin{cases} 0 & if\, 0 \leq x \leq 1, \\ 1 & if\, 1 < x \leq 2. \end{cases}$$

The second arc has constant transit time $\tau_{a_2} = 0$.

There exist a flow over time in G^B which sends D = 9 units of flow from s to t within given time T = 5. For, using temporally repeated flow (TRF) which sends flow at rate 1 into the s-t path containing lower bow arc b_1 during time interval [0,5) and flow rate 1 into the s-t path containing upper bow arc b_2 during time interval [0,4). This can also be calculate by $TRF = \sum_{e\in A^B}(T - \tau_e)x_e^B = (5-0)1 + (5-1)1 = 9$.

We define an inflow-preserving flow over time f in G^B which satisfies demand 8 within time T = 5. For, it sends flow at rate 2 into bow arc b_2 during [0,3), then it sends flow at the rate 1 into bow arc b_1 until time 2.

3 Non-existence of Earliest Arrival Flows

Earliest arrival flows are those maximum s-t flows over time that send, for each time $\theta \in [0, T)$, the maximum amount of flow from s to t. Since maximum flow for a fixed time horizon T exists, but it may

not be true for each $\theta \in [0, T)$. Gale [2] showed the existence of earliest arrival flows for general networks with constant transit times on the arcs and, more generally, for networks with time-dependent (but not flow-dependent) transit times and capacities on the arcs.

In case of flow-dependent transit times there exists an s-t flow over time that sends the maximum amount of flow from s to t for any time horizon T. But there may not be such a maximum s-t flow that is maximal for each $\theta \in [0, T)$.

Theorem 3.1: For inflow-dependent transit times, earliest arrival flow do not exist in general.
Proof: Consider the one-arc network, together with the simple linear transit time function as $\tau_a(x) = 2x \; for \; 0 \leq x \leq 2$, and a capacity two. We consider a flow model with inflow-dependent transit times. Let T = 6 be the considered time horizon. When sending flows from s to t at a flow rate of 2 in time interval [0,2) and at flow rate linearly decreasing from 2 to 0 in the time interval [2,6), then the flow of 8 units has been reached to the sink t by time T = 6. In fact , this is the maximum amount of flow that can be sent from s to t in this time horizon.
To construct an earliest arrival flow, we have to make sure that the maximum possible amount of flow has reached the sink for any $\theta \in [0, T)$. To show that this is not possible for this example we examine just two values of θ. Sending flow at the flow rate linearly decreasing from 2 to 0 in time interval [0,4) shows that an earliest arrival flow must send at least 4 units of flow to t up to time $\theta = 4$. In fact, sending any flow in this time interval at a higher flow rate would result in a decrease of the flow value reaching t up to time $\theta = 4$. It follows easily that any flow sending the maximum amount of flow up to $\theta = 4$ into t can not send more than 5 units of flow in to t up to $\theta = 6$. Since, however, the maximum flow for time horizon 6 is 8.

4 Conclusion

This paper presents the existing models of flow over times with inflow-dependent transit times with the help of *bow graph*. It also covers effect of the inflow-preserving flow and earliest arrival flow in inflow-dependent transit times.

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FlowLoc Problems on Evacuation Network

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Abstract

The FlowLoc problem allocates the facilities in the network with minimum flow loss. Contraflow is widely accepted solution approach for evacuation planning as it maximizes the outbound capacities of roads by reversing the required road directions from risk areas to safe places. In this work, the network facility location and the contraflow approach are combined and presented some efficient algorithms to solve the integrated problem.

Keywords: Evacuation network, dynamic flow, facility location, FlowLoc problem, contraflow

1 Introduction

In recent days, people are surviving under the threat of several natural as well as man-made disasters. An essential aspect of the awareness is the choice of appropriate shelter locations to all the needy population during disasters. Nevertheless, one has to take the consideration of traffic effects and its influences on the evacuation network. Due to the importance of the best possible choice of shelter locations for minimum flow loss, their efficient planning is one of the interested areas for the recent researchers. In evacuation network, the intersections of roads are considered as nodes, road segments between nodes are considered as arcs and routes are taken as paths. The initial places where evacuees are located and start to move are considered as source nodes and the safe places where they are supposed to draw are destination (sink) nodes. Most traffic delays occur in roads due the different facilities locations around the roads. Routing people to safety with proper facility locations is an innermost challenge to manage a regional evacuation, [1]. The authors in [2] integrated firstly the network flow with location theory and open the wide window of Flowloc theory in evacuation modeling. Different contraflow models with their efficient solution algorithms have been developed after [3]. For the large scale evacuations, the evacuation time has been improved by at least 40 percent with at most 30 percent of the total arc reversals, [3].

2 Denotations Prior Works

An evacuation network $N = (A, b_e, \theta_e, S, D, T)$ is a directed graph where V, $A \subseteq V \times V$, S, D, T represent the set of vertices, arcs, sources, sinks and time horizon respectively. The capacity and travel time vectors of $e \in A$ are denoted by b_e and θ_e, respectively. The evacuation time is represented by $T_d = \{0, 1, \cdots, T\}$ in discrete model, whereas it is $T_c = \{[0, 1), \cdots, [T, T+1)\}$ in continuous model. Let $f_{dyn} : A \times T_d \longrightarrow R_{\geq 0}$ be the dynamic network flow, $A_v^+ = \{(v, w) : (v, w) \in A\}$ and $A_v^- = \{(u, v) : (u, v) \in A\}$. The node - arc formulation of dynamic flow problem with $S = \{s\}$ and $D = \{d\}$ satisfies the following constraints:

$$\sum_{\tau=\theta_e}^{T} \sum_{e \in A_v^-} f_{dyn}(e, \tau - \theta_e) - \sum_{\tau=0}^{T} \sum_{e \in A_v^+} f_{dyn}(e, \tau) = 0, \ \forall v \notin \{s, d\} \quad (1)$$

$$\sum_{\tau=\theta_e}^{\sigma} \sum_{e \in A_v^-} f_{dyn}(e, \tau - \theta_e) - \sum_{\tau=0}^{\sigma} \sum_{e \in A_v^+} f_{dyn}(e, \tau) \geq 0, \ \forall \ v \notin \{s, d\}, \sigma \in T_d \quad (2)$$

$$\sum_{\tau=\theta_e}^{T} \sum_{e \in A_s^-} f_{dyn}(e, \tau - \theta_e) - \sum_{\tau=0}^{T} \sum_{e \in A_d^+} f_{dyn}(e, \tau) = 0 \quad (3)$$

$$f_{dyn}(e, \sigma) \leq b(e, \sigma) \qquad \forall e \in A, \ \sigma \in T_d. \quad (4)$$

The maximum dynamic flow problem maximize (5) satisfying Constraints (1-4).

$$val(f_{dyn}, T) = \sum_{\tau=\theta_e}^{T} \sum_{e \in A_s^-} f_{dyn}(e, \tau - \theta_e) = \sum_{0}^{T} \sum_{e \in A_d^+} f_{dyn}(e, \tau) \quad (5)$$

The continuous flow models introduced in [4] can be formulated as in the discrete flow models where the sum over time is replaced with the integrals. Author in [5] have presented different flow problems with algorithms for evacuation planning .

Problem 1. *Suppose F be the set of all facilities, $r : F \to N$ the size of the facilities and $nol : L \to N$ the number of facilities that can be placed on the possible locations and $L \subseteq A$ the set of all feasible locations. The FlowLoc problem asks for an allocation $loc : F \to L$ of the facilities to the arcs, such that the flow value in the network $N^{loc} = (A, b'_e, \theta_e, L, r_f, S, D, T)$ is maximized, where $b'_e = b_e - \max\{r_f : loc(f) = e\}$.*

If more than one facility is placed on location l, only the size of the largest facility determines the reduction of the capacity on the edge, for detail we refer to [2].

Problem 2. *The 1-Flowloc dynamic flow problem is a 1-Flowloc problem that asks to locate the facility in possible locations in dynamic network such that flow loss is minimum in $N^{loc} = (A, b'_e, \theta_e, L, r_f, S, D, T)$.*

The location of emergency units or other supports are most affecting factors in the evacuation network. Placing any facilities on arcs can result in a smaller maximum flow value or larger flow values on the arcs. This impact has been analyzed in [2] by using the different location scenarios. If more than one facility is placed on location l only the size of the largest facility dominates the reduction of the capacity. The multi terminal q-FlowLoc problem (q-MT-FlowLoc) has been introduced and provided some heuristic solutions for the problem as the problem is NP-hard, [6].

In contraflow approach, the auxiliary network of given network will be constructed by reversing given direction of arcs without any cost whenever the flow value can be improved from source to sink. The auxiliary network $\tilde{N}^{loc} = (A, \tilde{b}_e, \theta_e = 0, L, r_f, s, d)$ is constructed from given evacuation network N as: $\overrightarrow{e} = (v, w) \in \tilde{A}$, if $\overrightarrow{e} \in A$ or $\overleftarrow{e} = (w, v) \in A$. The arc capacity function $\tilde{b}$ is given by: $\tilde{b}_e := b(\overrightarrow{e}) + b(\overleftarrow{e})$ for all arcs $\overrightarrow{e} \in \tilde{A}$ and transit time is defined as follows:

$$\tilde{\theta}(\overrightarrow{e})[= \tilde{\theta}(\overleftarrow{e})] = \begin{cases} \theta(\overrightarrow{e}) & \text{for } \overrightarrow{e} \in A, \\ \theta(\overleftarrow{e}) & \text{otherwise,} \end{cases} \quad \forall \overrightarrow{e} \in \tilde{A}.$$

The utmost important property, the contraflow reconfiguration, the analytical solutions for various contraflow problems, we refer to [7, 5, 8] and the references therein for details. The contraflow problem can be solved with the same complexity as without contraflow but flow value may be double.

3 1-FlowLoc Contraflow Problems

In this section, we propose 1-Flowloc contraflow problems on static and continuous time dynamic networks with efficient solution procedures to the problems by integrating the 1-Flowloc problems presented in [2] and contraflow problems presented in [3].

Problem 3. *The 1-FlowLoc contraflow problem in static network finds a location $l = loc(f) \in L$ for the facility f with size r_f such that the reduction of the maximum flow value is as small as possible where arc can be reversed without any cost and $\theta_e = 0 \; \forall \; e \in A$.*

Algorithm 1. *1- Flowloc with Contraflow Algorithm*

1. *Given an evacuation network $N^{loc} = (A, b_e, \theta_e, L, r_f, s, d)$ with locations L.*
2. *Construct an auxiliary network as in [3], $\tilde{N}^{loc} = (A, \tilde{b}_e, \theta_e = 0, L, r_f, s, d)$ with capacity $\tilde{b}_e = b(\overrightarrow{e}) + b(\overleftarrow{e})$.*
3. *Solve the maximum network flow problem in $\tilde{N}^{loc}$ using 1- Flowloc algorithm, [2].*
4. *A arc $\overleftarrow{e} \in A$ is reversed if and only if the flow along $\overrightarrow{e} \in A$ is greater than $b(\overrightarrow{e})$ or there is a non-negative flow along $\overrightarrow{e} \notin A$.*

Theorem 1. *Algorithm 1 solves Problem 3 optimally in strongly polynomial time.*

Problem 4. *The 1-FlowLoc contraflow problem in dynamic network finds a location $l = loc(f) \in L$ for the facility f with size r_f such that the reduction of the maximum dynamic flow value is as small as possible where arc can be reversed without any cost at time zero.*

Algorithm 2. *Dynamic Flowloc with Contraflow*

1. *Given an evacuation network $N^{loc} = (A, b_e, \theta_e, L, r_f, s, d, T)$ with locations L.*
2. *Construct an auxiliary network $\tilde{N}^{loc} = (A, \tilde{b}_e, \tilde{\theta}_e, L, r_f, s, d, T)$ as in[3].*
3. *Solve the problem in $\tilde{N}^{loc} = (A, \tilde{b}_e, \tilde{\theta}_e, L, r_f, s, d, T)$, [2].*
4. *A arc $\overleftarrow{e} \in A$ is reversed if and only if the flow along $\overrightarrow{e} \in A$ is greater than $b(\overrightarrow{e})$ or there is a non-negative flow along $\overrightarrow{e} \notin A$.*

Theorem 2. *Algorithm 2 solves Problem 4 optimally in strongly polynomial time.*

Standing on the ideas of natural transformation as in [7] and [8], generalized network flow in [5], abstract flow in [7] and 1-Flowloc model in [2], we seek to extend the 1 - Flowloc problem to the generalized lossy and abstract networks in discrete as well as continuous time settings.

4 Conclusion

In this paper, we studied both Flowloc and contraflow models from literatures. Through these models we came to know that the location for facility is the most essential force behind the efficient evacuation planning. Integrating these models, we introduced 1-Flowloc contraflow approach for the first time. We proposed efficient algorithms for 1- Flowloc static and dynamic contraflow problems in two - terminal evacuation networks.

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A Novel Approach for Line Search Technique in Nonlinear Conjugate Gradient Method

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Abstract

An unconstrained optimization problem of the form

$$min\{f(x) : x \in R^n\} \tag{1}$$

where $f : R^n \rightarrowtail R$ is a continuously differentiable function and is bounded below, can be solved by a class methods called Nonlinear Conjugate Gradient (NLCG) methods, which have strong local and global convergence properties. By the NLCG method, the iterates $x_0, x_1, ...$ satisfy the recurrence relation

$$x_{k+1} = x_k + \alpha_k d_k \tag{2}$$

where line search algorithm is used to obtain a positive step size α_k and the search directions d_k, which is evacuated from:

$$d_{k+1} = -g_{k+1} + \beta_k d_k,\ d_0 = -g_0. \tag{3}$$

Noted that β_k is the CG parameter and $g_k = \Delta f(x_k)^T$, where the gradient $\Delta f(x_k)$ of f at x_k is a row vector and g_k is a column vector.

The beauty of the method is, it is characterized by low memory requirements. The success of $NLCG$ depends on an efficient line search technique. We propose a line search method, which guaranteed faster convergence of the $NLCG$ algorithm. With this line search method we present a modified $NLCG$ algorithm which is tested on $CUTEr$ [1] collection of problems. The test establishes strength of our algorithm in compare to other state of the art algorithms.

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Flow Dependent Transit Times Dynamic Flow for Evacuation Planning

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Abstract

Dissimilar to conventional static flow problem, this research studies network flows in relation to time. Any one caught up in a traffic jam would know that the existing premise of flow overtime with constant transit times on the arcs cannot access the real life road traffic. Challenges with flows overtime and constant transit times can be rephrased to static flow problem in time expanded networks. We studied an alternative time expanded network with flow dependent transit times to which the whole algorithmic tool box forwarded for static flows can be applied.

Keywords: Flow overtime, congestion, traffic jam, transit times, evacuation network.

1 Introduction

In developing countries like Nepal, the tendency of people clustering in the cities and metropolitan areas is increasing. The metropolitan areas are facing series of congestion problems due to increasing number of vehicles, which deteriorate the quality of life. Rapid increase in the population of cities, unavoidable travel demand and lack of new transportation facilities worsen the traffic condition.

In our daily life, network are visible everywhere. A good network of water supply and power supply makes our life comfortable and convenient at homes. A good network of cable keeps us connected to the world at every moment. Similarly, a good network of roads keeps mobility of a city normal. However, the flow on network affect the transit time. For example, let us suppose that the average transit time to travel from city center of Kathmandu to Tribhuvan university is 30 minutes technically. However, we hardly find that the distance is covered exactly in 30 minutes every time. It is likely to get affected by the number of vehicles running on the street. Thus, the transit time is not constant, but flow dependent.

2 Flow Dependent Transit Times

In fixed transit times, travel time on the arc is more or less remains unaffected by current flow situation on the arc. But empirical knowledge suggest something opposite. Everybody who was ever caught up in a traffic jam knows that the latter assumption often fails to capture essential characteristics of real life situation. In many applications, such as road traffic control, production systems and communication networks (i.e. internet) the amount of time needed to transverse an arc of underline network increases as the arc becomes more choked.

2.1 Model of dynamic traffic assignment

The basic model for time dependent flows with flow dependent transit times has been introduced by Merchant and Nemhauser[8]. They descretized the time horizon and developed a nonlinear and non convex model. A dynamic network $\mathbb{N} = (G, u_j, \tau_j, s, t)$ consist of directed graph $G = (V, A)$ having node set V and arc set A with a capacity function u_j and transit time function τ_j defined by $u_j, \tau_j : A \to \mathbb{R}^+$. The time dependent flow with time horizon T is given by the functions $f_j : [0, T) \to \mathbb{R}^+$, for $j \in A$, where $f_{\theta j}$ defines the rate of flow entering arc j at time θ, which arrives at the head node of arc j at time $\tau_j(f_{\theta j})$. In this model outflow from an arc in each time period depends on amount of flow on that arc at the beginning of time period. They use a cost function $h_{\theta j}$ and exit function g_j on each arc instead of transit time function. The transit time that is spend by the flow on arc j in period θ is $h_{\theta j}$ and if $f_{\theta j}$ is the amount of flow on arc j at the beginning of time period θ, $h_{\theta j}(f_{\theta j})$ is the cost during period θ and $g_j(f_{\theta j})$ is the amount of flow that exits from arc j. It has both analytical and computational problems due to non convexity of the model and it is not easily applicable to real world application.

The Merchant-Nemhauser Model

$$\text{Minimize} \quad \sum_{\theta=1}^{T} \sum_{j \in A} h_{\theta j}(f_{\theta j}) \tag{1}$$

subject to, for periods $\theta = 0, 1, 2, ..., T-1$

$$f_{\theta+1,j} = f_{\theta j} - g_j(f_{\theta j}) + d_{\theta j} \text{ for all } j \in A, \tag{2}$$

$$\sum_{j \in A(k)} d_{\theta j} = F_{\theta k} + \sum_{j \in B(k)} g_j(f_{\theta j}) \text{ for all } k \in V'. \tag{3}$$

$$f_{0j} = E_j \text{ for all } j \in A, \tag{4}$$

$$d_{\theta j} \geq 0, \text{ for all } j \in A, \tag{5}$$

where $d_{\theta j}$ = the inflow into arc j during period θ.
$F_{\theta k}$ = the inflow at node k in period θ and
E_j = the initial flow on arc j, i.e.$f_{0j} = E_j \geq 0$.

Carey[2] introduces a slight revision of the model of the Merchant and Nemhauser [8] yielding a convex problem instead of non convex one. Carey introduced flow control constraints

$$0 \leq b_{\theta j} \leq g_j(f_{\theta j}) \text{ for } \theta, j, \tag{6}$$

where $b_{\theta j}$ = the actual out flow from arc j in period θ. Flow controls can be used to keep the actual outflow $b_{\theta j}$ below the natural and unrestricted capacity level.

3 Solution Approaches

Kohlar, Langkau and Skutella[7] apply the time expanded network, they refer to this time expanded network as a fan graph. On any moment of time the transit times on an arc solely depend on the current rate of inflow into that arc. The flow dependent transit time emphasizing that transit times are considered as functions of the rate of inflow. Thus, the flow units traveling on the same arc at the same time don't necessarily experience the same pace. The flow overtime with inflow dependent transit times do not obey the first in first out (FIFO) property on an arc.

3.1 The fan graph

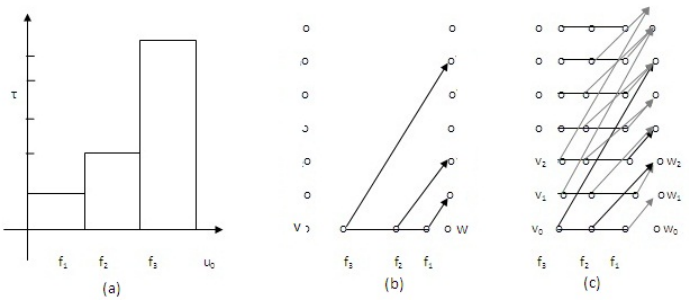

Figure 1: (a)Flow dependent transit times.(b)Expansion of single arc.(c)Time expanded graph of single arc.

To model flow dependent transit times, Kohlar, Langkau and Skutella[7] take a similar prospective i.e. they expand the graph as per the transit time function in such a way that transit time indirectly rely on the current flow rate. For instance, we can assume that the transit time function $\tau_j(f_j)$ of an arc j is given as piece wise constant, non decreasing, and left continuous function with only integral values.

3.2 Existence of earliest arrival flows with flow dependent transit times

Maximum dynamic flow exist for flow dependent transit times, but finding a maximum dynamic flow is NP hard. Maximal $s-t$ flows over time that sends maximum amount of flow from s to t for each time $\theta \in [0, T)$ is called earliest arrival flows. Existence of earliest arrival flows for general network with constant transit time on the arcs showed by D. Gale [6]. In case of flow dependent transit times there exists for

any fixed time horizon T an $s-t$ flow over time that sends the maximum amount of flow from $s-t$. It is quite natural to ask whether there is again such a maximum $s-t$ flow exist that is maximal also for each $\theta \in [0, T)$.

Theorem 1. *[1] For inflow-dependent transit times, earliest arrival flows do not exist in general.*

3.3 Approximation of flow-dependent earliest arrival Flows

As discussed earlier, in the case of flow-dependent transit times there are instances where there is no earliest arrival flow. Due to that Baumann and Kohlar[1] are interested in related optimization problem that determines almost earliest arrival flows. Instead of relaxing the amount of flow Baumann and Kohlar[1] relax the time up to when a certain amount of flow has reached the sink, i.e. they introduce the problem to minimize the lateness of flow called the α-earliest arrival flow problem.

Theorem 2. *[1] In the case of inflow dependent transit times, there are instances having no α-earliest arrival flow for $\alpha \leq 3/2 - \epsilon$, for all $\epsilon > 0$.*

4 Conclusion

In this survey, I studied model of flow dependent transit times basically inflow dependent transit times and their solution approaches which is very useful in evacuation. On the basis of this we are trying to reduce evacuation time so that we can evacuate maximum number of evacuees from dangerous zone to the safety places in minimum time.

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Generalized Continuous Dynamic Contraflow Approach on Lossy Network

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Abstract

The traditional network flow models that implicitly assume the flow conservation on every arcs have not been addressing the practical applications of physical transformation. Departed flow may not reach the destination due to leaks, evaporation, breeding, theft rates and so on. For this we consider the positive multipliers on the arcs that specify which portion of the flow entering an arc at its tail node reaches its head node. We study the model and propose solution techniques on generalized continuous dynamic flow and its contraflow reconfiguration. Contraflow plays a vital role in increasing the flow value significantly as well as reducing the time drastically. It helps to evacuate the people in given time horizon using the minimum loss path.

Keywords: Evacuation planning, lossy network, generalized maximum flow, continuous dynamic contraflow.

1 Introduction

To save the people and property from the disaster areas and normalize the situation is being more challenging day by day. Evacuation planner has to face some challenges to select transportation with the minimum losses in the disaster period. Concept of traditional and the real applications of the network models over the consumptions on arcs during the evacuation differ. Therefore, the generalization of the flow model is essential to understand the real application of the physical transportation. We consider positive multiplier on each arc which helps to specify the flow amount that arrived in head node from its corresponding tail node. Our concern will be to model the generalized flow and to give solution techniques on the continuous time setting. This significantly increases the capacity of the route and improves total flow amount by contraflow. Contraflow reconfiguration in the evacuation network has been adopted in many applications and analytical solutions, see Pyakurel et al. [7], Dhamala [1] and Pyakurel [6] for details.

Authors in [3] provide the network model of generalized maximum dynamic flow (GMDF) and prove that it is NP- hard if each arc contains loss(gain) factor and transit time together in discrete time settings. A network with identical multiplier ≤ 1 for all arcs is known as lossy network. We introduce the maximum generalized dynamic flow (MGDF) problem for single source and single sink lossy network on continuous time setting. Also we present a pseudo - polynomial time algorithm to solve the problem.

2 Basic Denotations

Let $G = (V, A)$ be a two-terminal digraph with $|V| = n$ nodes and $|A| = m$ arcs. We denote $A_i^{out} = \{(i, j) \in A : \forall j \in V\}$ and $A_i^{in} = \{(j, i) \in A : \forall j \in V\}$, where $A_s^{in} = A_d^{out} = \phi$. A generalized dynamic network is $N_g = (V, A, c_A, \lambda, \tau, s, d, T)$ with multiplier $0 < \lambda \leq 1$ which is proportional to transit time. We assume that $\lambda \equiv 2^{k\tau}$ where, $k < 0$ for each arc $e \in A$. The capacity $c_A(e) \in R^+$ denotes the maximum amount of flow that may enter the arc $e \in A$ per time period and transit time $\tau(e) \in Z^+$ gives the time needed to travel one unit of flow on arc e. The generalized continuous dynamic flow (GCDF) $f : A \times T \to R^+$ sends the flow amount $f(e, \sigma)$ from tail(e) that reaches $\lambda(e)f(e, \sigma + \tau(e))$ to the head(e) by the time $\sigma + \tau(e)$, where $\sigma \in [0, T)$ for given integer time T.

The maximum generalized continuous dynamic flow (MGCDF) problem maximizes the total amount of $s - d$ flow value $\vartheta(f, T)$ in equation 1 with respect to the conservation constraints 2 - 3 and capacity constraint 4 within the time horizon T.

$$\max\ \vartheta(f, T) = \int_0^T \sum_{e \in A_d^{in}} \lambda(e) f(e, \sigma - \tau(e)) d\sigma \tag{1}$$

such that

$$\int_{\tau(e)}^{T} \sum_{e \in A_i^{in}} \lambda(e) f(e, \sigma - \tau(e)) d\sigma - \int_{0}^{T} \sum_{e \in A_i^{out}} f(e, \sigma) d\sigma \quad = 0 \quad \forall i \notin \{s, d\} \tag{2}$$

$$\int_{\tau(e)}^{\xi} \sum_{e \in A_i^{in}} \lambda(e) f(e, \sigma - \tau(e)) d\sigma - \int_{0}^{\xi} \sum_{e \in A_i^{out}} f(e, \sigma) d\sigma \quad \geq 0 \quad \forall i \notin \{s, d\}, \xi \in [0, T) \tag{3}$$

$$0 \leq f(e, \sigma) \leq c_A(e, \sigma) \qquad \forall e \in A, \sigma \in [0, T) \tag{4}$$

2.1 Contraflow Configuration

Let $e^{-1} = (j, i) \in A$ be the reverse arc of $e = (i, j) \in A$. For a given generalized network $N_g = (V, A, c_A, \lambda, \tau, s, d, T)$ with integer inputs and symmetric travel times and loss factors, the generalized auxiliary network $\bar{N}_g = (V, E, c_E, \lambda, \tau, s, d, T)$ consists of the modified arc capacities and travel times, for all $\bar{e} \in E$ as follows: $c_E(\bar{e}) := c_A(e) + c_A(e^{-1})$, and

$$\tau(\bar{e}) = \begin{cases} \tau(e) & \text{if } e \in A \\ \tau(e^{-1}) & otherwise \end{cases}$$

The remaining graph structure and the data are unaltered.The modified loss factor is $\lambda(\bar{e}) = 2^{k\tau(\bar{e})}, k < 0$

2.2 Natural Transformation

Fleischer and Tardos [2] state that the amount of flow that arrives at the node j through the arc e at time step σ in the discrete approach is equal to the amount of flow arriving at j through the arc e during the unit interval of time $[\sigma, \sigma + 1)$. Then we can write $f(e, \sigma) = f(e, [\sigma, \sigma + 1))$ where discrete flow that enters arc e at time $\sigma = \{0, 1, ..., T - 1\}$ and continuous flow as $f(e, \sigma)$ may be in continuous time $\sigma \in [0, T)$.

3 Maximum Generalized Continuous Dynamic Contraflow

Authors [3] and [4] provide a pseudo-polynomial time algorithm to solve maximum generalized dynamc flow (MGDF) and generalized earliest arrival flow (GEAF) on lossy network. The discrete and continuous time approach are equivalent by natural transformation from section 2.2, [2]. We propose the Algorithm 1 to compute the generalized continuous dynamic contraflow on lossy network generating the ideas from [2], [3], [4], [5] and [6] and state Theorem 1 for its optimality.

Problem 1. *Given a dynamic network $N_g = (V, A, c_A, \lambda, \tau, s, d, T)$ the MGCDCF problem is to find a maximum continuous flow that can be sent from s to d within time $[0, T)$, if the direction of arcs can be reversed at time zero.*

Algorithm 1. *Maximum generalized continuous dynamic contraflow (MGCDCF)*

1. *Given a lossy network $N_g = (V, A, c_A, \lambda, \tau, s, d, T)$.*
2. *Obtain the auxiliary lossy network $\bar{N}_g = (V, E, c_E, \lambda, \tau, s, d, T)$ of N_g using the idea of contraflow configuration.*
3. *Compute the genralized maximum dynamic flow using the algorithm of ([3], [4]) on auxliary network.*
4. *Transform continuous dynamic flow into the discrete dynamic flow using the natural transformation $f(e, \sigma) = f(e, [\sigma, \sigma + 1))$ for the $\sigma \in [0, T)$, [2].*
5. *Perform flow decomposition into chain and cycle flows of the maximum flow resulting from Step* (2) *and remove all the cycle flows.*
6. *Arc $(i, j) \in A$ is reversed, if and only if the flow along arc (i, j) is greater than $c_A(i, j)$ or if there is a nonnegative flow along arc $(i, j) \notin A$ and the resulting flow is MGCDCF with the arc reversals for the network N_g.*

Theorem 1. *Algorithm* 1 *solves the GMCDCF problem for lossy network* $N_g = (V, A, c_A, \lambda, \tau, s, d, T)$ *to optimal in pusedo-polynomial time complexity.*

Moreover, an approximate generalized maximum continuous dynamic flow solution can be compute in polynomial time complexity using the FPTAS of ([3], [4]) on auxiliary network with arc reversal capability at time zero.

4 Conclusion

The generalized flow model, we consider here, is closer to reflect the real world situation with accurate result though of higher computational complicity. Our approach of MGCDCF on two terminal lossy network extends the result of discrete time setting to continuous time. To the best of our knowledge this problem we introduced here is for the first time.

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Evacuation Planning Problem Based on Non-Conserving Flow Model

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Abstract

Shifting as many people as possible from disastrous region to safer region in a minimum time period in an efficient way is an evacuation planning problem (EPP). Modeling the evacuation scenarios reflecting the real world characteristics and investigating an efficient route plan are becoming a crucial due to tremendous natural as well as human created disasters. EPPs modeled as network flow satisfying the flow conservation constraints have been extensively studied and the various efficient solution procedures have been established. Besides this, the network flow problem in which flow may not be conserved at nodes necessarily could also be useful to model the evacuation planning problem. This paper proposes a model for maximum flow evacuation planning problem of later kind with an efficient solution procedure on a single-source-single-sink network. Our model allows capability of holding the flow (evacuees) in the temporary shelter at intermediate nodes.

Keywords: Evacuation Planning Problem, Network Flow, Flow Conservation.

An Insight on the Evacuation Planning Optimization Problems on Transit-based System

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Abstract

Efficiency and efficacy of the evacuation planning under both predictable and unpredictable disasters depend upon the nature of transportation network, total affected population size and density, behavioral and organizational situations, traffic capacity and demands, evacuation objectives, time span and on many other factors. Evacuation scheduling, traffic route guidance, destination optimization, optimal route choice, dominant vehicle assignment and other various approaches have significant contribution to accelerate the evacuation process though their integrated optimal plan for a single comprehensive solution to the evacuation problem is always challenging.

This paper presents an insight on the evacuation planning optimization problems on transit-based system of the transportation network, emphasizing their solution strategies on disaster management.

Keywords: Evacuation planning, optimization, transit-based network, vehicle assignment.

1 Introduction

Evacuation is the organized, phased, and supervised withdrawal, dispersal, or removal of civilians from dangerous, or potentially dangerous areas, and their reception, and care in safe areas in utmost reality. It deals to have the optimal and efficient use of vehicles to save life during or after the disasters. The increasing rate of disasters demands the comprehensive analysis and planning for the evacuation management. Past evacuation experiences are to take account of the planning and mitigation strategies which are followed by the response and recovery to normalize the situation. Disaster operations can be performed before or after the disasters as pre-and post-disaster operations. Short-notice evacuations, facility location, and stock pre-positioning are carried out as the main pre-disaster operations whereas the relief distribution, logistic support services, and the casualty transportations are the main aspect of the post-disaster operations [1].

Evacuation planning strategies and their operations may vary due to their applicable geographical scales; behaviour, density and size of the affected population; nature and modes of transportation network; traffic capacity; evacuation objectives; and the time spans. Mainly the evacuees may be *auto-based* or *transit-based*, depending upon whether they can be evacuated by using their own vehicles or need to be sent towards transit hubs for evacuation. In large cities many people fall on second category and are to be given the special attention on evacuation planning.

For transit-based evacuation system, a simplified version of one of the earlist algorithms, capacity constrained route planer algorithm is presented in [2] based on some industry standard algorithm and is claimed better than most of the heuristic algorithms and are also modified in various versions for different cases. Authors in [3] have presented the simple version of quickest path evacuation routine algorithm at which the running time is determined by the number of iterations and is bounded above mainly by total number of paths rather than the number of evcauess. This work presents an insight on the evacuation planning optimization problems on different transportation network based on transit-based system with focus on their solution strategies on disaster management.

2 Evacuation Planning Problems on Transit-based Networks

Different types of trsansportation networks are there in real practice. So, one has to be careful getting their solutions as they tend to be large and exhibit an exponential complexity with the problem size. Their performance, and efficiency depends upon the nature of road network, population density, the behavior of evacuees and on many other factors. Different models and strategies have been developed so far for the transit-based system on transportation network. Among them, prominent bus-based evacuation problems, as a unique variant of vehicle routing problem are proposed by [4], with the objective to minimize the time of evacuation. Considering the exact number of evacuees are not known in advance it can also be expanded to the robust scenarios.

It seems that sending each vehicles to its closest shelter to last pickup node is the appropriate route to be assigned for the optimal routing. But, it is not always.

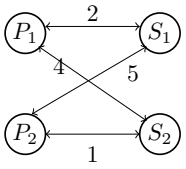

Figure 1: A simple network

Example 1. *In this simple network as in Figure 1, let a bus which has picked up a full load of evacuees at the demand nodes P_1 can still pick up a full load at P_2 with uncapacitated shelters S_1 and S_2. Then, if the shelter closest to its last pickup node is assigned, the bus would be on P_1 - S_1 - P_2 - S_2 and will have the cost of* 8*, whereas the optimal solution would be on the route P_1 - S_2 - P_2 - S_2 with cost of* 6*.*

As far as the split delivery is concerned, the split delivery network will not always improve the evacuation duration. Moreover, one vehicle covering all the routes will have approximately the same cost as multiple vehicles covering the same routes in simple evacuation network, for details we refer to [5].

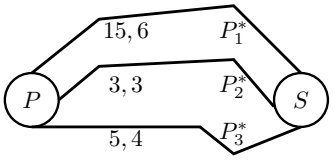

Figure 2: An evacuation network

Considering both the transit time and capacity on each path the concept of *combined evacuation time* (CET) and the *quickest paths* has been introduced by [3]. For T be the travel time of the path (the sum of travel time of edges in the path), C be the capacity of path (the minimum capacity of the edges in the path) and x be the number of evacuees at the source P , the evacuation time ET is calculated as

$$ET = T + \lceil \frac{x}{C} \rceil - 1. \tag{1}$$

As far as the *quickest path* is concerned, the path P_i is said to be the quickest path if and only if $T_i + \lceil \frac{x}{C_i} \rceil - 1 \leq T_j + \lceil \frac{x}{C_j} \rceil - 1$, for all $j \in \{1, 2, \ldots, k\} \backslash \{i\}$. Let $P_1^*, P_2^*, \ldots, P_k^*$ be k edge-disjoint paths from source P to sink S, with C_i and T_i and be the capacity and transit times of paths P_i and x be the number of evacuees at the source or the demand node P, then the combined evacuation time is given by

$$CET(P_1^*, P_2^*, \ldots, P_k^*) = \left\lceil \frac{x + \sum_{i=1}^{k} C_i T_i}{\sum_{i=1}^{k} C_i} \right\rceil - 1 \tag{2}$$

Example 2. *Consider three possible paths P_1^*, P_2^*, and P_3^* in between demand node P and the sink S with their respective travel time T and capacity C as in Figure 2. Suppose the evacuees at demand node be* 52 *then the ET through these paths can be calculated by using equation 1 as* 23*,* 20*, and* 17 *respectively among them ET(P_3^*) be choosen as the quickest path. But if the next path P_1^* be added on the evacuation route then the CET as in equation 2 becomes $CET(P_3^*, P_1^*) = 16$, which is shorter than the current evacuation time. Moreover, by adding the next path P_2^* also on the evacuation route, the CET becomes $CET(P_1^*, P_2^*, P_3^*) = 13$, further improved, which is smaller even than the route P_1^* with longest travel time. Hence, we can remove the route P_1^* with longer travel time from the evacuation route, since $CET(P_2^*, P_3^*) = 11 < CET(P_1^*, P_2^*, P_3^*)$ and the evacuation time be reduced even more by* 2*.*

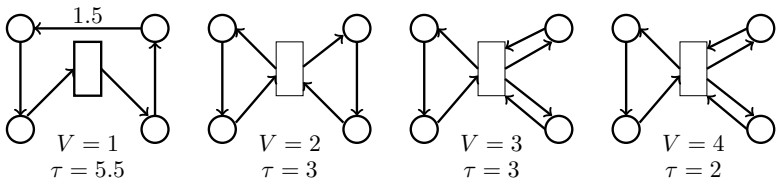

Figure 3: Different scenarios of vehicle assignment

By various approaches including some empirical evidences, Bish [4] has concluded some useful results on BEP regarding the fleet size and different objectives:

- *For a single vehicle as the fleet size, the min-max and cost objectives have equivalent optimal solutions.*
- *For the min-max objective there is an optimal threshold fleet size. Increasing the fleet size beyond this threshold does not impact optimality.*
- *For the min-max objective, the evacuation duration does not always decrease in a convex manner with the number of vehicles.*

Example 3. *Consider a simple scenario with four different assignment with one, two, three and four vehicles as in Figure 3 where vehicles start from the depot S, denoted by square and assigned to the demands P_i, denoted by circles and finally return to the depot again. Let all the unmarks arcs are with length unity, the number of vehicles (V) assigned and the respective maximuum route length (τ) is shown as in Figure 4.*

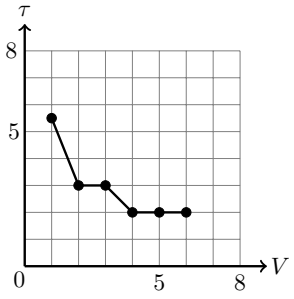

Figure 4: Relation between τ & V.

The most prominent applications of the transit vehicles with their optimal routing and scheduling has been applied to evacuate the entire city of Toronto [6], Canada with a population of about 2.37 million. In a hypothetical case study as in [7] of the evacuation planning of transit dependent people of Kathmandu valley the population of around 25, 672 within the area of 1.45 km^2 were evacuated by using branch-and-bound and tabu search algorithms. The best results obtained for an instance are; evacuation time of 29 minutes with 6 or 5 sources and 5 sinks for evacuation of 50% population using 140 buses having 90 evacuees per bus capacity and 15 km/hr speed.

3 Conclusions

With some insights on various types of the evacuation planning optimization problems their solution strategiees on different transportation network with focus on transit-based system which are of remarkable importance on disaster management are presented briefly and lucidly with appropriate examples and illustrations. Different mathematical models, algorithms and the respective solution strategies which were developed and in practice over the years in such systems are also addressed so far. With some real-world applications and their possible extensions, some open problems on the transportation network focused on the transit-based systems are also highlighted expecting that it should be able to guide much more interest into this important and growing area of research.

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Transformational Leadership and Employees' Job satisfaction: Evidence of Schools in Nepal

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Abstract

The interests of the organization and its members need to be aligned. Such is a task for the transformational leader. The transformational leader inspires, intellectually stimulates, and is individually considerate of them. Transformational leadership style focuses on the development of followers and their needs. The study investigates transformational leadership and job satisfaction by means of descriptive and analytical research methodology. This research paper aims to analyze the relationship between transformational leadership variables and employees' job satisfaction in schools of Nepal. The research paper also aims to measure the level of job satisfaction among employees working in schools in Nepal and to explore the factors of transformational leadership in schools of Nepal. This research paper also aims to project the transformational leadership behavior in Nepalese context and its relevance with employee's job satisfaction through quantitative research design. The research uses Multifactor Leadership Questionnaire (MLQ form 5X) for measuring Transformational leadership style whereas Minnesota Satisfaction Questionnaire (MSQ) is used to measure the level of satisfaction among employees. The study investigates transformational leadership and job satisfaction by means of descriptive and analytical research methodology. The research paper reveals that there is significantly positive relationship between transformational leadership and employee job satisfaction. The research paper also shows that the employees in schools of Nepal are satisfied with their jobs. Hence, transformational leadership behavior must be considered by the school leader to insure the employees' job satisfaction which leads to increment of effectiveness, efficiency and performance of the employees.

Keywords: Transformational Leadership; Leadership Style; Job Satisfaction; Schools.

Gender Differences on Predicting Objective Career Success Outcome – Occupational Hierarchy Among Civil Servant Officers Working at Ministries in Kathmandu Valley, Nepal

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Abstract

This paper aims to examine the factors influencing on objective career outcome (occupational hierarchy) among civil servant officers working at ministries in Kathmandu valley, Nepal. More precisely, the paper targets at development of gender-specific model predicting the likelihood of occupational hierarchy. The paper has adopted objectivist research approach. 254 civil servant officers participated in self-administrated survey conducted in Kathmandu valley during the year 2015/2016. The research has performed binomial logistic regression analysis to examine the effects of human capital components, networking behaviors, masculine hegemonic culture and family responsibilities on predicting the likelihood of hierarchal success. Human capital components: occupational tenure and foreign training; and networking behavior: being visible are significant variables that influence on predicting the likelihood of hierarchal success. However, occupational tenure did not predict the likelihood of hierarchal success for women. None of family responsibilities and masculine hegemonic culture were found to influence the hierarchal success. Because of the no responses available from LGBTQ community, the paper is limited to the binary categories of gender. The paper is an additional empirical evidence on career development literature with respect to objective career success from gender perspective. In addition, literature on gender balance at workplace has also been added with additional evidence. In order to embrace gender diversity at workplace, especially in upper level, the paper can contribute to develop empowerment strategies. This paper contributes by examining the influence of human capital components, networking behaviors, masculine hegemonic culture and family responsibilities on getting occupational hierarchy in Nepali context with reference to civil service.

Keywords: Occupational hierarchy, Civil Servant Officers, Gender

Econometric Analysis of Remittance Inflow and Economic Growth of Nepal

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Abstract

The significance of remittances has been considerable in economic growth via changed in consumption and investment pattern. Because of the growing role of remittance in Nepalese economy the objective of this study is to identify the long run relationship as well as cause and effect relationship between Remittance and GDP in Nepal. Johansen cointegration test and Granger Causality test have been used to study annual time series data from 1974/75 to 2015/16. The Johansen cointegration suggests that there is no long run equilibrium relationship between GDP and Remittance. Engle Granger causality test finds that there is uni-directional causality running from Remittance to GDP.

Keywords: Economic Growth, Remittance, Inflow, GDP, Cointegration.

Consumer Trust in E-commerce in Kathmandu Valley

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Abstract

The paper examined the online consumer trust and its influencing factors in the specific context of Ecommerce The purpose of this study is to examine the factors (i.e. Security, Word of Mouth, Quality of Information, Past Experience, Brand Reputation, Attitude towards Online Shopping) affects consumer trust in Ecommerce. Data were collected through survey via questionnaire Sample was selected in a convenience and snowball basis. The sample size was 150, 30 each on the basis of age group. Structured questionnaire consisted of demographic questions, single choice questions, multiple questions, Likert scale questions and ranking questions. Frequency analysis, correlation, ANOVA test, independent sample t-test were used for data analysis. The findings of the study indicated that security/privacy, word of mouth, online experience, quality information and brand reputation appear to have a significant and positive relationship with online brand trust. Security and brand reputation were among the most important factors for consumer to feel trust when purchasing online. The study recommended that online vendors should focus on providing security as an important factor for consumer to feel trust and service provider should provide information to customer's about the products and their company. Likewise, past experience, brand reputations were also an important factor for consumer to feel trust. Analysis is done considering only the past and present purchasing pattern through e-commerce websites. The generalizability of results has been restricted, given that the respondents were drawn from convenience sampling. On the basis of the research, it has been found that online vendors should focus on providing security as an important factor for consumer to feel trust. Service provider should provide information to customer's about the products and their company. Among the factors important for consumer to feel trust security, quality of information, past experience and brand awareness had positive relation with gender, educational level, age group, 0ccupation respectively Key words: Trust, E-commerce, Primary Data, Descriptive and Inferential Analysis.

Women Autonomy, Wealth Status and Maternal Healthcare Utilization among Nigerian Women: Factor Analysis and Score Approach

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Abstract

The prevalence of non utilization of these services among 26% of Nigerian Women of reproductive age is still a major concern to all stakeholders in the actualization Sustainable Development Goals by year 2030. However, considering the complexity healthcare utilization in Nigeria, the relationship between a particular health care utilization pattern and the linkage between women autonomy and wealth status has not been established so far. The aim of this study is to determine the patterns of women autonomy and poverty-wealth indices and establish their relationships with maternal healthcare utilization in Nigeria. A 2013 data of Nigerian Demographic Health Survey (NDHS) was used to assess estimates, at rural and urban level. Factor analysis was used for exploring the existence of patterns in women autonomy and wealth status and factor score for their relationship with maternal healthcare utilization in both rural and urban population. There exists a strong relationship between the linkage of women autonomy, household wealth status and maternal utilization of healthcare services of rural and urban Nigeria women.

Import, Export and Economic Growth of Nepal: Empirical Analysis

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Abstract

This paper aims to explore the relationship between export, import, and economic growth of Nepal. To attain this purpose, annual time series data for the periods between financial years 1974/1975 to 2016/2017 were tested using Johansen Cointegration approach, Wald Test and Granger Causality test. The result showed the short-run relationship between exports to GDP but no short-run relationship between imports to GDP in Nepal. On the other hand, it was found strong evidence for bidirectional causality between export and economic growth. However, unidirectional causality was found from economic growth to import without any causality between imports to export. These results suggest exports are the main source of economic growth for short-run as well as long-run in Nepal.

Keywords: Economic Growth, Exports, Imports, Unit-root, Cointegration.

Neck Circumference as a Useful Marker for Screening Overweight and Obesity in College Students

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Abstract

Neck circumference (NC) measurement is one of the simple screening measurements, which can be used as an index of upper body fat distribution to identify overweight. The aim of this study is to determine the relationship between NC and overweight/obesity.

In this cross-sectional study a total 198 college students (120 Female, 78 Male) aged $18-24$ years participated. A questionnaire, which consisted of demographic features and anthropometric measurements, was used. Students with $NC \geq 37cm$ for male and $\geq 34cm$ for female and BMI $\geq 25kg/m2$ require evaluation of overweight status.

The percentages of the male and female students with $BMI \geq 25kg/m2$ were 9% and 15.8% respectively and with high NC were 47.4% and 23.3% respectively. The percentages of male and female students with high waist circumference were 9% and 9.2% respectively. In both gender there were positive significant correlations between neck circumference, body weight (male, r=0.572; female, r=0.319; p=0.001), waist circumference (male, $r = 0.407$; female, $r = 0.413$; $p = 0.001$), hip circumference (male, $r = 0.546$; female, $r = 0.326$; $p = 0.001$), BMI (male, $r = 0.532$; female, $r = 0.367; p = 0.001$), waist to hip ratio (female, $r = .299; p = .001$) and waist to height ratio (male, $r = 0.33$; female, $r = 0.426; p = 0.001$).

A significant association was found between NC and conventional overweight/obesity indexes. This study indicates neck circumference is a simple screening measure that can be used to identify overweight/obesity.

Keywords: Neck circumference, Body Mass Index, Overweight, Anthropometry

Occupational Stress and Its Impact on Turnover Intention among Employees in Nepalese Commercial Banks

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Abstract

The objective of this research is to identify the major determinants (stressors) of occupational stress and to find out which determinant of occupational stress has impact and relational influence on turnover intention of employees working in Nepalese Commercial Banks in the year 2017. Out of total 300 structured questionnaire distributed to the selected employees, only 286 respondents have been administered for descriptive and inferential analysis, where seven variables of occupational stress have been analyzed. The overall results reveal that from among the occupational stress variables (stressors), work-life balance was a major cause having strong impact on the turnover intention among employees, whereas, all the variables proved to have significant relationship with employee turnover intention. The finding sheds lights on the major stressors that cause stress among employees which affect their job satisfaction and organizational commitment, thus, leading to turnover intention. Hence, managers must devise effective HRM practices that help to minimize the job related stress of employees and reduce the turnover of the human assets.

Keywords: Human resources management, Occupational stress, Stressors, Turnover intention, HRM practices.

Study on the Horse-Race Betting Market in South Korea using System Dynamics Modeling[1]

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Abstract

This study presents a system dynamics model for the horse-race betting market in South Korea. In addition to the existing off-line betting, the introduction of an on-line betting platform including a mobile application can be considered. We investigate the effect of the adoption of new technology by using a multigeneration Bass diffusion model to measure the number of users in the market. We assumed the three-generations model and investigated the dynamics between off-line betting, an off-line screen betting platform, and an on-line betting platform. The mobile-apps betting business diffused with the coexistence of a first-generation offline betting system can be seen in the proposed model.

Keywords: System Dynamics, Technology diffusion, Bass diffusion model, Horse racing

1 Introduction

In South Korea, the horse-racing business started in 1898, and many horseracing-related promotional activities have been conducted in South Korea. The pari-mutuel betting business was started in 1923 in South Korea [1], and now the Korean Racing Authority (KRA) provides six different betting types: Win, Place, Quinella, Exacta, Quinella Place, and Trio. The statistics of the gambling industry in 2015 reported that there are a total of 33 betting stations including three offline (on course) and remote screen-based stations (off course) in South Korea. Because of legal issues, mobile-application-based internet betting is only in consideration. This internet-based betting platform on horseracing in South Korea can be considered as the third-generation strategy. The on-course and off-course remote technology is the first- and second-generation technology, respectively. We study here the diffusion of new mobile-application-based internet betting technology using a system dynamics approach.

System dynamics, a method to learn the dynamics of a complex system and understand its structure, is a perspective and set of conceptual tools. It deals with a model and analyzes responses using a computer to understand and improve the system performance [2]. The dynamics model can be quantitative, using a causal loop, but also qualitative on data analysis. We use system dynamics modeling to investigate the diffusion of new technology. A diffusion dynamics model explains the growth of products, innovations, or new technology within a system. Many researchers have studied mathematical modeling of diffusion, and the Bass model [3] has been widely used for diffusion analysis. Norton and Bass [4] and Mahajan and Muller [5] studied the diffusion patterns of successive generations of a technology in marketing. In most of the models, after the implementation of new technology, previous strategies would be obsolete. Consider the diffusion of smart phones and the previous cellular phones that were limited to voices calls. Jun et al. [6] mathematically modeled a choice-based diffusion for multiple generations of products.

We propose a new diffusion model that reflects the coexistence of multigeneration technologies in the horserace-betting market: on course, off course (screen-based remote stations), and mobile apps. The model is based on the multigeneration Bass model [5] that has been applied to technology diffusion by considering different generations together. This study depicts three successive generations and the diffusion of a new betting platform.

2 Modelling and Analysis

Section 2 provides the conceptual model of the horseracing market using causal and loop diagrams, and a quantitative model using stocks and flow diagram.

[1]This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(NRF-2017R1D1A3B03028784).

2.1 Qualitative modelling

In Figure 1, the horseracing market is described by a three-generation model using a causal-loop diagram, which shows that as the number of users using a mobile betting system increases, business volume will increase. Having more mobile users and adventurous people may promote the mobile betting business. The qualitative model in the figure also depicts that the racing ticket price is controlled, although the number of mobile betting users increases. Similarly, the adventurous people affect the offline betting business.

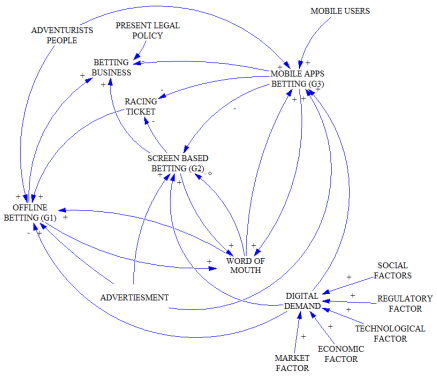


Figure 1: Causal loop diagram of the horseracing market

2.2 Quantitative modelling

The stock and flow diagram in Figure 2 based on the multigeneration Bass model [5] is applied to analyze our multigeneration horseracing market quantitatively. Coefficients of innovation, imitation, and adoption for the first, second, and third generation are respectively estimated.

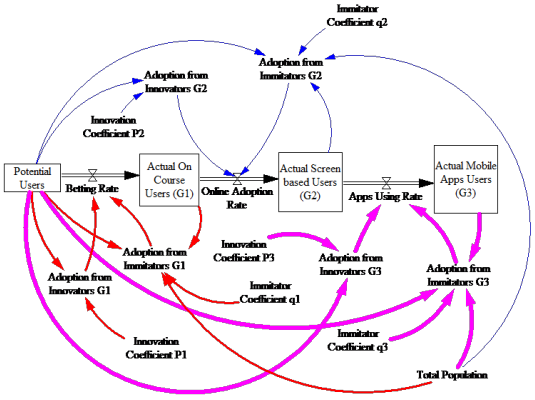
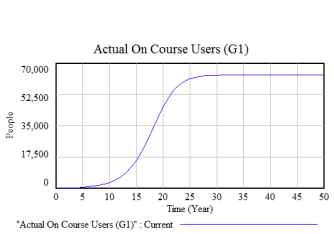
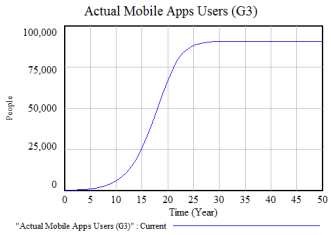


Figure 2: Stock and flow diagram of different generation model

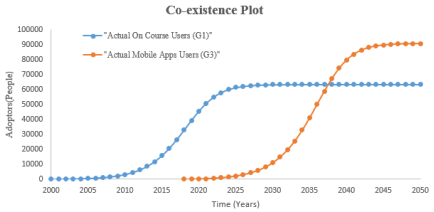
The indicators connected with red are first-generation on-course betting technology, which is the basic Bass model. The blue and pink connecters represent the second- and third- generation technology features, which are extended in this proposed model for the multigenerational technology diffusion analysis. For example, we use the following figures: each generation had an average market potential m= 50,000, total population is set to be 100,000, and the coefficients of innovation and imitation for the first and second generation are set to be $(p_1, q_1) = (0.03, 0.4)$, and $(p_2, q_2) = (0.002, 0.6)$, respectively; finally, for the third generation based on mobile app technology, $(p_1, q_1) = (0.02, 0.38)$. As a result, Figure 3 shows that the number of third-generation technology users is twice the number of on-course offline betting users. In this model, the number of screen-based users (second generation) is decreased, and the total business volume will increase.



(a) Offline users



(b) Mobile apps users



(c) Co-existence plot

Figure 3: Results of multi-generation model

3 Conclusion and Future study

The horse-race betting market in South Korea will be increased after the launch of the new mobile-apps-based betting technology. At the same time, the first-generation offline on-course betting business will continue to exist. The causal-loop diagram also shows that increasing the internet, mobile, and apps users because of the user-friendly environment and the global demand will also increase the overall horse-race betting market. Thus, the technology effects increase the total sales volume of the horse-race betting market. The further validation, scenario analysis, and the various applications for use of this model are to be done in future studies.

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A Study on Service Quality and Customer Satisfaction in Banking Sector

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Abstract

In the present scenario of dynamic business environment with changing technology and competition, customer satisfaction is one of the important dimensions which can be achieved through the service quality. So, the present study focuses on the dimension of customer satisfaction towards the service quality. This study was undertaken using SERVQUAL model to examine the five dimensions of service quality as: tangibility, reliability, responsiveness, assurance and empathy on customer satisfaction related to a banking sector. A Self structured questionnaire was used for a data collection procedure based on literature review. Non random sampling technique is being used for this study. Descriptive and inferential analysis has being conducted utilizing SPSS data.

Keywords: customer satisfaction, service quality, competition

Effect of Microfinance on Women Entrepreneurship A Case Study of Rupandehi District

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Abstract

Bridging the gap between socially responsible investment bankers, World Bank officials, and non-profit workers, the idea of microfinance has become paramount to the development of women entrepreneurs. The intense emphasis of microfinance is on women's economic and social empowerment. So, this paper makes an attempt to evaluate the effectiveness of microfinance on women entrepreneurs' performance in terms of their economic and social empowerment. A descriptive and quasi-experimental research on 124 women entrepreneurs of Rupandehi district through a semi-structured questionnaire was conducted.

The indicators of women's economic and social empowerment were business volume and turnover, saving and expenditure, ownership of assets, freedom of decision making and mobility, family and social relationships and education and health status. Paired sample t test and two related sample test were used to know the difference in women's empowerment before joining microfinance program and after joining microfinance program. The findings of the study revealed that microfinance is a powerful instrument in enhancing women's entrepreneurial performance for all its indicators and economic and social empowerment. The main problem that the women entrepreneurs were facing was lack of capital and none of the MFIs of Rupandehi district provides training services which creates them with a challenge to become successful women entrepreneur.

Keywords: Microfinance, Women's economic and social empowerment, Women entrepreneurs, Decision making, Saving, Expenditure

Management Practice and Performance of Public Enterprises in Nepal

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Abstract

The primary objective of this study was to examine the impact of management practice on performance of Nepalese public enterprises. The study sought to identify the managerial problems are faced by Nepalese public enterprises. Descriptive and correlational research design were used to analyze the collected data by using relevant statistical, financial and mathematical tools with the help of help Statistical Package for Social Science (SPSS) computer software version 20 and presented in textual form and tables The population identified for this study was operating (37) Nepalese PEs of which 10 enterprises were selected as a sample from population based on cluster and purposive sample technique. The primary data had been collected through five point likert scale questionnaire and which were personally distributed to the head office' officers who are the respondents in the sample. Secondary data had been collected from latest available five years annual report of Financial Comptroller General office (FCGO), Ministry of Finance, Government of Nepal and annual report of selected Nepalese PEs. The study found that the level overall management practice (planning, decision making, leadership and controlling practice) of Nepalese public enterprises is not in satisfactory level, it is also found that, controlling practice would emerge with the highest independently positive effect on performance of PEs which is statistically significant for this study at 95% confidence level (p = .000). This study concludes that the controlling practice is the prime factor for this study. The Nepalese public enterprises are suffering from different managerial problems. Basically, the study established that the Nepalese PEs are suffering from five most prominent managerial problem which are: the government cannot focus to apply emerging concept of management, the public enterprises has not utilize its capacity, the role of trade unions are more responsible on panel of employees rather than welfare of public enterprises, the government cannot formulate lean, clean and green public enterprises (which is also one emerging concept of management) and top level executives are frequently changed. The finding on the correlation between aggregate Government investment and actual performance of Nepalese public enterprises is moderately negative correlated. The study emphasized and recommended to improve the level of overall management practice, especially focus to improve the controlling practice for better performance of Nepalese public enterprises. It is hoped that the findings should assist policies makers, advisers, owners, management team and other stockholders in designing and implementing policies and programs for better performance of Nepalese public enterprises.

Keywords: Planning, decision making, leadership and controlling practice, performance

A Comparative Study of Bank Selection Factors Based on Demographic Profile in Nepal

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Abstract

This research is intended to identify the important factors that are considered by customers while choosing commercial banks in Nepal based on their demographic profile. Six factors; reliability, convenience, assurance, value added service, accessibility and responsiveness were analyzed along with their sub factors. The twenty nine sub factors comprise: good brand name/image, good reputation, good security management, privacy/confidentiality, ease of opening an account, sms/mobile banking and internet/online banking, several branches, convenient branch locations, parking space, good interest rate on deposits, ease of opening a current account, low interest rate on loans, ease of obtaining loans, innovative product/ services, debit/credit, locker, account to account balance transfer and e-payment facility, wide ATM network, functional and secured ATMs, 24 hours availability of ATM services, amount withdrawal limit, friendly staffs, knowledge, skill and expertise, clear communication and response, professionalism and attitude of staffs and appearance of bank.

The findings suggest that the most important factor for customers is responsiveness followed by convenience, accessibility, reliability and value added service while choosing commercial banks. Then, friendly and courteous manner of staffs, good security management, higher interest rate on deposits, bank maintaining privacy/ confidentiality and clear communication and quick response from staffs are the top five sub factors.

The research concluded that in the average score of reliability, value added service and accessibility it is found that there is significant difference based on gender. Then, there is significant difference on assurance in respect to age group. There is also significant difference in reliability and accessibility based on occupation. However, there is no significant difference in the bank selection factors on the basis of income. In the average score of convenience, assurance, value added service and accessibility, there is significant difference based on location.

Keywords: Comparative study, bank selection factors, commercial banks

Monetary Policy and Economic Growth: A study from SAARC Countries Using ADRL Model

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Abstract

This paper examine the role played by monetary policy in promoting economic growth in SAARC countries over the period 2000-2016 using economic growth (Real GDP), broad money, inflation, interest rate, and real exchange rate. The major objective of the study is to examine the impact of monetary policy on economic growth Data are collected from the authorized source of the government bodies' ad agencies like World Bank and Asian development bank. The unit root test (ADF test) of the study results indicates that the variables have different integration order. Subsequently, the bound testing (ARDL) approach and ECM-ARDL Model are applied in order to examine the long run and causal relationship between the variables. Furthermore, the empirical result of the study revealed coefficient of money supply (board) and exchange rate are significantly positive whereas inflation and interest rate are negative. The result also revealed that there is both the short and the long run relationship between monetary policy and economic growth.

Keywords: Monetary Policy, Economic Growth, Unit Root Test, Bound Testing, Stability Test, SAARC.

Financial Literacy Among Employees in Wailing Municipality

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Abstract

This study surveys 100 employees in Waling Municipality to examine their financial literacy; the impact of demographic, educational and personality characteristics on financial literacy. Mean, ANOVA and logistic regression were used in carrying out analysis. Results show that most of the employees have advance level of financial knowledge but they lack in understanding of time value of money, money illusion, compound interest and inflation. Employees are highly influenced by their life experience and job and they have positive attitude towards savings. The study further identified income, education level and financial influence as determinants of financial knowledge; and financial knowledge is unaffected by gender, financial behavior and financial attitude. It is concluded that employees have advance level of financial knowledge. However, overall financial knowledge of the students is affected by some of their demographic, educational and personality characteristics.

Cyber Threat and SOC in Nepalese Context

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Abstract

A cyber threat is deemed any malicious act that attempts to gain access to a computer network without authorization or permission from the owner(s).Cybersecurity is experiencing enormous growth as an industry and as a theme in the daily lives of people and thebusiness world.Nepal is an emerging country in the world of cyberspace, and its underlying infrastructure is vulnerable to a wide range of risksfrom both physical and cyber threats and hazards. Constant defacement of both private and public Nepali domains, the large scale financial attacks and cyber heist are all consequences of a weak security posture that is publicly visible. This includes banking and financial fraud, intellectual property violations, and other crimes, all of which have substantial human and economic consequences.As a result, such highly visible breaches and attacks have brought an intense focus on various organizations' incident detection, investigation and mitigation capabilities. Once the problem is identified, what is needed then and what will work in the particular organization culture and the way to get there become of paramount importance.One solution to the problem is to build a Security Operations Center (SOC), which requires collaboration and communication among multiple functions, disparate technology, and varying processes and procedures.

Keywords: Cyberspace, Cyber threat, Security Operation Center, ICT

1 Background

Technology is changing and so is our need and dependency on it. Organizations are now heavily dependent on the ever-changing technology and information systems. These information systems process and hold information vital to the operation and survival of an organization including organization and customer confidential data, employee data and other information that are highly critical, which if it falls in the wrong hands, can compromise the integrity of any organization and cause prodigious damage to the organization. A threat, in the context of computer security, refers to anything that has the potential to cause serious harm to a computer system. It is something that may or may not happen butif it happens, it has the potential to cause serious damage. According to the Oxford Dictionary, "a cyber threat is the possibility of a malicious attempt to damage or disrupt a computer network or system."A threat is a possible danger that might exploit a vulnerability to breach security and therefore cause possible harm[1]. Computer Security Threats are possible dangers that can affect the smooth functioning of the PC. These may be a small piece of adware or a harmful Trojan malware[2]. In the present age, computer security threats are constantly increasing as the world is going digital.As a result, new markets can and do mature very rapidly, leading to intense competition. In such an environment, time is often a critical success factor, a fact that has led to a permanent change in the way we do business and has also had an impact on the way we perceive risk in general. This is just as true for service oriented industries as it is for producers of consumable goods—one of the keys to success is the ability to deliver rapidly[3].

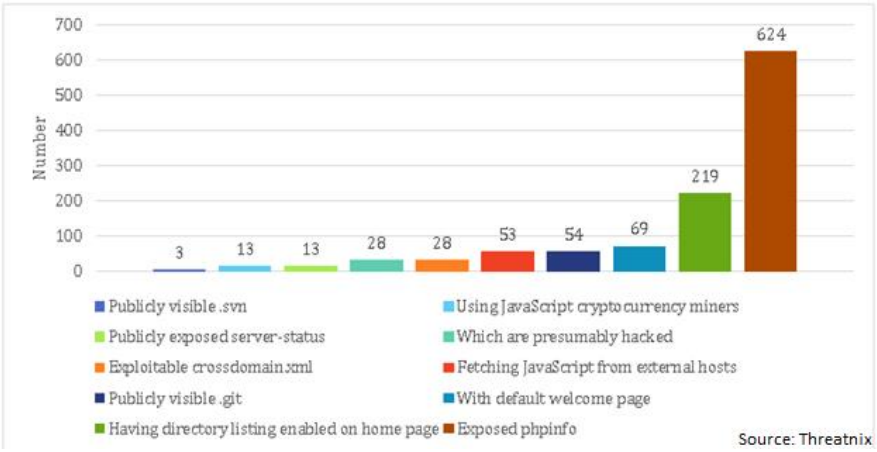
A Security Operations Center (SOC) is an organized and highly skilled team whose mission is to continuously monitor and improve an organization's security posture while preventing, detecting, analyzing, and responding to cyber security incidents with the aid of both technology and well-defined processes and procedures. In other words, a security operations center (SOC) is a centralized unit that deals with security issues at the organizational and technical level. A SOC within a building or facility is a central location from where the staff supervise the site, using data processing technology [4].The function of a SOC is to maintain situational awareness of events on the computer systems and networks that it monitors.Such a center provides an essential business control aimed at protecting ICT systems and supporting Cyber Defense Strategy[5]. Its overarching purpose is to ensure that incidents are identified and resolved swiftly, and to maintain safe and secure business operations.

2 Nepalese Cyberspace and Cyber threat

In this age of cyber warfare, we cannot ignore the possibility of any large scale cyber-attacks, state sponsored or otherwise, that may cripple our cyber infrastructure. It is no secret that the security posture of Nepali cyber world is not up to the mark.The history of computers in Nepal startsin 2028 BS, when the government

leased a second-generation IBM 1401 computer for use in the population census. From that year onward, computers are being used more and more in in different business organizations. Now-a-days probably each and every institution, business organization, communication center, ticket counter are using computers in their daily work. Many of the business organizations rely on computers and expose their work on cyberspace, and so cyber threats are increasingly becominga big problems in our society. Nepal is a member of the international community and cannot stay apart from these threats. Earlier, technology and connectivity were just supports to realize business objectives; now they have become essential in the running of the organizations.Technology has become the enabler of businesses we do and activities we are engaged in. It runs our businesses and it has a huge impact on our daily business activities, personal and social life.

Organizations in Nepal working in the field of information security and also doing some research range from financial sector, telecommunication service provider, internet service provider, airlines industry to other IT based companies. A study was conducted onorganizational structure, formulation and implementation of information security, information security vulnerabilities, attacks and threats, technologies used for information security, organizational structure for information security, and strategies for information security[6]. In the study 61.3% respondents were from financial service providers from commercial banks, development banks, finance companies and insurance companies, 25.8% respondents were from other IT based companies, 6.5% were from internet service providers, 3.2% from telecommunication service providers, and 3.2% from airlines companies. In another study it was found that out of 27 e-banking sites 4 were vulnerable to POODLE [7]. Nepalese domains are also found in Cryptojacking in which 9 out of 11785 TLDs are using coinhive directly on their homepage. Similarly, 768 websites were defaced and most of them are commercial sites which are followed by government sites[7]. Nearly 624 websites out of 11785 were exposed to phpinfo and other different threats [7].



3 Role of SOC

Security Operations Center (SOC) is a dedicated facility with a dedicated team performing not just security but other critical 24/7 IT operations from the same facility in order to reduce costs. In Stamford Convention, Gartner explains that traditional SOC functions and new ones, such as threat intelligence, computer incident response team (CIRT) and operational technology (OT) functions, can be integrated into one SOC facility[8]. Thus, a Security Operation Center (SOC) is made up of five distinct modules: event generators, event collectors, message database, analysis engines and reaction management software. Since the SOC is a team, collaboration tools have to be carefully designed to give the members the best user experience available. This would in turn give the SOC the best ability to produce value for the businesses. This goal must be accomplished with all the security assurance requirements needed for a Security Operations Center[9]. The main problem encountered when building a SOC is the integration of all these modules, usually built as autonomous parts, while matching availability, integrity and security of data and their transmission channels[10].Many functions have to be carried out and so analysts will be assigned to two or three tiers. The primary functions provided by the team members will be analyses grounded on the real-monitoring of events, the detection of securityincidents or data breaches, the response to these incidents, and the remediation of the consequences of every detected incident. All of these actions have to be coordinated: collaboration, timing, and efficiency are of paramount importance for the SOC overall

organization. Each member of the team has to be fully aware of both the mission and the strategy of the SOC. Therefore, an effective leadership is of utmost importance to make the required impact. The key question for most organizations will be whether they would opt to develop an in-house SOC, adopt a hybrid solution with Managed Security Service Provider (MSSP) support, or fully outsource the SOC. A number of factors will come into play here, most notably the security and confidentiality requirements, the size of the organization and network, as well as the budget and timeframe. An effective SOC is a combination of people, procedures and technology.

4 Conclusion

Various studies show that Nepal cyberspace is critical withan enormous amount of cyber threat present in it. The aim of cyber security efforts should be to make Nepal a hard target and thereby increase the trust and confidence of all Nepalese to engage in the benefits the internet brings. To combat the cyberthreat present in the Nepalese cyberspace, a consolidated approach is needed. The concept of SOC may provide the best answer and solution to this ever-increasing challenge to cyber security in the Nepalese context. Effective cyber security requires an alliance between government and the private sector, with organizations and their users taking greater responsibility for the security of their networks and information. Separating the SOC and IT teams into disparate elements helps reduce the conflicting pressures and priorities between these two elements. When a SOC is adopted, a policy of ongoing assessment will need to be employed across all areas (policies, processes, skill levels and technological controls), in order to identify areas of strength and weakness, so that resources can be allocated to remedy the weak areas and enhance the effectiveness of the strong areas.Properly trained, motivated and appropriately supervised personnel in each area is an essential element for a holistic security solution. Appropriate policies and well-practiced procedures will mean that timely and suitable responses can be enacted to mitigate the impact of all security incidents.

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Application of Queueing Systems in Production and Delivery

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Abstract

Queueing theory is applied in different fields including production houses. Production houses produces items one after another in a sequential order. Some of the products are produced in a mass whereas some are produced single. In this paper, we take some of the mathematical models of queueing systems and calculate the mean waiting time in the queue and in the system, mean service time in the queue and in the system by the requested jobs arrivals. Finally, we verify the results by simulation using MATLAB.

Keywords: Queueing System, Production, Server, Waiting, Arrival.

1 Introduction

Queueing theory is applied in many of the production houses. Manufacturers Produce their products one after another following queueing discipline. Some of the items are produced in a bulk whereas some are produced single. All the products produced by the manufacturers are to be delivered from one place to other following different queueing models. There can be a single or multiple servers to facilitate the customers but which of the queueing discipline to follow depends upon the available resources and customer's request. There are one or more production houses which can be assumed as a server. These production companies produce different items and are distributed to number of retailers. While delivering those products whole-seller is generally independent but would like to sell the products as much as possible and as quick as possible. Orders arriving to the whole-seller are independent and identically distributed ($i.i.d.$) random variables which are generally independent and service are also generally independent or follow Markovian process.

Let λ be the request arrival for the products at node i and μ be the service by which items are delivered then we can express the performance measures of the queue length of the request which are not delivered. The waiting time of the retailers before the delivery and the request.

There are some production houses which produces more than one products and a retailer may require one or more of the products at a time. In this situation the items can be delivered either by a single station or from the multiple stations. In some case customers move in a cycle to collect the items from one station to the other station.

2 Some Related Works

Some of the researchers have performed their research activities in this area and some of them are described as follows:

Iannoni and Morabito [1] studied the processes of harvesting and transportation of raw materials by means of logistic supply system in agro industries. Wu [2] evaluated the role of different batching behaviour in manufacturing system. Rashid et al. [3] derived some mathematical models for the applications of queueing theory in production inventory optimization. Ziarnetzky and Mönch [4] presented production planning formulation using simplified semiconductor supply chain consisting of a single front-end facility and back-end facility. Zavanella et al. [5] dealt with an analytical approach to model the power request using queueing theory for the consequent energy use in a production system.

These are some of the literatures which help us establish the following mathematical model.

3 Mathematical Model

There are some usual notations for this model and some of them are described as follows:

(i) Arrival from the outside to node i follows a Poisson process with mean γ_i.

(ii) Service (holding) times at each channel at node i are independent and exponentially distributed with parameter μ_i (a node's service rate may be allowed to depend on its queue length).

(iii) The probability that a customer who has completed service at node i will go next to node j (routing probability) is r_{ij}(independent of the state the system), where $i = 1, 2, \ldots, k$ and $j = 0, 1, 2, \ldots k$ where r_{i0} indicates the probability that a customer will leave the system from node i.

When $\gamma_i = 0$ for all i no customers enter in the system from the outside. When $r_{i0} = 0$ for all i, no customer may leave the system and follow the service in cyclic queue. For the system $i = 1, 2$; $j = 0, 1, 2$; $r_{12} = r_{21} = 1$ where node 1 represents the operating machine and node 2 represents the repair facility. It is important to note that customers always make a cyclic service from node 1 to node 2 and then back to node 1.

In our assumption we have

$$\gamma_i = \begin{cases} \lambda & \text{i=1} \\ 0 & elsewhere \end{cases}$$

and

$$r_{ij} = \begin{cases} 1 & j = i+1, \quad 1 \le i \le k-1 \\ 1 & i = k, j = 0 \\ 0 & elsewhere \end{cases}$$

Now we discuss some the the mathematical models and some of the performance measures relating to manufacturing and supply system.

3.1 $M/G/1$ Queueing Model

This is the model in which arrival is Markovian but service is generally distributed. There is a single server to provide the service which helps the arrivals for the better service.

Average number of customers in the system

$$L = \frac{\lambda^2\sigma_s^2 + \rho^2}{2(1-\rho)} + \rho$$

Mean number of jobs at unit i is

$$L_i = \frac{\lambda^2\sigma_s^2 + \rho_i^2}{2(1-\rho_i)} + \rho_i, \qquad i = 1, 2, 3, ..., N$$

where σ_i^2 is the variance of service time in the system.

Therefore the mean work in process is

$$L = \sum_{i=1}^{N} L_i$$

The total time of the job started in the network until it finishes the work and exit from the system is called the mean time which is denoted by $E(W)$ and is calculated by the formula

$$L = \bar{\lambda} E(W)$$

where $\bar{\lambda} = \sum_{i=1}^{N} \lambda_i$ and the single formula for the calculation of the mean waiting time is

$$E(W) = \frac{1}{\lambda} \sum_{i=1}^{N} \frac{\lambda^2\sigma_s^2 + \rho_i^2}{2(1-\rho_i)} + \rho_i$$

There are some other standard queueing models also for which we will calculate the performance measures like mean waiting time in the queue and in the system, mean number of customers in the queue and in the system.

4 Conclusion

We have been observing application of queueing system in many of our daily life activities. In this paper, we have taken some of the standard queueing models and observed different performance measures like mean waiting time in the queue and in the system, mean service time in the queue and in the system by the requested jobs arrivals. We verify the results obtained by using MATLAB simulation.

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Steady State Expression for a Repairable Single Server Queue with Working Vacations and System Disasters

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Abstract

A repairable single server queue with working vacations and system disasters is considered. If there are no customers in the system, the server is allowed to take a working vacation without completely stopping its service. There is a possibility of breakdowns happening in a system. When the system suffers a server breakdown and the server goes to the failure state, all customers in the queue are flushed away and the repairing process is started immediately. The time independent expressions for system size probabilities of the queueing system are derived by making use of probability generating function method.

Keywords: M/M/1 queue, repairable server, working vacations, system disasters

1 Introduction

Applications of queueing model with vacations can be seen in various fields such as network service, web service, file transfer service and mail service. Working vacation is a type of vacation policies and the concept was introduced by Servi and Finn [5] the classical single server vacation model. In working vacation policy, the server does not stop the service for customers, but service rate is reduced to a lower rate from the normal service rate. The M/G/1 queue with working vacations was analyzed by Aissani et al [1] to derive the expressions for joint probability distribution of the server state and system size probabilities of the queue when server is in steady-state by using the Laplace and z- transforms. Recently, Vijaya Laxmi and Rajesh [7] analyzed single sever queue with customer impatience and variant working vacation policy. They obtained the explicit expressions for system size probabilities and some performance measures at steady state. Catastrophes also received increased attention of researchers in the last few decades as their applications are widely used in service systems, computer systems and manufacturing systems. Gelenbe [2] introduced the concept of catastrophes and Krishna Kumar and Arivudainambi [3] analyzed the transient solution for M/M/1 queue with catastrophes. An M/M/R/N queueing system with balking, reneging and server break-downs was analyzed by Wang and Chang [8]. The studying of queues subjected to catastrophes, breakdowns and repairable servers has received increased attention of researchers in the past few decades. The transient solution for M/M/1 queue subjected to catastrophes with server failure and non-zero repairable time was derived by Krishna Kumar and Pavavi [4]. A single server queueing system with balking, catastrophes, server failures and repairs was analyzed by Tarabia [6] by extending the model of Krishna Kumar and Pavai [4] with balking feature and the author obtained transient and steady state probabilities for the system.

The literature give evidence that there is no available research related analyzing of a repairable single server queue with working vacations and system disasters in steady state. Therefore, in this research, the time independent solutions of a M/M/1 queue with working vacations and system disasters are obtained. This paper is organized as follows. Section 2 includes the model for a repairable single server queue with working vacations and system disasters in steady state. The results of the explicit expressions for the time independent system size probabilities are derived in section 3. Conclusions of this work are discussed under section 4.

2 Model Description

Consider a single server queueing model with system failure and working vacations. Arrivals are allowed to join the system according to a Poisson distribution with rate λ and service takes place according to an exponential distribution with rate μ. The server takes a working vacation without completely stopping its service if there are no customers in the system. Working vacation policy has an exponential distribution with mean $1/\gamma$ and it serves the customers with service rate $\mu_v(< \mu)$ during the working vacation. The system faces server breakdowns at a Poisson rate η. It means that life time of the system is exponentially distributed with mean $1/\eta$.When the system suffers a server breakdown and the server goes to the failure

state, all customers in the queue are flushed away and the repairing process is started immediately. The repair time has an exponential distribution with mean $1/\nu$. It is assumed that inter-arrival times, service times, repair times and vacation times are mutually independent and the service discipline is First-In First-Out (FIFO).

$$b = \begin{cases} 0, & \text{if the server being in failure state} \\ 1, & \text{if the server being in functional state} \\ 2, & \text{if the server being in working vacation} \end{cases}$$

Let $\pi_{b,n}$ be the time independent probabilities for the system to be in the state b with n customers. Then, the set of forward Kolmogorov differential difference equations governing the process are given by

$$(\lambda+\nu)\pi_{0,0} = \eta\sum_{n=1}^{\infty}(\pi_{1,n}+\pi_{2,n}) \quad (1)$$

$$(\lambda+\nu)\pi_{0,n} = \lambda\pi_{0,n-1}, n \geq 1 \quad (2)$$

$$(\lambda+\mu+\eta)\pi_{1,1} = \mu\pi_{1,2}+\nu\pi_{0,1}+\gamma\pi_{2,1} \quad (3)$$

$$(\lambda+\mu+\eta)\pi_{1,n} = \lambda\pi_{1,n-1}+\mu\pi_{1,n+1}+\nu\pi_{0,n}+\gamma\pi_{2,n}; n \geq 2 \quad (4)$$

$$\lambda\pi_{2,0} = \mu_v\pi_{2,1}+\mu\pi_{1,1}+\nu\pi_{0,0} \quad (5)$$

$$(\lambda+\mu_v+\eta+\gamma)\pi_{2,n} = \lambda\pi_{2,n-1}+\mu_v\pi_{2,n+1}; n \geq 1 \quad (6)$$

3 Steady state analysis

Using the Equation (2), we are able to obtain

$$\pi_{0,n} = \left(\frac{\lambda}{\lambda+\nu}\right)^n \pi_{0,0} \quad (7)$$

Applying the normalization condition, we can derive

$$\sum_{n=1}^{\infty}(\pi_{1,n}+\pi_{2,n}) = 1-\pi_{2,0}-\sum_{n=0}^{\infty}\pi_{0,n}$$

Substituting the Equation (7) to the above equation and after some algebra, we have

$$\pi_{0,0} = \frac{\nu\eta}{(1+\nu)(\lambda+\nu)}\left[1-\pi_{2,0}\right]$$

Define $P_1(z)=\sum_{n=1}^{\infty}\pi_{1,n}z^n$ and $P_2(z)=\sum_{n=1}^{\infty}\pi_{2,n}z^n$. Then, by the Equation (6), we will have

$$P_2(z) = \frac{\lambda z\pi_{2,0}-\mu_v\pi_{2,1}}{\left[\lambda+\mu_v+\eta+\gamma-\lambda z-\frac{\mu_v}{z}\right]} \quad (8)$$

It is noted that $\lambda z^2-(\lambda+\mu_v+\eta+\gamma)z+\mu_v=0$ is a quadric polynomial with roots $|z_{21}^*|<1$ and $|z_{22}^*|>1$. Where $z_{21}^* = \frac{(\lambda+\mu_v+\eta+\gamma)-\sqrt{(\lambda+\mu_v+\eta+\gamma)^2-4\lambda\mu_v}}{2\lambda}$ and $z_{22}^* = \frac{(\lambda+\mu_v+\eta+\gamma)+\sqrt{(\lambda+\mu_v+\eta+\gamma)^2-4\lambda\mu_v}}{2\lambda}$. Substituting z_{21}^* to the Equation (8), we have $\pi_{2,1}=\frac{\lambda z_{21}^*}{\mu_v}\pi_{2,0}$. Then

$$P_2(z) = \frac{\lambda\left(z-z_{21}^*\right)\pi_{2,0}}{\left[\lambda+\mu_v+\eta+\gamma-\lambda z-\frac{\mu_v}{z}\right]}$$

Substituting the value for z_{21}^* and after some mathematical calculations, we have

$$P_2(z) = \frac{\lambda\pi_{2,0}}{z_{22}^*}\sum_{n=0}^{\infty}\left(\frac{z}{z_{22}^*}\right)^n$$

Comparing the coefficients of nth term of the above equation, we will have

$$\pi_{2,n} = \frac{\lambda}{\left(z_{22}^*\right)^{n+1}}\pi_{2,0}$$

Using the Equation (5) and substituting the values for $\pi_{2,1}$ and $\pi_{0,0}$, we are able to obtain

$$\pi_{2,0} = [b + \mu\pi_{1,1}]\, c$$

where
$b = \frac{\nu^2\eta}{\lambda(1+\nu)(\lambda+\nu)}$, $c = \sum_{n=1}^{\infty}\sum_{j=0}^{n}(-1)^j\binom{n}{j}a^j b^{n-j}$ and $a = \frac{\mu_v}{(z_{22}^*)^2}$

By the Equations (3) and (4) and after some algebra, we can derive

$$P_1(z) = \frac{\frac{\nu\lambda\pi_{0,0}z}{[\nu+\lambda(1-z)]} + \frac{\lambda\gamma\pi_{2,0}z}{z_{22}^*[z_{22}^*-z]} - \mu\pi_{1,1}}{\left[\lambda+\mu+\eta-\lambda z-\frac{\mu}{z}\right]} \tag{9}$$

It is clear that $\lambda z^2-(\lambda+\mu+\eta)z+\mu=0$ is a quadric polynomial with roots $|z_{11}^*|<1$ and $|z_{12}^*|>1$. Where $z_{11}^* = \frac{(\lambda+\mu+\eta)-\sqrt{(\lambda+\mu+\eta)^2-4\lambda\mu}}{2\lambda}$ and $z_{12}^* = \frac{(\lambda+\mu+\eta)+\sqrt{(\lambda+\mu+\eta)^2-4\lambda\mu}}{2\lambda}$. Substituting z_{11}^* to the Equation (9), we have

$$\pi_{1,1} = \left[\frac{\lambda bd}{\nu} + bc\left(f-\frac{\lambda bd}{\nu}\right)\right]\sum_{n=1}^{\infty}\mu^n c^n\sum_{r=0}^{n}(-1)^r\binom{n}{r}f^r\left(\frac{\lambda bd}{\nu}\right)^{n-r}$$

where
$d = \frac{\nu\lambda z_{11}^*}{\mu\left[\nu+\lambda(1-z_{11}^*)\right]}$ and $f = \frac{\lambda\gamma z_{11}^*}{\mu z_{22}^*\left[z_{22}^*-z_{11}^*\right]}$

4 Conclusions

A repairable single server queue with working vacations and system disasters is considered in steady state and the explicit expressions for system size probabilities of the queueing system are derived using the probability generating function method.

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Selection of an Off-highway Vehicle for a Construction Company Using a Hybrid Approach

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Abstract

The selection of a proper off-highway vehicle plays a vital role especially for a construction company. In the ever growing competitive market, it becomes a formidable task to select a suitable off-highway vehicle for a construction company which deals with the transportation of heavy stones, metal ores and other building materials in uneven roads and hazardous mining site. In this paper,using a combined AHP/QFD model, the authors select a suitable "off-highway vehicle"for a construction company in order to maximize its productivity and profitability. The adopted integrated approach considers five customer requirements(CRs)such as Loaded body volume (LBV),Mileage, Price,Maximum speed and robustness. AHP is employed to calculate the priority values of each CR; Meanwhile five technical requirements (TRs) such as Gross vehicle weight(GVW), Maximum power, fuel tank capacity, Gear-box and grade ability are chosen for QFD analysis.Five domestic and international off-highway vehicle manufacturing company of India namely Eicher, Tata Motors, Mahindra Navistar, Bharat Benz and Ashok Ley land are considered as viable alternatives.The result shows that Tata LPK 2518 is the most preferable choice with the aforementioned criteria. The AHP/QFD integrated model is preferred for such complex decision making problems.

Keywords: Analytic Hierarchy Process; Quality Function Deployment; Off-Highway vehicle

1 Introduction

In the present case study, the authors have considered the issues related to the supply transportation system of a construction company, which deals with the construction of a dam in a hilly area. Hence its major functionality includes the transportation of loose materials such as sand, gravel, dirt etc.in uneven areas and country side roads. Thus selecting a particular off-highway vehicle among its competitive alternatives is a very formidable job. The selection process involves the consideration of both the customer requirement and technical requirements.

1.1 Off-Highway Vehicle

An Off-high way vehicle is a truck used for transporting loose material (such as sand, gravel, or dirt). In road construction projects, there is a requirement of removal of earth all along the earmarked site till the requisite depth followed by laying of multiple layers of materials such as 'good earth',Granular sub base, Macadam layers and bitumen mixes. Off-highway vehicles are used for the transport of all these materials in road construction (road-site to dump and burrow or plant to road-site). The total volume of materials that can be carried by an Off-highway vehicle at a time is called its Loaded body volume(LBV).The LBV of a truck is generally expressed in cubic meter. The highest grade a vehicle can ascend while maintaining a particular speed is s termed that vehicle's "grade ability". The rest criteria are self-explanatory and hence are not defined due to the word limitation of this manuscript.

1.2 Case Study and Adopted Methodology

A case study of a construction company requiring with a massive volume of transportation of loose materials will now be analyzed to scale this adopted method. The company wishes to buy a number of heavy duty Off-highway vehicles for its transportation purposes. The basic operation to be performed by an Off-highway vehicle in that firm is material handling for its smooth production. A committee consisting of managers from various departments considered 5 latest Off-highway vehicle models that can perform the desired tasks. The 5 Off-highway vehicle models chosen for this particular case study are Eicher Terra 25, Tata LPK-2518, Mahindra Navistar MN25, Bharat Benz 2523 and Ashok Leyland 2516T il. Out of these five, the best-suited Off-highway vehicle has to be purchased for the desired job. The following section deals with the steps of the selection procedure, which is adopted from Bhattacharya et al. [1] and Chuang et al. [2]. Some of the calculation matrices are not shown due to page limitation.

Step 1: Identification of customer requirements (CRs).

Five customer requirements (CRs) are identified while choosing an Off-Highway vehicle are listed below,
•Loaded body volume (LBV)
•Fuel economy(mileage)
•Price
•Maximum speed
• Robustness

Step 2: Identification of technical requirements (TRs).

Five customer requirements (CRs) are identified while choosing an Off-Highway vehicle are listed below,
•Gross Vehicle Weight (GVW)
• Maximum Power delivered
• Fuel tank capacity
•Total number of gears
|*bullet* Grade ability

Step 3: Construction of central relationship matrix using expertise knowledge of QFD team

(This matrix is not shown due to page limitation)

Step 4: Calculation of degree of importance for customer requirements by using AHP

A decision matrix is constructed to measure the relative degree of importance for each customer requirement, based on Saaty [3].This is a matrix of $5X5$ elements. The corresponding normalized values and hence the priority vector for each CR is calculated in the following (Table 1).

	LBW	Mieleage	Price	Max. Speed	Robustness	**PV**
LBW	0.049	0.096	0.012	0.218	0.023	**0.080**
Mileage	0.298	0.579	0.429	0.187	0.746	**.447**
Price	0.248	0.082	0.061	0.281	0.023	**.140**
Max. Speed	0.007	0.096	0.007	.031	0.020	**.032**
Robustness	0.397	0.144	0.490	0.281	0.186	**.299**

Table 1: Normalized and Priority Values of CRs

Step 5: Computation of the degree of importance of technical requirements:

The degree of importance of each TR is calculated by the following equation.

$$W_j = \sum_{i}^{m} R_{ij} c_i \tag{1}$$

Where W_j is the degree of importance for the jth technical requirement; $(j = 1, 2, ..., n)$; c_i is the importance weighing of the ith customer requirement i.e. the priority values (PVs) obtained from table 3 and R_{ij} is the quantified relationship between the ith customer requirement and the jth technical criteria in the central relationship matrix; The calculated degree of importance for each TR is shown in the last row of the following table (Table -2)

Step 6: Normalization of the degree of importance of technical criteria

The Normalization of the degree of importance of technical criteria is done by the following formula.

$$\bar{W_j} = \frac{w_j}{\sum_{j=1}^{n} R}.100 \tag{2}$$

	Technical Requirements for robot selection					
Customer's Requirement	GVW	Max.Power	Fuel capacity	Gear no	Grade ability	**PV**
LBV	9	8	6	4	9	**0.080**
Mileage	8	9	3	8	2	**.447**
Price	5	7	2	4	1	**.140**
Max. Speed	7	9	4	9	8	**.032**
Robustness	7	8	3	5	9	**.299**
Degree of importance	**7.313**	**8.323**	**3.126**	**6.239**	**4.701**	

Table 2: Relationship between CRs and TRs and PV of CRs

Step 7: Construction of pairwise comparison matrices for each technical requirement

The next task of the QFD team is to find out the ranking of the five given Off-highway vehicle based upon the 5 conflicting TR.5 pairwise comparison matrices are produced using Saaty [3], based on the information on each TR.

Step 8: Evaluation of score e_{ij}, for each technical requirement for each Off-highway vehicle-alternative:

The priority values for each technical requirements (TRs) are calculated in their respective normalized matrix table.

Step 9: Computation of overall score:

The overall score is calculated by using the following equation

$$S_j = \sum_{i}^{n} \bar{w_j} e_{ij} \tag{3}$$

Here S_j is the overall score for the jth robot-alternative ($j = 1, 2, ...,$); $\bar{w_j}$ is the normalized importance degree of the jth technical criteria($j = 1, 2, ..., n$); and $e_i j$ is the PV value of the jth alternative on the ith technical criteria. The overall score calculated is shown in the last row of the following table (Table 3)

		Importance Weights of 5 Off-highway vehicle Veichles				
TR	Weights (in %)	Eicher Terra 25	Tata LPK 2518	Mahindra MN 25	Bharatbenz 2523	Ashok Leyland 2516 T il
GVW	24.621	0.054	0.638	0.232	0.044	0.238
Max.Power	28.023	0.110	0.078	0.212	0.560	0.036
Fual capacity	10.525	0.071	0.577	0.186	0.122	0.041
Gear box	21	0.083	0.466	0.057	0.355	0.036
Gradeability	15.828	0.069	0.323	0.122	0.449	0.033
Overall Scores		**7.994**	**38.865**	**16.738**	**32.622**	**8.578**

Table 3: Final Score of the Alternative Vehicles

Step 10: Ranking of all the vehicle alternatives

The ranking of the various alternative companies is done based on the Overall scores obtained from the above table and selection of the best one using the analogy 'the higher the score, the better the selection' [2]. From table above, it is clear that Tata LPK 2518 has the highest precedence among all and it has the highest overall score and the ranking is as follows. **Tata LPK 2518** >Bharatbenz 2523 >Mahindra Navistar MN 25 >Ashok Leyland 2516T il >Eichr Terra 25.

2 Discussion and conclusion

In this paper the authors have tried to show the effectiveness of the proposed model. In this article, AHP is used to measure the priority for each TR just to avoid the problem that arises from the traditional QFD model whereas the QFD method is applied to identify the technical requirement criteria AHP is also used here to assess the priorities of each Off-highway vehicle alternative for each TR. The proposed methodology can provide a firm with an objective method for making a proper selection satisfying the overall CRs. Decision-makers have to make decisions when the volume of information is very condensed,and the type of information is very hazy in nature.

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An Auction Based Vehicle Routing Model for Ridesharing in Transportation to Workplace

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Abstract

Transportation to workplace is an important daily issue for people around the world. We develop a binary linear programming model to illustrate our proposed system for transportation in a workplace. Here we use the concept of ridesharing along with the auction mechanism. People who come to the workplace with their own cars (drivers) can pick up their colleagues (riders) to work. We use some appropriate constraints in order to make the model close to reality. In the objective function, we seek to maximize the profit obtained by implementation of ridesharing. Each rider offers a price to pay for being served, and also specifies which of the preset stations he/she can go to. The higher the price offered by a rider and the higher the number of stations he/she can potentially go to, the higher the chance of being served. By solving the model, it will be determined which riders to be served and which stations the drivers go to for picking up the riders. It is possible that some riders may not get served. The proposed model is based on vehicle routing problem but it has its own complicating features. To validate the model, we solve some specific examples using the GAMS software package to obtain the optimal solutions.

Keywords: Vehicle routing, Ridesharing, Auction

Robust Bayesian Analysis of Generalized Inverted Family of Distributions

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Abstract

Inferential procedures for generalized family of distributions has engaged the attention of many authors. The generalized inverted family of distributions (GIFD) considered in this paper was purposed by Potdar and Shirke (2013). If $\mathbb{G}_\lambda$ be a scale family of lifetime distributions (where λ is the scale parameter) with cumulative distribution function (cdf) and probability density function (pdf) $G(\cdot)$ and $g(\cdot)$, respectively. Then the pdf of the GIFD is given by

$$f(x;\lambda,\alpha) = \frac{\alpha}{\lambda x^2} g\left(\frac{1}{\lambda x}\right)\left[G\left(\frac{1}{\lambda x}\right)\right]^{\alpha-1},\ x \geq 0,\ \alpha,\lambda > 0$$

In this paper we developed the robust Bayesian inference for the GIFD under an ϵ-contamination class of prior distributions for the shape parameter α, with different possibilities of known and unknown scale parameter. We used Type II censoring and Bartholomew sampling scheme (1963) for the following derivations under the squared-error loss function (SELF) and LINEX loss function (LLF) : ML-II Bayes estimators of the i) parameters; ii) Reliability function and; iii) Hazard function. With the help of simulated data robustness of the estimators are shown. Analysis of a real data set is also presented.

Keywords: GIFD, ϵ-contamination class of prior distributions, ML-II posterior density, Reliability function, Hazard function, SELF, LINEX loss function, Type II censoring, Sampling scheme of Bartholomew, Markov Chain Monte Carlo (MCMC) procedure, Metropolis-Hastings algorithm, Gibbs sampling technique

1 Introduction

Inferential procedures for generalized family of distributions has engaged the attention of many authors. In one of the most recent studies, Chaturvedi and Kumari (2017a) gave the estimation and testing procedures for the reliability functions for generalized family of lifetime distributions. In generalized family of distributions, a scale family of distributions plays an important role in lifetime data analysis. Somewhat earlier, Potdar and Shirke (2016) proposed the reliability estimation for the generalised inverted Rayleigh distribution. In another study, Potdar and Shirke (2013) presented the inference for the parameters of generalized inverted family of distributions. Chaturvedi and Pathak (2013) presented the estimation of reliability function for a family of exponentiated distributions.

Here, it is pertinent to the current study to briefly discuss Potdar and Shirke (2013). Let $\mathbb{G}_\lambda$ be a scale family of lifetime distributions (where λ is the scale parameter) with cumulative distribution function (cdf) and probability density function (pdf) $G(\cdot)$ and $g(\cdot)$, respectively. The authors generalized this family by introducing a shape parameter α to obtain a generalized scale family of distributions. If Y be a random variable having distribution belonging to a generalized scale family of distribution with cdf $F_Y(\cdot)$, then the distribution of $X = (1/Y)$, belongs to generalized inverted scale family of distributions. The pdf of the generalized inverted scale family of distributions are given by

$$f(x;\lambda,\alpha) = \frac{\alpha}{\lambda x^2} g\left(\frac{1}{\lambda x}\right)\left[G\left(\frac{1}{\lambda x}\right)\right]^{\alpha-1},\ x \geq 0,\ \alpha,\lambda > 0. \tag{1}$$

Bayesian analysis rests on the idea or belief that in most practical situations the statistician will possess some subjective a priori information concerning the probable values of the parameter. A difficulty arises when the prior information available to the experimenter is not enough for the elicitation of a single prior density for the parameters but may summarizes as a class of prior distributions. In such a situation it becomes impossible to proceed with the usual Bayesian procedures which require a single prior distribution. The robust Bayesian viewpoint provides a way to deal with such problems and to make decisions which behave satisfactory over the class of prior distributions. Since Good (1950), assumed that the subjective information can be quantified in terms of a class Γ of possible distributions. The goal is to make inferences or decisions which are robust or flexible over Γ, i.e., which are relatively insensitive to derivations as the

prior distribution varies over Γ. For a brief review of the literature on robustness in Bayesian model, one may refer to Jeffreys (1961), Box and Tiao (1962), Good (1965, 1967, 1980), Lindley (1961), Dempster (1976) and Box (1980).

Different ϵ-contamination classes of prior distributions have been discussed by Huber (1973), Berger and Berliner (1983), Berger(1985) and Chaturvedi (1993, 1998). The class, Γ, of prior distributions to be considered here is the ϵ-contamination class

$$\Gamma = \{\pi : \pi = (1-\epsilon)\pi_o + \epsilon q; q \in Q\},$$

where $0 \leq \epsilon \leq 1$ is given, π_o is a particular prior distribution and Q is the class of all positive contaminations. There are several reasons for consideration of this class. First, it is a sensible class to consider in light of the prior elicitation, c.f. Kadane et. al. (1980) makes specification of an initial believable prior, π_o, an attractive starting point(because of the subsequent robustification), π_o can often be chosen to be some convenient functional form, for example, a conjugate prior. ϵ is the error of judgment in the selection of π_o. For a detailed review on Bayesian robustness one may refer to Berger et. al. (2000). Bayesian analysis based on ϵ-contamination class of priors has been extensively studied by authors like Berger(1982, 1983), Chaturvedi et. al. (2013) and Chaturvedi and Kumari (2017b) to cite a few.

In life testing and reliability studies, the experimenter may not always obtain complete information on failure times for all experimental units. Data obtained from such experiments are called censored data and one of the most common scheme is Type II censoring, which is based on number of failures, i.e., in this scheme the life testing experiment will be terminated upon the r^{th} (r is pre-fixed) failure. The scheme is often adopted for toxicology experiments and life testing applications by engineers as it has been proven to save time and money. Also, in real life complete data may not be available always, therefor it is always better to work with censored data. That is why, Type II censoring scheme is considered here. Several authors have developed inferential procedures based on Type II censored samples; see for example, Balakrishnan and Han (2008) and Chaturvedi and Kumari (2015).

2 Conclusion

The importance of number of failures in type II censoring and importance of termination time t_o, under sampling scheme of Bartholomew (1963) is shown through simulation. Comparison between type II censoring and the sampling scheme of Bartholomew is discussed. Also, the comparison between different method of estimation is also performed. Finally, the robustness of the estimators are proved with the help of simulated data and a real data set is discussed

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A New Method of Estimating the Process Capability Index for Skewed Distribution Using Confidence Interval of Parameters

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Abstract

This paper deals with a new method of deriving the Process Capability Index (PCI) when the quality characteristic X follows a positively skewed distribution. The focus of the paper is to derive a new estimate of PCI by taking into account the 100(1-α)% Confidence Interval (CI) of the parameter(s) and arriving at a new expression. The formula C_s proposed by Wright (1995) which contains a component for Skewness, is reexamined and improved by utilizing the lower, middle and upper values of the CI for each parameter. The weighted average of the three possible estimates of C_s is proposed as the new estimate by taking the weights inversely proportional to the squared deviation from the hypothetical value of C_s. The properties of the estimate are studied by simulation using one parameter exponential distribution.

Keywords: Exponential distribution, Confidence Interval, Process Capability

1 Introduction

One of the measures of process performance is the Process Capability Index (PCI) and the simplest form is the ratio $\frac{(USL-LSL)}{6\sigma}$ where LSL and USL denote the Lower and Upper Specification Limits respectively and σ is the process standard deviation (sd).When the process is not centered the PCI is calculated as $C_{pk} = Min\left\{\frac{(\mu-LSL)}{3\sigma}\ ,\ \frac{(USL-\mu)}{3\sigma}\right\}$ where μ denotes the mean of the process. Vännman [1, 2] proposed a new expression for the PCI that takes into account the eccentricity and spread, calling it a super structure, which is given by

$$C_p(u,v) = \frac{d - u|\mu - M|}{3\sqrt{\{\sigma^2 + v(\mu - T)^2\}}} \tag{1}$$

where $d = \frac{(USL-LSL)}{2}$, $M = \frac{(USL+LSL)}{2}$ and $0 \leq (u, v) \leq 1$

The formula in (1) does not work well for non-normal distributions. There are several methods of handling non-normality like a) data transformation or b) using quantiles to replace the location and spread parameters. Wrights [3] proposed the following expression for PCI by taking into account the skewness measure along with μ and σ as

$$C_s = \frac{d - |\mu - M|}{3\sqrt{\{\sigma^2 + (\mu - T)^2 + |\frac{\mu_3}{\sigma}|\}}} \tag{2}$$

This formula can be used for both skewed and symmetric distributions. A further study on Writes method was carried out by Pearn and Chang [4].

In this paper we focus on proposing a new estimate of C_s assuming that X follows exponential distribution with parameter θ.

The novel aspect studied in this paper is the use of CI of $\frac{1}{\theta}$ and finding the weighted average of C_s obtained by at the lower, middle and upper values of the CI. The component of skewness will however be replaced by its point estimate to keep the computations simple. We will show by simulation that the new formula has better properties than the PCI obtained with the point estimates of μ and σ.

In the following section we develop the new estimate of C_s.

2 Wrights PCI with Exponential Distribution

Let X follows exponential distribution with density

$$f(x,\theta) = \begin{cases} \theta e^{-\theta x}, & x > 0 \\ 0, & \text{otherwise} \end{cases}$$

For this distribution, $\mu = \frac{1}{\theta}$, $\sigma = \frac{1}{\theta}$ and $\mu_3 = \frac{2}{\theta^3}$. With these values the Writes formula reduces to

$$\mathrm{C}_s(\theta) = \frac{d - \left|\frac{1}{\theta} - M\right|}{3\sqrt{\{(\frac{1}{\theta})^2 + (\frac{1}{\theta} - T)^2 + \left|\frac{2}{\theta^2}\right|\}}} \tag{3}$$

The 100(1-α)% CI of $\frac{1}{\theta}$ is given by

$$\left[\frac{2n}{\hat{\theta}\chi^2_{1-\alpha/2,2n}}, \frac{2n}{\hat{\theta}\chi^2_{\alpha/2,2n}}\right] \tag{4}$$

where $\hat{\theta} = \frac{1}{\bar{x}}$ is the point estimator of θ. $\hat{\theta}\chi^2_{1-\alpha/2,2n}$ and $\hat{\theta}\chi^2_{\alpha/2,2n}$ respectively are the upper and lower percentile points on the chi square distribution. Define $\theta_1 = \frac{2n\bar{x}}{\chi^2_{1-\alpha/2,2n}}$, $\theta_2 = \bar{x}$ and $\theta_3 = \frac{2n\bar{x}}{\chi^2_{\alpha/2,2n}}$. These three values will be potential estimators of θ because they are like pessimistic, normal and optimistic values of the true parameter (like those used in PERT time estimates) covered by the confidence interval. Sai Sarada et.al [5] have used this method and proposed a new estimator of the Vännman's PCI by utilizing 9 possible estimates derived from 3^2 combination of normal mean and variance. With exponential distribution we need only $\frac{1}{\theta}$ and its confidence intervals. Hence we get three possible estimates of C_s .

Let us calculate the true PCI (T_0) obtainable when θ is known (by hypothesis). Then

$$\mathrm{T}_0 = \frac{d - \left|\frac{1}{\theta} - M\right|}{3\sqrt{\{(\frac{1}{\theta})^2 + (\frac{1}{\theta} - T)^2 + \left|\frac{2}{\theta^2}\right|\}}} \tag{5}$$

At each level of θ_1, θ_2 and θ_3 we get

$$\mathrm{C}_{si} = \frac{d - \left|\theta_i - M\right|}{3\sqrt{\{3\theta_i^2 + (\theta_i - T)^2\}}} \tag{6}$$

Define d_i = (C_{si} - T_0)$^{-2}$ for i = 1, 2, 3 and $w_i = \frac{d_i}{\Sigma d_i}$, so that $\Sigma w_i = 1$. It means the weight is inversely proportional to the squared deviation from T_0. The new estimate is

$$C_s{}^{CI} = \sum_{i=1}^{3} w_i C_{si} \; i.e., C_s{}^{CI} = w_1 C_{s1} + w_2 C_{s2} + w_3 C_{s3} \tag{7}$$

The value given by C_{s2} is the commonly used point estimate and $\mathrm{C}_s{}^{CI}$ can be compared with C_{s2}. In the following section the model is evaluated by simulated data.

2.1 Simulated results

Consider the parameters $\theta = 0.4$, LSL = 0, USL = 15 and T = 2.5. We get mean = 2.5. We wrote a macro in SPSS and have run k = 1000 trails each of size n = 100 and evaluated all the parameters. The mean, standard error and bootstrap CI of $\mathrm{C}_s{}^{CI}$ and C_{s2} are given in Table 1.

Parameter	Mean	Standard Error	Bootstrap Confidence Interval	
			Upper	Lower
$\mathrm{C}_s{}^{CI}$	0.5848	0.0007	0.5807	0.5883
C_{s2}	0.5631	0.0024	0.5578	0.5854
T_0	0.5774	-	-	-

Table 1: Summary statistics of 1000 simulated trails

The standard error of $\mathrm{C}_s{}^{CI}$ is found to be much smaller than that of C_{s2} . $\mathrm{C}_s{}^{CI}$ has mean bias of 0.000088 while C_{s2} has mean bias of -0.000169. This shows that $\mathrm{C}_s{}^{CI}$ closer to T_0 than C_{s2}. The pattern of estimates is shown in Figure 1.

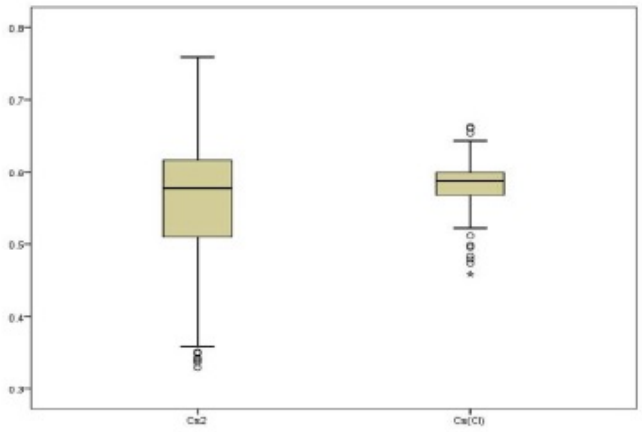

Figure 1: Box plot of distribution of $C_s{}^{CI}$ and C_{s2}

3 Conclusion

We conclude that new estimators of PCI obtained by exploiting the boundary values of the confidence intervals of process parameters is more consistent than those obtained by using the point estimators for the process moments. In a way we stress that unbiasedness need not always be enough and information around the point estimate can be utilized to estimate the true parameter effectively.

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Estimation and Testing Procedures of the Reliability Functions of Nakagami Distribution

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Abstract

We consider here the Nakagami distribution. Two measures of Reliability namely $R(t) = P(X > t)$ and $P = Pr(X > Y)$ are discussed broadly. We develop point and interval estimation procedures for $\lambda, R(t)$ and P. Uniformly Minimum Variance Unbiased Estimators (UMVUES) and Maximum Likelihood Estimators (MLEs) are developed for the said parameters. A new technique of obtaining these estimators is introduced. Asymptotic confidence intervals of the parameter based on MLE and $\log(MLE)$ are also constructed. Then, testing procedures for various hypotheses are developed. Coding using Markov Chain Monte Carlo (MCMC) simulation in R language has been done for comparing the results obtained. A real data analysis is performed to describe the procedure clearly.

Keywords: Nakagami Distribution, Point Estimation, Testing Procedures, Confidence Interval, Markov Chain Monte Carlo (MCMC) procedure.

Dividend Practices of Top three Neplese Commercial bank including Nabil Bank Limited: A Case of Commercial Bank of Nepal

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Abstract

This paper tests the dividend practices of Top three commercial banks of Nepal including Nabil Bank Limited and its effect in secondary market.
This study examines whether or not this is consistent in the context of Nepalese Commercial Bank of Nepal. This study is motivated by the observation that much of dividend policy theory is implicitly based on a capital market perspective. The data were taken from Nepal Stock Exchange Limited of Nabil Bank Limited and other commercial banks. To achieve the objective of the study, a descriptive and causal comparative research design has been administered. The index has been calculated from 2005 till 2015 using Principal Component Analysis. The major finding of the study shows that the managerial decisions for the dividend and effects on various dimensions like, demand and supply (market depth) and market price of share. There exists positive correlation of dividend pay-out ratio and market price of share. The findings of the study could be useful for research students, regulators and investors. This could support to review the impact of dividend practices in secondary market.

Keywords: Dividend practices, market price per share, principal component analysis, secondary market.

Productivity Improvement through Effective Operations Management

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Abstract

TransWeld Nepal Company Pvt. Ltd. is one of leading Transformer Manufacturing Company in Nepal. It is located near to ring road at Dhapasi. It is $IS09001$(Quality Management System) certified company. Transformer is an Electrical Machine. It transforms AC voltage and current to high and low values. It's customers are Rural Electrification Projects, different Industries, Housing, Departmental Stores etc. The company's success depends upon success of Marketing and Operations Management.

Inventory System, technicians, different machines and quality system are vital for better operations of the company. Marketing people gets orders directly from customers and by contacting to proper people. Quality system has been maintained from incoming material, production process to final dispatch. Inventory system has been maintained maintaining minimum level of inventory of all materials so that production would not have been delayed due to lack of raw materials. The principle behind keeping minimum stock of raw materials is that costly raw materials stock are kept for low number of transformers while cheap raw materials are kept for large number of transformers. In addition to this, easily and locally available raw materials stock are kept lower number. Costly raw materials like copper and core are kept minimum stock for low number of transformers.

Technical people are vital for quality of transformers. Experienced Electrical Engineer designs transformers. Mistake in design would lead to huge loss if it is not identified before production. So, one sample is produced before going to mass production. Different technicians manufacture transformer using raw materials. Core cutting, core assembling, Winding, core and coil assembling, dehumidification, tanking, testing, tank metal parts fabrication, painting etc. are fully dependent on technicians. Any mistake in manufacturing means rework and loss. It is better to do correct work at first time. Experienced and skilled technicians have been deployed for production of fault less products. There are different machines Core Cutting, Winding Machine, Dehumidification Chamber, Oil Filter machine, Electrical testing equipments, Welding Machine, Compressor, Overhead crane etc. If any machine does not perform correctly at any time means delay in production causing loss of time. It means loss to the company. All machines are kept in good condition by maintaining Preventive Maintenane Plan. Transportation of Finished Transformers to customers premises is another important factor because transformers may damage during transportation.

As it is $ISO9001$ (Quality Management System) certified company, the company runs systematically. It is system dependent rather than person dependent. Rework and delay causes loss to the company effecting productivity. So, in every step of operations the company is careful to avoid rework and delay.

Keywords: Productivity, Operations management, Management system

The Determinants of Access to Credit Facilities for Farmers' in Dhading District, Nepal

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Abstract

Access to credit is essential to enhance productivity and promotes the standard of living of people. The present study intends to analyze the determinants of farmer's access to credit in Dhading District, Nepal with the specific objectives to: examine demographic and socio-economic factors that influence in credit acquisition of farmers; analyze sources of credit available to farmers; evaluate constrains faced by farmers in credit acquisition.

A structured questionnaire was formulated to guide the study and the data were collected from one hundred ninety (190) farmers based on convenience from household level. Descriptive statistics and binary logit regression model were used to analyze the data. The VIF was also employed to test the multicollinearity among variables used in the analysis.

Results indicated that 55.8% of the sampled farmers accessed credit whereas the remaining 44.2% did not access credit. The data of access to credit for the farmers were assessed with the variables like age, gender, educational level, household size, farm size, farming experience, monthly income, other sources of income, member of cooperative, and training. The result of analysis revealed that the educational level, other sources of income, monthly income, membership of cooperative and training had a positive and significant relationship with access to credit while age, gender, household size, farm size and farming experience had the non-significant relationship. It was also found that farmers encountered problems of high-interest rate, lack of collateral, cucumber procedure and delay in loan approval/disbursement as constraints to acquire credit.

Thus, financial institutions consider that farming income depends on seasonality so the agricultural credit services should be extended and should ensure that the farmers get credit at a subsidized interest rate. And finally, farmers should be provided technical knowledge about how to utilize credit for the enhancement of farm productivity by using better farming practices and better inputs.

Keywords: Access to credit, descriptive statistics, binary logit regression, productivity

The Relative Efficiency of Local Government in Nepal

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Abstract

This study has covered the overall aspects of local governance and service delivery of local governments in context of Nepal and aims to compare the relative efficiencies of District Development Committees (DDCs) of Nepal. Study has used data regarding local governance and service delivery of 75 DDCs of Nepal from 2011/12 to 2015/16. The study period covers the data before restructuring of the local bodies in Nepal. Data Envelopment Analysis (DEA) has been used for measuring the relative efficiency of local bodies. Both input and out oriented models have been employed to measure the relative efficiencies. Moreover, Malmquist productivity index has been used to some selected local bodies in order to complement the findings regarding the relative efficiencies. Capital expenditure, recurrent expenditure, Expenditure under Local Governance and Community Development Program are considered to be input variable and Performance measurement scale (1-5) converted from performance measurement (PM) scores (1-100) is considered to be output variable. Personal Information Manager (PIM) software is used to compute relative efficiencies.

Out of the total 75 DDCs, namely Dhankuta, Okhaldhunga, Dolakha, Kathmandu, Lalitpur, Bhaktapur, Manang, Kashki, Rukum, Dailekh, Dadeldhura are found efficient in terms of Global Technical Efficiency and Local Pure Technical Efficiency. The DDCs were, on average, 86.52 per cent technically efficient under constant return to scale and 89.52 per cent technically efficient under variable return to scale and 97 per cent scale efficient. The average PM score of Mahottari is only 38 but from the available inputs, the target average PM score is 63.22. It means that from the same inputs Mahottari DDC could have been improved at least 63.22 in performance measurement score. So Mahottari DDC is highly inefficient to utilize the available resources to obtain target PM score 63.22 (66.36 % gain) of the total 75 DDCs.

In 2011/12, on average, 44.34 per cent DDCs were technical efficient in the case of constant returns to scale and 73.93 per cent efficient in case of variable return to scale but 60 per cent scale efficient. However, in 2015/16, on average, only 22.99 per cent DDCs were technical efficient in the case of constant returns to scale and 55.48 per cent efficient in the case of variable returns to scale but 41 per cent technical efficient. Keywords:

Keywords: District development committees, Data envelopment analysis, Malmquist productivity index, Relative efficiency, Technical efficiency

Public Investment in Nepal: A Case of Transportation Expenditure

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Abstract

The rapid growth in public investment in various sectors are assumed after decades of conflict and unstable political situation. The declaration of Federal Republic nation, Nepal, is going to embark on accelerated economic growth. This has somewhat caused concern among policy makers of its implication for economic growth. And the investment of government on transportation infrastructure is the core strategies and called as the infrastructure of infrastructures. The main aim of this study is therefore, to explain the relationship between economic growth and the public investment on transportation sector in Nepal. Primarily, this study has focused on distinction of expenditures and Five Year plans among three systems (Panchayat, Democratic and Republic) showing the trend and structure of expenditure over these systems. The result shows the trend of investment of Government on public expenditure has increased in Republic System. This study used a time series data collected between 1975 and 2016 for further analysis. The statistical and econometric tools has been used for the study. The tools include the unit root test, lag length selection criteria, Johansen cointegration and VAR Granger Causality/ Block Exogeneity to investigate the relationship between public investment expenditure and economic growth in Nepal. Results revealed that the variables are not stationary in their original form but stationary has been found after first difference that is I (1). The obtained regression model has been found to be satisfactory by diagnostic tests (errors are normally distributed, no serial correlation and homosedastic). The data explained positively significant influence of RTC expenditure on GDP and hence it is contributing to economic growth. Furthermore, the results showed short run unidirectional causation from RTC (Real Transportation Capital) expenditure to RGDP (Real Gross Domestic Product).

Keywords: VAR Granger Causality/ Block Exogeneity, Johansen Cointegration, Unit Root Test, Lag Length Selection, Public Expenditure Component, Economic Growth

Performance Assessment of Ongoing Construction Projects under Town Development Fund, Nepal

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Abstract

Problems related to performances of the construction projects appear through different directions. Most of the projects fail either in time performance or in cost performance or both. The identification of the factors that adversely affect the overall performance of the project and the consequences it imparts on projects is very essential.

In this research, the performance indices (Cost performance index, CPI and Scheduled Performance Index, SPI) of the ongoing construction projects funded by German government-owned development bank KfW (Kreditanstalt für Wiederaufbau) through Town Development Fund (TDF) were calculated to find out the variance in planned and actual physical and financial parameters. The factors causing adverse impact on the performance and their effects on the projects were investigated and ranking of those factors and effects were carried out. The factors affecting the overall project performance were ranked using Relative Importance Index (RII).

Using Earned Value Analysis method, it was observed that though the projects were within stipulated budget, the time overrun is severe. The mean planned duration for the projects under study is 15.2 months with standard deviation of 1.03 months for 75 percent work completion (with standard deviation of 30 percent) while the mean actual duration for the projects were 24.70 months with Standard Deviation of 11.64 months for 53 percent work complete in average (with 43 percent standard deviation).This study shows material related factors as the most important factors among the groups for time overrun in projects under study. The second important factor being the consultant related factors followed by client related factor and contractor related factors. With respect to the perceived effects of the time overrun in the projects under study held by the respondents, the number one potential effect of the time overrun in project is cost overrun followed by arbitration, Litigation, Dispute arousal and Total abandonment.

Keywords: Time and Cost Performance, Effects of Factors, Earned Value Analysis, Relative Important Index

Impact of Corporate Governance on Financial Performance – A Survey of Stakeholders of Commercial Banks in Nepal

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Abstract

Corporate Governance is a system of laws and approaches through which corporation are directed and controlled with intention of monitoring the action of management and directors and evade the misdeed of corporate officers. After East Asian financial crisis in 1997, both commercial and Industrial sector have became awake on corporate governance. It has been observed from the decade study that, there is significance benefits from corporate governance on firm performance. There exists many studies of relationship between corporate governance and firm performance in developed countries, however less research has conducted in case of developing countries like Nepal. The recent corporate scandal in some of the financial institutions of Nepal have stimulate the importance of corporate governance practices in Nepalese banking sectors. This study is coined to measure the relationship between corporate governance and financial performance of Nepalses commercial banks on the basis of survey of stakeholders of corresponding banks. In this study seven constructs with 28 items were used to measure corporate governance whereas four items were used to measure the financial performance. Samples data has been collected from Chairman, CEO, Director, company secretary, manager and shareholders of commercial banks. Confirmatory factor analysis was measured through path analysis applying structural equation modeling. Modification indices and standardized residual analysis were used as diagnostic measure of model fit. The empirical findings from structural model confirms that commitment to governance represents the generic mechanism through which perceived shareholder's right, perceived board responsibility and perceived disclosure standard are able to positively influence the bank performance.

Keywords: Corporate governance, Bank performance, Path analysis, SEM, Model fit.

SAFTA and Trade in Member Countries

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Abstract

In early 2004, the SAARC member countries agreed to form a South Asian Free Trade Area (SAFTA), which has become a parallel initiative to the multilateral trade liberalisation commitments of the South Asian countries. SAFTA has come into force since July, 2006, with the aim of boosting intraregional trade among the seven SAARC countries.

This paper's purpose is to examine the implications of SAFTA for the South Asian countries. The paper has an objective to find out whether being a SAFTA country increases trade or not. It tries to see whether there is any increase in the trade flows between the SAFTA member countries after 2006 when SAFTA became operational.
Using a Gravity model, the paper explores the welfare impact of regional integration with trade facilitation in South Asia. By applying Gravity model, the paper tries to explain bilateral trade flows with a set of explanatory variables that try to predict the impact of being a SAFTA country.

Since there are limited complentarities in the region, even under free trade mechanism, the expansion of intra -regional trade does not seem to be very substantial. In order to make SAFTA effective, trade liberalization is a necessary condition, but not a sufficient one.

Keywords: SAFTA, Gravity model, Bilateral trade flows

Development of Advanced Planning System for Smart Factory

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Abstract

The purpose of this paper was to compare the allocation of resources by SPT, EDD, and Slack in schedule plan. Heuristic algorithm suitable for Company Y was proposed by developing database and algorithm for APS development for Smart Factory. The proposed algorithm has flexibility to be applied to various bolt processing companies.

Keywords: Smart Factory, Scheduling, Advanced Planning System

1 Introduction

The study depicts to develop a scheduling program for company Y, a manufacturer of automotive bolts. Y is a corporation and mainstay of the root industry that is specialized in forging, heat treatment, and surface treatment [1], which leads to achieve more advancement of smart plant construction in response to the weakening of the labor base, accelerating of manufacturing technology. Smart plant [2] construction is necessary to develop technologies that take account in the characteristics of activeness, intelligence, reliability, agility, and connectivity. Therefore, it is necessary to develop APS (Advanced Planning and Scheduling), which is a new approach for optimal planning and scheduling, which requires production efficiency. The purpose of this paper is to compare the allocation of resources by SPT, EDD, and Slack in schedule plan.

2 Research Methodology

The process of the automobile bolt production plant consists of six steps in sequence. The six steps are, Forging process for plastic deformation of metal, rolling process to make bolt groove, Machining process for special shaping, Heat treatment process to meet physical/ mechanical criteria, Plating process to coat metal surface with thin layer, and Packaging process to package finished product. There are some products that need to be processed in the order mentioned above, but others that are out of order. Basically, it corresponds to job shop. We implemented a simulator to determine the order of operations for each process. In each process, various priority rules are used to identify the most efficient priority rules, and the schedules determined by the priority rules are converted into daily work instructions. In this paper, we solve this problem using C # in computer language in Visual Studio 2008 environment [3]. The procedure for solving the problems are as follows.

1. Create a data table to retrieve data such as order, facility, routing, process, and machining time in Microsoft Excel, that will contain order-specific results and facility-specific results.
2. Create an initialization function for scheduling. This initialization function adjusts the plant's System Clock to factory uptime. Then initialize the event list, process queue, and wipOrder.
3. Create a function to write to the result storage table, remove data from the queue, modify the status, and add it to the event list.
4. Create a function that updates the event list by traversing the event list selecting from the queue, storing the results, and updating the event list.
5. Create a function to update the factory's System Clock.

In the above procedure, steps 3, 4, and 5 are included in the function of the Simulation process. This function continues until the event list is empty or the System Clock is equal to the planning horizon. For all events that are the same as the current system clock, select the queue corresponding to the event and modify the system clock to the minimum value in the event list.

3 Conclusion

In this paper, we proposed a heuristic algorithm suitable for Company Y by developing database and algorithm for APS development for Smart Factory. The proposed algorithm has flexibility to be applied to various bolt processing companies.

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A Smarter Way to Improvise Learning Outcomes Based on Computer Application

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Abstract

Abstract - In any educational quality improvement endeavor, measurement plays a major role since it provides the information for any decision making mechanism. There is always a need to devise a standard teaching model which can be used as a benchmark to evaluate the quality of education imparted. Based on the output, preventive as well as corrective line of action can be taken, if required. The present research deals with a standard prototype application developed for a leading academic institution. It has served as a basis of a simple, user-friendly interface to manage the entire training cycle with excellent results. The project has been tested at a user level. The project has been developed in a less known relational database called FileMaker which is a product of Apple Company. The current project which has been named as EduGain version 1.0 which be demonstrated practically during any research assignment.

Keywords: RDBMS, ICT, Information Technology, Edugain, FileMaker.

1 Introduction

Most of us are aware of the fact that a large number of the educational establishments all over the world are managing their business manually in the small & medium enterprises segment. We are unable to find an automated application which can be used as standard for the academic as well as non-academic educational establishments. Although we all are of aware of the concept of database/relational database but still we have not been able to apply it effectively till date.

Accurate planning and scheduling of orders, better data predictions, quick response to queries and online detailed information of orders is must for doing business. As a result in the past few years many industries have invested in integrated systems, along with strong infrastructure. The change from customized modular software to ERP is the current trend in most companies [3]. A small number of schools all over the world have deployed an ERP (Enterprise Resource Planning) to manage the day to day activities but still a lot needs to be done in this area. Considering all this in mind a comprehensive mini sized ERP related to academic domain was planned & executed.

2 Motivation

Motivation plays a major role in the successful development as well as deployment of any project. A live example of motivation behind a project is well known Indian project called IRCTC to manage to entire travel business across the country. Indian Railway Catering and Tourism Corporation Ltd. has been set up by the Ministry of Railways with the basic purpose of hiving off entire catering and tourism activity of the railways to the new Corporation so as to professionalize and upgrade these services with public-private participation [2].

Similarly United States has done very well in the field of online business as a result of perfect motivation in terms of automation. The overall system to maintain the records of individuals related to the issuance of residency cards in the Kurdistan region is another perfect example of motivation.

The current academic institution has been working on an action plan which aims at automation of entire academic as well as non-academic activities in the form of Information and Communications Technology (ICT). ICTs have multidirectional ability to perform tasks like teaching and training, educational administration, in library service and research conduct and analysis. The following figure describes the application areas of ICTs in Distance Education sector [4].

As shown in the figure 1 above ICT has various areas of applications in the education sector like:-

- Communication among instructor and learners.
- Educational administrators.
- Instructional system.
- Library services.

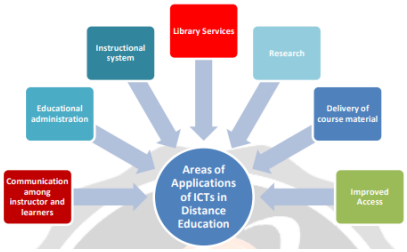

Figure 1: Applications of ICT in Education Sector

- Research.
- Delivery of course material.
- Improved access

.

Therefore with all these terms in our mind it was decided to work on a system applicable to the whole University following the University laid down rules & regulations. With the initiative of the management and the dedication of a development team, the system was designed & implemented.

2.1 System Development

EduGain version 1.0 is being used as a standalone system currently. Later on there are plans to migrate the same application to Client-Server environment.

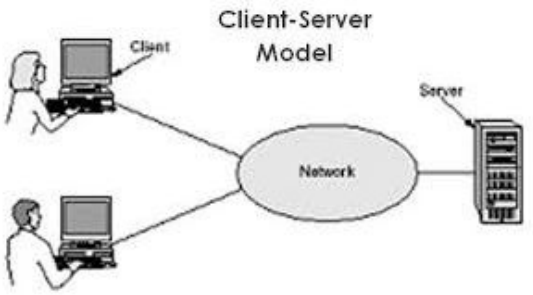

Figure 2: Client-Server Environment

A client/server system is "a networked computing model that distributes processes between clients and servers, which supply the requested service." [6] .

We have tested our application on a standalone mode although the same works perfect on Local Area Network (LAN) as well. The usefulness of any project becomes manifold if the same is deployed over a network using Client-Server architecture. This can be worked out gradually in the next phase. There is always the availability of very fast & efficient file servers at the backend for fast data processing which is very crucial for any business. Further one thing has to be kept in mind that the application should be hardware as well as software independent. Figure 3 below shows the screenshot of the main screen of the application EduGain version 1.0

Figure 3 above shows the user login screen. Here we have options like:-

• Guest Account • Account Name and Password •Change Password •OK • Cancel Figure 4:

Figure 4 above shows the main menu for our application. It shows the name as well as version of our application. It has options to go to the various other options like Welcome, Main Menu or exit out of the application.

Figure 55 above shows the various application modules that we have like:-

- Main Menu
- Attendance cum Marks module
- Student Management
- Reference book
- Plus more . . .

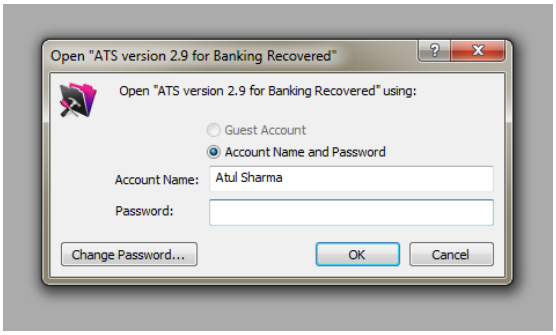

Figure 3: User Login Screen

Figure 4: Main screen of the Application

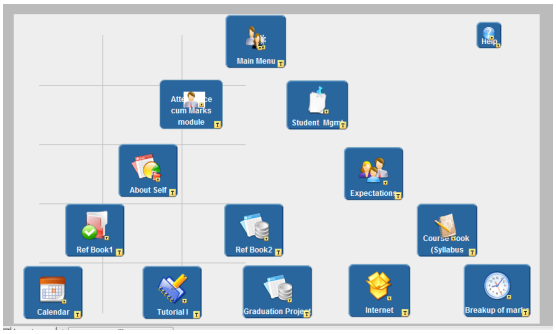

Figure 5: Sub modules of EduGain 1.0

2.2 Analysis and Definition

A continuous and regular series of discussions were held at all the levels to understand and design a full proof robust system. Based on these inputs SRS (System requirement specifications) was laid down. A software requirements specification (SRS) is a document that captures complete description about how the system is expected to perform. It is usually signed off at the end of requirements engineering phase [5]. The SRS usually consists of rich input to understand the existing procedures/activities performed in the entire business. We can incorporate our future requirements in the SRS as well. Paper documentation was prepared based on the inputs collected from all the required ends

Figure 6 above shows the user-case diagram. Here we find that the teacher can handle student details like:

1. Student's details including Name, Class, Group, Session, Gender etc.
2. Periodic attendance i.e. daily, monthly etc.
3. Chapters to study.

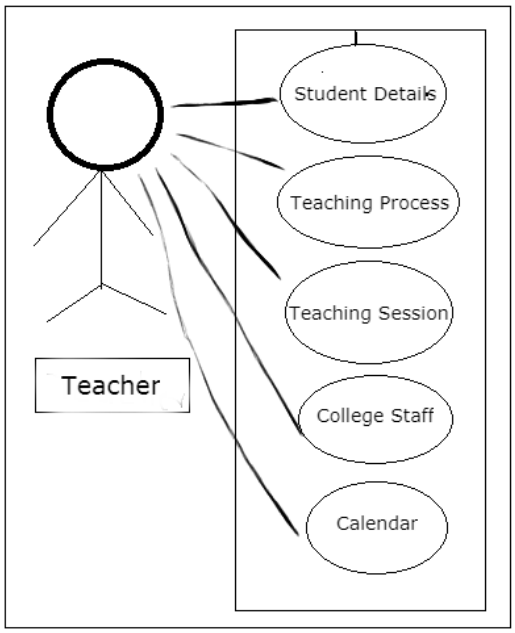

Figure 6: User-case Diagram

4. Marks for Exams

Great Grand Fathers Name	Text	
Nick Name	Text	
Full Name	Text	Indexed
Name Arabic	Calculation (Number)	= Kurdish1 & " " &Kurdish2 & " " & Kurdish3
Class	Text	Indexed
Group	Text	Indexed
Session	Text	Indexed
Active	Text	Indexed
Notes	Text	Indexed
Total Attendance	Calculation (Number)	Unstored, = Count (Line Items::Actual Status)
Present	Calculation (Number)	Unstored, = Sum(Line Items::Actual Status)
Per Present	Calculation (Number)	Unstored, = (Present/Total Attendance)*100
Days Absent	Calculation (Number)	Unstored, = (Total Attendance-Present)
Per Absent	Calculation (Number)	Unstored, = (Days Absent/Total Attendance)*100
CM_Tot_Att	Calculation (Number)	Unstored, = Sum (Line Items::Tot Attn cm)
CM_Present	Calculation (Number)	Unstored, = Sum(Line Items::Actual Status cm)
CM_PerPresent	Calculation (Number)	Unstored, = (CM_Present / CM_Tot_Att)*100
CM_DaysAbsent	Calculation (Number)	Unstored, = Sum (Line Items::Actual Status absent cm)
CM_PerAbsent	Calculation (Number)	Unstored, = (CM_DaysAbsent/CM_Tot_Att)*100
Contact No.	Text	

Figure 7: Details of Student Master Table

Figure 7 above shows the various fields present in the table Student Master. Other features include teaching process, teaching session, directory of all references, calendar, course book, breakup of marks etc.

With some hardships the required system for this goal was understood from the users. There was indeed a lot of cooperation from the administrative staff.

2.3 Software Design

It is a well known fact that software design forms the most critical element of any project. In other words the success of any project depends on the quality of the software design. Software Design is the study of the modern methods, technologies, languages, principles and practices that make it possible to conceive, create, validate and evolve complex software systems [1]. It consists of understanding user requirements completely & correctly. Further we need to complete the paperwork like SRS, DFD's, and ERD's as well. Making a complete sketch of Data tables & their fields is again a very important part of software design.

2.3.1 Data Model

Data modeling consists of defining a well thought of structure database based on our requirement. An example of entity as defined in a database is shown below:-

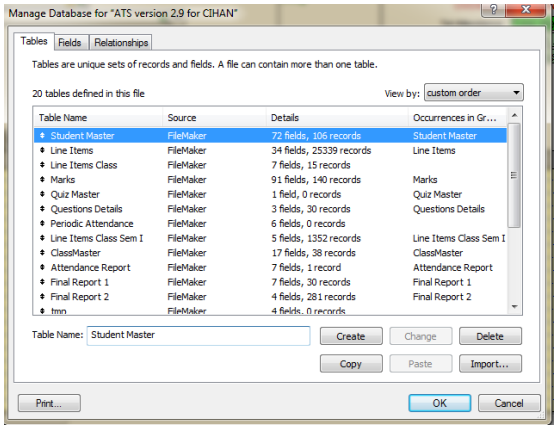

Figure 8: The Database Structure

The figure 8 shows a typical database structure as created in the File Maker. It has been shown as a sample database structure for the application in figure 8 above. Like this we have other database structures as well. We need to link them together as per our requirement which is the most common feature of any RDBMS.

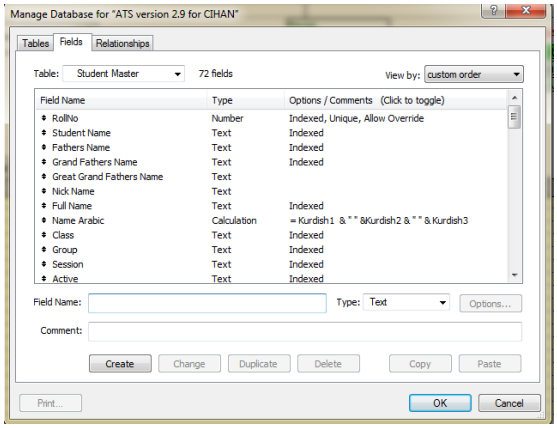

Figure 9: A Typical File Maker Table structure

Figure 9 above shows the fields of the table Student Master. A table comprises of various fields. These fields have a unique name, type etc. Like the table student master as shown above there may be various other fields linked to the other tables as well. Further we need to link tables to buildup relationship which provide desired output. These are the basic building blocks of any application using RDBMS.

During the designing of the database, we need to make right decisions to make the best use of an effective and efficient system. A well worked on database takes less time and efforts to process and produce end results. For the reason a lot of the success of the project depends on the designing of the data model. It should be scalable with the options to modify as and when required. It should be easy to understand & user-friendly. We need to take care of data redundancy. Further our application should be flexible so that it can be used anywhere with no hardware or software limitations and should work perfectly well with changing requirements with minimum efforts.

In figure 10 above we show the most important entities of the model and their relationships as defined & used in a typical class/session. Our whole project is usually based on this ER diagram (Entity-relationship) diagrams.

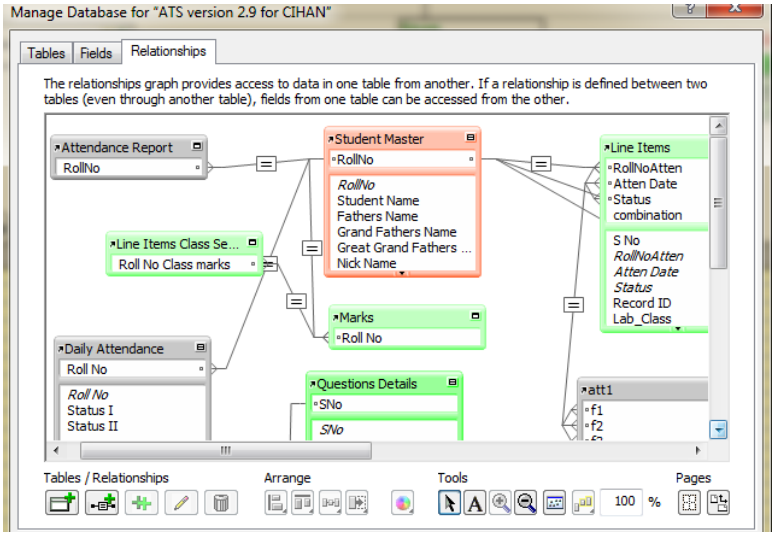

Figure 10: A Typical Entity-Relationship Diagram in FileMaker

2.4 Implementation

The next step is the implementation of the application software which has been developed as a constructive effort of the entire team. The communication between the database and the software includes:

bullet Storing data/information in the database *bullet* Retrieving the required data/information as required *bullet* Modifying data/information as and when required

3 Conclusions

The need of managing the information electronically has been growing man folds in all areas of the Kurdistan region. As we all know that education is considered to be very essential for the development of any nation. Therefore, Class Management Systems like EduGain version 1 have been suggested as the best option to manage schools/colleges in a perfect manner.

The EduGain version 1 application software has been built based on actual procedures and practices being followed in the institution. Therefore, this system may be considered as a very critical step aimed towards implementing digitally based information management in Schools/Universities.

The practical aspect of the research paper would be demonstrated practically during the conference.

Acknowledgment

The application has been developed as a result of perfect teamwork. The same has been highly promoted and appreciated by the Management of the Institution. Further we thank all those who supported the project by providing valuable feedback.

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other terminologies used in the field of quality assurance. Retrieved November 6, 2017, from *https* : $//www.tutorialspoint.com/software_testing_dictionary/software_requirement_specification.htm$

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Determinants of Commercial Bank Profitability

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Abstract

Profit does not happen, it must be managed. The profitability of a commercial bank gets influenced by different variables. Such types of variables can be categorized into internal and external variables. In this study 13 years financial variables has been taken for development of profitability model commercial bank of Nepal. The panel data has been taken form annual supervision report of Nepal Rastrya Bank (Central Bank of Nepal) and other sources. The descriptive statistics has shown that total assets, total liability, term deposit, operating income, operating expenses, interest income and interest expenses and profit have been increased significantly in latter period than beginning period. In profit of commercial bank each independent variable has significant role which would be explained in this article by correlation coefficient correlation 0.987 t0 0.813 . There have been developed four model of commercial bank profitability. The total assets have positive impact of profitability of commercial bank.

Keywords: Profitability, commercial bank, assets, liabilities, operating expenses, interest income.

The Use of Operational Research in Decisions Made by the Government of Nepal for Education Sectors for Full Growth and Development of the People

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Abstract

Loss of human resource is the greatest loss among the loss of different resources required to develop the country. Plans and programs carried out in the country has greater impact on the development of its people. The article intends to revel the status of the use of operation research to this direction. The research is based on the qualitative information received from the depth interview of some administrators involved actively in educations sectors and some administrators correctly being engaged in the current situation.

Keywords: education sectors, primary education, secondary education, higher education, formulation of plans and policies, implementation of plans and policies.

Appointment of new CEOs of BFI in Nepal Stock Exchange

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Abstract

The purpose of this paper is to investigate stockholders' reaction to an announcement of the appointment of a new CEO in banking and financial institutions that are listed companies in NEPSE. We consider all type of appointment of CEOs between 2011 and 2018. Leadership in any business set the direction and simultaneously affect its profitability and general operations. When an organization changes their CEO, it can have market prices responding either bullish or bearish way. To examine the changes in the market price, an event study was applied. The abnormal returns were measured using the CAAR in the entire (-90, +90) window of the event date of the announcements. There were no significant reactions to such announcements. This is first attempt to carry out a research related to stockholders' reaction to CEO appointments in Nepalese context. The market price movement to an announcement of a new CEO appointment is always a shareholders' interest.

Keywords: CEO appointments; abnormal return; event study, NEPSE, investors' reaction, efficient market hypothesis

Effect of Capital Structure on Bank Performance of Commercial Banks in Nepal

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Abstract

This paper examines the effect of firm specific variable on earning per share and market price per share of commercial banks in Nepal over a period from 2006/07 to 2016/17. Earnings per share and market price per share is dependent variable whereas, total assets, total debt, shareholders' equity and total investment are independent variables. Data are collected from annual report of the respective banks, and NRB website. The study is based on 106 observations from 10 commercial banks of Nepal. The regression models are estimated to test the significant and importance of effect of firm specific variable on earning per share and market price per share determinant of Nepalese commercial banks. The result shows that there is positive correlation between earning per share with total assets and total investment whereas, negatively correlated to total debt and shareholders' equity. Similarly, market price per share is positively related to total assets, and total investment, whereas negatively related to total debt and shareholders' equity.

The result shows the positive beta coefficient for total assets and total investment whereas, negative for total debt and shareholders' equity for model 1. Likewise, beta coefficient is positive for total assets and total investment whereas, negative for total debt and shareholders' equity for model 2.

Keywords: Total Assets, Total Debt, Shareholders' Equity, Total Investment, Correlation, Regression.

Glance of Quality Regulatory Bodies Operations and Challenges in Nepal

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Abstract

The Government of Nepal (GoN) have Regulatory Bodies operation challenges in Nepal. The regulatory bodies are the authorized body to implement and compliance monitoring bodies in the area of product or service industry in Nepal. We required an independent evaluation of conformity assessment bodies against recognized standards to ensure their impartiality and competence. Through, the application of national and international standards, government, procurers and consumers can have confidence in the calibration and test results, inspection reports, universities accreditation, personal certifications provided. In this global scenario an accreditation bodies are established in many countries with the primary purpose of ensuring that conformity assessment bodies are subject to oversight by an authoritative body.

Accreditation bodies, which is an evaluating body by peers as competent, sign arrangements that enhance the acceptance of products and services across world. Basically, every country have non-tariff-barrier (NTB) for their product and service volume within their home land. However, the Technical Barriers to Trade (TBT) main objective to conformity to the international requirement on the signing agreement between first party and second party. The international market currently not accepting the output product or services if not fulfill their national standard requirement which is the challenges for academic, manufactures and service providers, thereby creating a framework to support international trade through the removal of technical barriers.

In this context The WTO members have a right to implement TBT agreement strongly to encourages members to base their measures on international standards as a means to facilitate trade required accreditation body, Mutual Recognition Agreement (MRA) and other necessary policy formation within country. So, without endorse Accreditation Act by the Parliament birth of Quality Council of Nepal as an apex body to govern the accreditation body and certification assessment bodies in Nepal. Accreditation provides assurance to Government to rely on commercial providers of evaluation and inspection services in the manufacturing and service sector and it enable innovation and the dissemination of good practice. This will leverage more competitive economy through the international acceptance of results and certificates and the removal of technical barriers to trade in international arena. It build supply chain and public trust of activities that have the potential to impact on public confidence, health and safety or the environment.

These arrangements are managed by the International Accreditation Forum (IAF), in the fields of management systems, products, services, personnel and other similar programmes of conformity assessment, and the International Laboratory Accreditation Cooperation (ILAC), in the field of laboratory and inspection accreditation. In Nepal we have different councils in sector wise to enforce the regulatory norms within our country. The Department of Drug Administration (DDA) for Pharmaceuticals and its product and service delivery area. The Department of Food Technology and Quality Control for the Food sector whether product and service area. The Nepal Bureau of Standards and Metrology (NBSM) for Nepal Standards (NS) for governing and which is an ISO representative in Nepal and develop the standards as per requirement. Other concern ministry are there for their respective enforce the law in academic area UGC has established a decade back QAA program for quality advocacy in relation to measuring the equivalency of the various academic degrees earned from the universities across the world. Ministry of Health, environment and Education focuses for enforcement law in their respective area. However operational challenges and common umbrella not allocated till the now and which is the basic challenges in Nepal to up-liftment of quality enhancement.

It is this relationship with government that is posing perhaps the most fundamental challenge that accreditation is built on and reflective of the core values of the academy, test report, sample report, local certification and international volunteer certification and council certifications. The Future of Accreditation has confronted to date. This challenge as of now two are government moving to take on at least some of the political decision for Accreditation Act. Similarly, development of an approach to political decision making and accreditation that is regulatory in nature and based on assumptions and values that do not align with accreditation's traditional mutual values and practices.

Today, government is poised to alter core accreditation practice—something that has not happened since the establishment of the public-private partnership, the traditional mutual practices of accreditation are increasingly eclipsed by regulatory practices imposed by government, both in the scope and the attention to the details of accreditation practice.

Optimal Production Plan in Flour Mills of Nigeria Public Liability Company: Linear Programming and Sensitivity Analysis

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Abstract

This paper presents analysis of optimal production plan in Flour Mills of Nigeria Plc. The study incorporates LP and SA techniques to determine segment that contributes most to the objective function. This research takes into consideration five main segments that is food, agro-allied, packaging, port operation and logistics and real state of the company and financial information extracted from the company annual report for the year ended March 31, 2017. The LP analysis reveal that milling and sales of flour and rice and production and sales of pasta, snacks, sugar and noodles in the food segment contribute 72, 156, 441, 200 to profit representing 7.57% increase over the initial total contribution of 66, 689, 068, 000 with production of 1,250 units of the food items. It is also found that each extra '000 spent on the binding constraints (cost of sales), would produce 0.15 extra contribution. Finally, SA analysis improves LP result by 1.34% and 0.88% respectively for units of production in the food segment and total contribution to profit. Hence, it is concluded that milling and sales of flour and rice and production and sales of pasta, snacks, sugar and noodles are more profitable to the company. Therefore, the management of FMN Plc should give more attention to the segment in order to maximize profit.

Keywords: Optimal production plan, LP, SA, FMN PLC, food segment.

The Role of Motivation, Constraint and Negotiation on the Domestic Leisure Travellers from Kathmandu Valley

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Abstract

With increasing study of consumer behaviour, the role of constraint and negotiation hasn't been well studied in the context of Nepal. This paper aims to understand how the constraint-effects-mitigation model developed by Hubbard and Mannell applies in the context of domestic leisure tourism for citizens of Kathmandu valley.For the purpose of quantitative data analysis, convenience sampling method was used in consideration to limitation of time and resource. Self-administered questionnaires were distributed through social media, which was then analysed using IBM SPSS.

The main findings of this paper was that in the context of Kathmandu valley, motivation and constraints both had relation with negotiation, however, there was no direct relation of either with participation. Whereas, negotiation had a positive relation with participation. Unlike in the Hubbard and Mannell's study, there was no direct relation between constraint and negotiation established in this paper. Within the variables itself, structural constraints was deemed as the most important, while achievements were the most motivating factor. Finally, to mitigate the constraints, time management was ranked as the most important factor.

Due to the lack of study of constraint-effects-mitigation model in Kathmandu valley's context, the paper has delved into the psychology governing Kathmandu valley citizens and found that the domestic travellers from Kathmandu valley doesn't have their participation determined by motivation or constraints itself. Instead, it is determined by their ability to negotiate.

Keywords: Consumer Behaviour, Motivation, Constraint-effects-mitigation, Domestic leisure travel

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Introduction: Briefly describe the objective of the research and explain why it is important.

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Results: Present results in a clear, logical sequence. If tables are used, do not duplicate tabular data in text, but do describe important trends and points.

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Examples (Reference to a journal publication):

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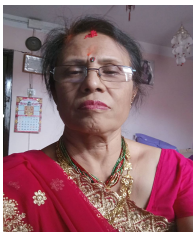

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