



# Onwards to Recovery through Operations Research

13th Triennial International Conference of the  
Association of Asia Pacific Operational  
Research Societies (APORS)

November 9-12, 2022

Eastwood Richmond Hotel / Online  
Philippines

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## *Time for OR is Here and Now*



**Francis Z. Miranda**

*APORS 2022 Conference  
Chair/*

Welcome to the 13th Triennial International Conference of the Association of Asia Pacific Operational Research Societies (APORS). Our theme for the 2022 APORS conference is *Onwards to Recovery through Operations Research*.

I wish I could say that we are really on our way to recovery. However, there is still a lot of uncertainty in the horizon with the ongoing Covid pandemic, the war in Ukraine, and the consequences of both crises such as the supply chain crunch, the increase in petroleum prices and the rising inflation globally. Indeed, we live in a VUCA (volatile, uncertain, complex and ambiguous) world.

With this backdrop, it is even more essential to use Operations Research to prepare ourselves for the future and lead us to the recovery that we are looking for. We should rely on the analytical methods in OR to guide us in making better decisions, instead of relying on emotion, politics and other subjective factors like what is unfortunately happening in our world today.

I would like to thank our IFORS Distinguished Lecturer, keynote speakers, member society contributors, youth forum contributors, the special healthcare track contributors, the other paper presenters, participants, and the rest of the APORS 2022 Conference Organizing Committee for making this event possible. I hope that all attendees will be inspired by this conference. As Operations Research leaders and practitioners, let us help pave the way to recovery!

## *Sharing with, Learning from Others*



**Marie Shella T. Mariscal**  
*President, ORSP*

On behalf of the Operations Research Society of the Philippines (ORSP), I welcome you to the 13<sup>th</sup> Triennial International Conference of the Association of Asia Pacific Operational Research Societies (APORS) with the theme *“Onward to Recovery Through Operations Research.”* It is nice to see operations research professionals, practitioners, and academicians from the different Asia Pacific countries gather in this long-overdue event after the global pandemic.

Though not a full face-to-face event with some opting to join online, it is not less valuable as a venue to discuss and learn about the role that OR has or could play towards Asia-Pacific and world recovery. The conference has three days of plenary talks and paper presentations on actual OR applications and methodology that go beyond pandemic-related topics. We have special tracks on National Contributions and Youth Forum.

I enjoin you to take part in the various social events we have organized, especially the banquet sponsored by the Tourism Promotions Board (TRB). These are all great opportunities to mingle with conference participants and make professional and personal discoveries!

To our distinguished speakers, authors, board members, and participants, thank you for your valuable time and effort to make this conference happen. I hope, somehow, it paves the way towards better decisions in the future.

## *Progress Despite Obstacles*



**Yu-Hong Dai**

*President, Association of  
Asia-Pacific Operational  
Research Societies (APORS)*

The Triennial International Conference of the Association of Asia-Pacific Operational Research Societies is the most important event for APORS member societies and for the OR practitioners and academics in the region, because it provides an excellent opportunity for us to meet and share our research results and practical experiences.

Although I know that due to the Covid19 many of you, like myself, are not able to attend the 13<sup>th</sup> APORS Conference in Philippines in person, I would like to welcome all the participants either on site or online. With the theme of “Onward to Recovery through OR”, the conference programme covers many interesting topics of pandemic response and recovery using OR analytics and tools. I think these research and applications are valuable for

fighting the global recovery of the pandemic.

During the past three years, APORS Council has made many efforts in encouraging and organizing exchanges online within and among the member societies in the region. For example, we organized the First APORS Youth Forum and we have established three groups: **APSIG/PHE** (APORS Special Interest Group on Public Healthcare Emergency), **APSIG/OPT** (APORS Special Interest Group on Optimization) and **APYAG** (APORS Youths Activity Group). Through well-organized webinars and online workshops, we can still maintain effective exchanges and knowledge sharing.

I would like to take this opportunity to thank Francis Miranda and the ORSP Organizing Committee for your great work to make this conference attractive. I would also like to thank all the guest speakers, keynote and plenary speakers, paper presenters for your strong support and your interesting presentations. Finally, I hope all the attendees from the Asia-Pacific region and from the different parts of the world will enjoy the APORS 13<sup>th</sup> Conference and the Philippines.

## *Unity in Diversity*

On behalf of the International Federation of Operational Research Societies (IFORS), it is my great pleasure to welcome you to the 13<sup>th</sup> Triennial International Conference of the Association of Asia-Pacific Operational Research Societies (APORS), May I congratulate Dr. Francis Miranda and the Organising Committee for putting together such a comprehensive programme for the conference --- no mean feat in these challenging and uncertain times under the shadow of Covid19.



**Janny M.Y. Leung**

*President, International Federation of Operational Research Societies (IFORS)*

As the global federation of OR societies, IFORS has the responsibility to promote operational research as a unified science and advance its application around the world. Since its established in 1959, IFORS has fostered the dissemination of knowledge and sharing best practices across the four regions of IFORS around the world. As a multi-disciplinary science strongly grounded in practice, operational research continue to play a critical role in developing solutions to the many complex global challenges that are facing the world today.

Among the four regions of IFORS, APORS is by far the most diverse. Geographically, the countries of the twelve APORS Member Societies span two continents and ten time zones. APORS includes one of the oldest and one of newest Member Societies of IFORS. Thus, the triennial APORS conference provides an invaluable opportunity for operational research practitioners and academics across the region to get together to exchange ideas and to share experiences.

I hope the many stimulating interactions at the conference may spark the beginnings of new research directions, new innovations and new friendships.

# Program Schedule

Manila Philippines, November 9- 12, 2022

## Conference Schedule Overview

### 9-Nov

9:00 Leave Richmond Hotel for City Tour

12:00 Lunch (own account)

17:00 Back at Hotel

19:00 Welcome Dinner at 2 Acropolis Drive

Business Attire

### 10-Nov

Start	Mins	End	
7:30	60	8:30	Registration
8:30	15	8:45	Opening Ceremonies
8:45	40	9:25	Guest Speaker - Lilia Guillermo, BIR Commissioner
9:25	20	9:45	Coffee Break
9:45	5	9:50	Introduction of IFORS
9:50	60	10:50	IFORS Distinguished Lecture - Ahti Salo
10:50	60	11:50	Keynote- Karla Hoffman
11:50	100	13:30	Lunch Break
13:30	60	14:30	Parallel 1
			A- Covid-19 Analytics
			B- Supply Chain Planning Mktg/ Retail
14:30	10	14:40	Break
14:40	60	15:40	Parallel 2
			A- Public Health and Disease Control
			B- Scheduling
15:40	20	16:00	Coffee Break
16:00	60	17:00	Parallel 3
			A- Marketing and Finance
			B- Network Optimization

# Program Schedule

11-Nov

Start	Mins	End		
7:30	30	8:00	Registration	
8:00	60	9:00	Plenary Nina Kajji	
9:00	60	10:00	Plenary Gerhard Wilhelm Weber	
10:00	30	10:30	Coffee Break	
10:30	60	11:30	Plenary Jim Cochran	
11:30	60	12:30	Plenary Gordon Dash	
12:30	60	13:30	Lunch Break	
13:30	60	14:30	Parallel 4	
			A- Local Governance and Emergency Response	B- Inventory Management
14:30	60	15:30	Parallel 5	
			A- Transportation- Freight & Fleet Mgt	B- Mathematical Modeling
15:30	20	15:50	Coffee Break	
15:50	60	16:50	Parallel 6	
			A- Covid 19 Response & Recovery	B- Analytics & Machine Learning
17:15			Departure for SMX Aura, BGC	
18:30	150	21:00	Conference Banquet	Business Attire
21:40			Back at Richmond	

# Program Schedule

12-Nov

Start	Mins	End	
8:00	60	9:00	Parallel 7
			A- Healthcare & Industry; Mgt in New Normal Times
			B- Finance & E- Commerce
9:00	5	9:05	Break
9:05	20	9:25	Invited Paper on Machine Learning
9:25	60	10:25	National Contributions 1
10:25	20	10:45	Coffee Break
10:45	60	11:45	National Contributions 2
11:45	60	12:45	Lunch Break
12:45	60	13:45	National Contributions 3
13:45	60	14:45	Youth Forum 1
14:45	20	15:05	Coffee Break
15:05	80	16:25	Youth Forum 2
			Closing Ceremonies
16:25	10	16:35	Report from the Technical Committee
			Message from the former DOST Secretary F. de la Peña
16:35	5	16:40	Message from APORS President
16:40	5	16:45	Invitation to 14th APORS, China
16:45	10	16:55	Message from IFORS President
			Message from APORS VP for IFORS and Chair, Organizing Committee
16:55	5	17:00	

# *Opening Ceremonies*

## *Guest Speaker*

November 10, Thursday

0845 – 0925

Ms. Guillermo's entire career is in government service. Her massive accomplishments in modernizing major government operations, alongside academic qualifications, extensive professional experience, training, membership in several organizations, garnered her an award "One of the most powerful women in I.T. in the Philippines" (June 2013).

Prior to becoming the Commissioner of the Bureau of the Internal Revenue (BIR), Ms. Guillermo was the BSP Assistant Governor of Technology and Digital Innovation Office under the Office of the Governor where she manages the completion of the BSP I.T. Modernization Roadmap of 2018-2023 and the Bank's journey in Digital Transformation.



**Lilia Catris Guillermo,  
CESO 1**

*Commissioner  
Bureau of Internal Revenue*

Ms. Guillermo was an Undersecretary of the Department of Budget and Management where she spearheaded I.T. innovations at the DBM and was given the responsibility of managing and developing systems needed for the modernization of the Public Financial Management Program (PFM).

Another highlight of her career was at the helm her service in the Bureau of Internal Revenue (BIR) where she was designated Deputy Commissioner and acted as the Project Director of the biggest I.T. project in government, the World Bank-assisted "Tax Computerization Project".

In 2006, she was seconded to the Asian Development Bank as an Information & Communications Technology Expert to Kyrgyz Republic to conduct a technical mission on the modernization of their Revenue Administration.

She received the 2019 Presidential Gawad Career Executive Service Award, pursuant to Executive Order (EO) No. 715 (s.2008). Most recently, BSP conferred to her a Gawad Gantimpala Award during its 18th BSP PRAISE Awards themed "Pagpupugay sa Husay at Tapat ng Paglilingkod sa Panahon ng Pagbabago."

Ms. Guillermo is a graduate of Bachelor of Science degree major in Statistics and received an M.S. Industrial Engineering degree in 1981 both from the University of the Philippines.

# *Plenary Talks*

November 10, Thursday

0950 – 1050

## IFORS Distinguished Lecture

### Addressing Strategic Problems under Uncertainty: Advances in Scenario and Decision Analysis

#### ABSTRACT

In crises such as the COVID-19 pandemic, policy and decision makers are under extreme pressure as they must assess major uncertainties before committing themselves to decision alternatives which can have far-reaching consequences for health, environment, economy and society. In order to ensure that relevant uncertainties and their impacts in the evaluation of alternatives are systematically assessed, effective methods of scenario and decision analysis are needed.

In this talk, I first summarize personal experiences from the policy initiatives which the Prime Minister's Office in Finland introduced to strengthen the dialogue between policy makers and researchers. Specifically, the COVID-19 Science Panel had an impactful role in advising the Government during the pandemic while the production of widely disseminated research reviews provided science-based support to a broad range of senior policy makers. The need for collaborative risk management was recognized, reflecting the fact that in many-faceted problems such as the COVID-19 pandemic, there is a need to bring in expertise from a broad range of stakeholders.

Second, I discuss the benefits of using scenario analysis as a tool for exploring the implications of uncertainties for strategic decisions. Even in situations where scenarios are built primarily from qualitative expert judgments, it can be helpful to leverage quantitative techniques to guide the development of scenarios which are both diverse and comprehensive. When dealing with safety-critical systems, there are reasons to deploy theoretically sound probabilistic methods which, unlike qualitative approaches, can be integrated with techniques of statistical analysis and data science.

Third, I present advances in solving multi-stage decision problems which can be represented as influence diagrams where interdependencies between decisions, uncertainties and consequences are shown as directed acyclic networks. Conventional approaches to solving influence diagrams (such as using dy-

dynamic programming to solve the equivalent decision tree representation) make the 'no-forgetting' assumption in that all earlier decisions must be known when making later ones; yet this assumption may not hold in distributed decision problems. Moreover, earlier approaches have limitations in identifying all non dominated solutions and accommodating relevant logical, resource and risk constraints.

Against this backdrop, Decision Programming is a novel framework (Salo et al., 2022) which accommodates such constraints without making the 'no forgetting' assumption. Technically, the influence diagram is converted into the equivalent mixed-integer linear programming formulation which can be solved with standard commercial solvers. The Decision Programming framework is very flexible and can be extended to optimize information structures in order to determine (i) what optional information should be acquired to guide decisions and (ii) how this information should be exploited. Several numerical examples are presented to illustrate that the optimization of information structures holds considerable promise, for example, in devising testing and screening strategies in the presence of resource and risk constraints.

***Ahti Salo***  
SPEAKER



**Professor Salo** has worked extensively on the development of decision analytic methods and their uses in resource allocation, innovation management, risk management, technology foresight, and efficiency analysis. He has published widely in leading international journals (including *Management Science* and *Operations Research*) and received awards for his research from the Decision Analysis Society of the Institute for Operations Research and the Management Sciences (INFORMS). In 2019, he won the [MCDM Edgeworth-Pareto Award](#), the highest distinction of the International Society for Multiple Criteria Decision Making. He serves on the Editorial Boards of several refereed journals.

Professor Salo has directed a broad range of basic and applied research projects funded by leading industrial firms, industrial federations, and funding agencies. He has been visiting professor at the London Business School, Université Paris-Dauphine, and the University of Vienna. He has been the President of the [Finnish Operations Research Society](#) (FORS) for two biennial terms. In 2010-11, he was the European and Middle East representative on the International Activities Committee of INFORMS. In 2010-16, he was a jury member of the [EDDA Doctoral Dissertation Award](#) of the Association of European Operational Research Societies (EURO) and chaired this jury in 2016.

He served on the Board of the Association of Parliament Members and Researchers (Tutkas) in 1999-2019. In spring 2020, he was a member of the [Science Panel](#), appointed by the Prime Minister's Office for obtaining scientific support for the management of the COVID-19 pandemic. In 2020-2023, he is a member of the [Government Foresight Group](#), appointed by the Prime Minister's Office of Finland.

# *Keynote Speech*

November 10, Thursday

1050 – 1150

## **From the Battlefield to the Gig Economy: How Hybrid Optimization Can Guide Decision Making in Highly Dynamic and Unpredictable Settings**

### **ABSTRACT**

This talk describes the use of optimization to assist in real-time decision-making where solutions must be available almost instantaneously. We highlight the success of these methods in two very different settings: (a) the routing and scheduling of deliveries in gig-economy applications; and (b) the problem of sustaining communications in a highly dynamic battlefield environment. In the first of these applications, we present the problem of assigning drivers to service requests and presenting the drivers with an efficient routing of all request locations. The decision framework for these assignment problems often has competing objectives (e.g., minimizing cost to the company, providing assignments that are profitable to the drivers, and assuring that customers receive their orders in a timely fashion). The process may include predicting whether a driver will accept a given assignment and the notification to both the customer and the supplier (e.g., the restaurant providing the food to be delivered). If the drivers are not hired on a schedule, then the driver might refuse an offer and it might, therefore, take multiple “offers” to alternative drivers before the assignment is finalized. The entire process of allocating of assignments to drivers, notifying customers of expected delivery time and alerting suppliers to new demands must be done in under a minute. In our second application, there is the need to reassign wireless channels to a military unit (or units) that lose communication capabilities due to enemy jamming or other interference issues. The need to recover quickly while assuring that reassignments do not harm other units is essential to overall battlefield success. Our approach uses hybrid algorithms designed with problem structure in mind to help satisfy challenging time requirements. In both applications, we work to generate multiple feasible solutions quickly, update prior solutions with new information, and bound the solution space. This hybrid approach obtains near-optimal solutions within the tight timeframe that these applications demand. These fast hybrid algorithms use standard optimization solvers in conjunction with feasibility checkers, constraint programming, and/or decision diagrams. These techniques are likely to be applicable in many other settings.

## **Karla Hoffman**

**SPEAKER**

**Karla L. Hoffman** is IFORS VP representing the North American region (NORAM). The fourth President of INFORMS and an INFORMS fellow, she is a professor of systems engineering and OR in the Volgenau School of Engineering of George Mason University, USA. Her research has focused on practical applications of operations research and optimization to problems including transportation scheduling, airport landing slot allocation, spectrum auctions, and telecommunications budgeting. Among her latest distinctions include the 2018 INFORMS Franz Edelman Award for her work with the US Federal Communications Commission on spectrum allocation. Other awards include the Department of Commerce Silver Medal and the Applied Research Award of the National Institute of Standards and Technology as well as the Kimball and Omega Rho Lecturer Awards. Hoffman graduated from Rutgers University with a BS in Mathematics, earned her MBA from George Washington University, where she completed her doctorate in operations research from the engineering school.



**November 11, Friday**

**0800 – 0900**

## **XAI: Confounding Disease States and the Determinants of Sovereign SDG Healthcare Accessibility**

### **ABSTRACT**

This talk discusses the importance of modeling global healthcare accessibility. For any nation, healthcare accessibility is a complex measure rooted in individuals of all ages' ability to receive healthcare, especially for those with demonstrated anxiety effects. Driven by sovereign socioeconomic interests and the United Nations sustainable development goals (SDGs), there has been a steep rise in the use of analytics to investigate healthcare accessibility. Of the seventeen SDGs, the third goal seeks to *"achieve universal health coverage" to promote access to essential healthcare services and access to safe, effective, quality, affordable essential medicine and vaccines for all*. Over the past decade or so, nations have been observed to be committed to the advancement of healthcare equity. But then, to the world's surprise and dismay, the dawning of the COVID-19 pandemic slowed and then disparaged advances in health outcomes – a condition characterized by restricted access to medical

facilities and services. With a flattening of the COVID-19 curve, sovereign decision-makers now seek to slow the re-emergence of healthcare inequities.

In the contemporary analytics era, shaping a national healthcare policy requires a combination of forward-thinking administrative management and the ability to design new products and services. The rebuild partly rests on extracting updated insights from evolving 'big data' databases. The challenge – no two countries are alike in organizing the shift from the data science-driven pre-COVID period to a new era of disruptive AI and cognitive technologies that utilize digital health solutions to transform care for an entire population. Take the Southeast Asian region as an example. Across region neighbors (i.e., Cambodia, Vietnam, Thailand, and Indonesia), we can observe different healthcare management systems in alternate stages of development.

This talk discusses our current study, which aims to promote the global development of national healthcare accessibility through the implementation of explainable artificial intelligence (XAI). XAI represents a set of processes and methods applied to machine learning algorithms to promote human trust and comprehension of the AI-produced results. To exemplify the potential for the universal appeal of XAI in healthcare administration, we propose an empirical analysis of the top seven chronic health-impacting conditions. The data is obtained from the U.S. Center for Medicare and Medicaid Services (CMS). Medicare is the U.S. national health plan for people 65+, certain younger people with disabilities, and a class of people with end-stage renal disease.

According to CMS, most beneficiaries have multiple chronic disease states. Understanding the confounding nature of disease states requires integrating various measures into one framework. Empirically, the nonlinear interactions among the multiple and binary disease state response variables make the modeling exercise complex. Accordingly, we invoke a multivariate Bayesian enhanced radial basis function neural network with regularization enhancements to estimate error-minimizing classification weights and effectively model the complex response function.

Model explainability and trustworthiness are approached by adopting XAI encapsulated in SHAP values. Enumerated SHAP values permit us to evaluate the contribution made by each predictor-feature variable to all model prediction points. Preliminary studies indicate that our solutions show a classification accuracy (overall correct classification) of 98.73% and 87.33% for hypertension and depression. Focusing on patients with heart disease, we report that over the COVID-19 era, patients express their ability to pay rent has decreased, feel less financially secure, and overall experience greater anxiety.

***Nina Kajiji***  
SPEAKER



**Nina Kajiji** is a Principal of The NKD Group, Inc. She is also an adjunct associate professor in the Computer Science and Statistics Department at the University of Rhode Island. She has been conferred the title Accredited Professional Statistician™ from the American Statistical Association.

Her principal research interests are in applied optimization, volatility modeling, and artificial intelligence (AI). Application fields include: socially respon-

sible investing, modeling risk, neuroscience-based modeling for the development of smart cities, ‘big data’ analysis of intra-day municipal bond yield curves, and obtaining complex educational assessment elasticity metrics. Her research continues to expand to include ‘big data’ analytics featuring visualization, high-performance computing, and explainable AI (XAI) to assist in complex data mining.

Dr. Kajiji’s academic research has been published in several operational research journals, finance journals, and, most recently, in the journal *Neuroscience*. Besides contributing several book chapters, Nina is currently co-authoring two e-Books titled “*Applied Risk Management: Valuation of Derivatives under AI and Data Science Technologies*” ([www.ARMDAT.com](http://www.ARMDAT.com)) and “*AI and Data Science in Applied Security and Investment Management*” ([www.aisimbook.online](http://www.aisimbook.online)).

Nina is the co-architect of the cloud-based computing platform, *WinORS<sub>e-AI</sub>* 2021. The computing platform is geared towards solving problems using techniques commonly used in financial engineering, statistics, operations research, and economics. Research models using *WinORS<sub>e-AI</sub>* have been presented to capital market professionals in Italy, India, Thailand, South Africa, Lithuania, Turkey, and the UK. Some specialized techniques incorporated in *WinORS<sub>e-AI</sub>* 2021 are combinatorial non-linear goal programming, Bayesian enhanced regularized univariate and multivariate radial basis neural network, Explainable AI (XAI) using SHAP, and more. Nina has taught courses in Statistics, Time Series Analysis, Operations Research, and Finance at various Universities in the U.S. and internationally. She is a member of the Greek-based RiskGroupAuth, an interdisciplinary research group (think-tank) specializing in developing risk assessment and management tools for modern energy systems.

For her volunteer work, Nina has been awarded the President’s Volunteer Service Award (Gold Level) from the President’s Council on Service and Civic Participation. She was named Woman of the Year by the National Association of Professional Women. She currently serves as the co-Chair of the European Working Group on Operational Research for Development (EWG-ORD).

November 11, Friday

0900– 1000

## The Kerkenes Eco-Center Project OR Meets Archaeology, Architecture and Engineering for Science and the Improvement of Living Conditions in Rural Anatolia

### ABSTRACT

In this paper co-authored with Geoffrey Summers, Francois Summers, and Soofia Tahira Elias-Ozkan from the Middle East Technical University, Ankara, Turkey, I will introduce, through an example, how Operations Research for Development applications are highly interdisciplinary in character, and how OR, together with state-of-the-art tools and devices from engineering, natural and social sciences,

could serve projects of architecture, history, water management, agriculture and education, with the goal of improving living conditions.

The Kerkenes Eco-Center Project was initiated in 2002 with the following objectives:

- To advocate the use of renewable sources of energy;
- To act as a stimulus and a catalyst for environment-friendly building with appropriate materials and energy efficient designs;
- To act as a dynamic experimental base for testing designs, materials and activities suitable for viable and sustainable village life;
- To encourage village development and income generating activities that might halt and even reverse migration from rural areas to the cities.

I will discuss a very successful program for the promotion of solar energy, a drip irrigation scheme for organic gardens, solid waste separation for composting and recycling, reuse of grey-water and promotion of appropriate materials and design for energy efficient buildings.

Şahmuratlı Village possesses a world class cultural heritage site, ancient Pteria, an Iron Age mountain-top city founded on the Kerkenes Dağ. The Kerkenes Eco-Centre piloted schemes for renewable energy and appropriate technologies against a background of climate change, socio-economic inequality and rapid depopulation of rural areas in favour of urban growth. The Kerkenes Eco-Centre experiments with appropriate building materials and energy efficient designs, drip irrigation for organic gardens, solar energy, solar drying and cooking, recycling, stimulating and creating income generating activities for both men and women.

International agencies assist in raising political commitment to a low carbon high growth economy in Turkey. This small project makes use of an existing Eco-centre in Turkey to promote energy efficient and renewable energy designs. It brings together local officials, businessmen, MPs and villagers to stimulate more formal work at the Municipality level, greater replication of ideas in other regional areas, and an increased media awareness of how local projects fit into the bigger strategic goals on energy and climate change.

Other activities involve the production of stabilized mud bricks with the Parry Brick Press. This press was also used to compress wastepaper into briquettes to be burnt as fuel in the traditional stove during winter months. Garden activities in the Kerkenes Eco-Center continued to yield vegetables. Meetings with housewives in the village helped to understand their needs and aspirations. Discussed were solar energy use for cooking and domestic water heaters as well as for income generating activities.

In Kerkenes, Ankara and various places in Europe and all over the world, modern OR offers a platform and methodology for scientifically discussing and supporting local development and the improvement of living conditions.

## *Gerhard-Wilhelm Weber*

SPEAKER

**Gerhard-Wilhelm Weber** is a Professor at Poznan University of Technology, Poznan, Poland, at Faculty of Engineering Management. His innovative research covers the areas of mathematics, statistics, operational research, data science, machine learning, artificial intelligence, inverse problems, remote sensing, finance, economics, optimization, optimal control, management science, neuroscience, biology, medicine, psychology, development, physics, chemistry, literature and arts, cosmology, spirituality, Christianity, religions and ideologies, generalized space-time design, research, shift and travel.



He is internationally involved in the organization of scientific activities. He received Diploma and Doctorate in Mathematics, and Economics / Business Administration, at RWTH Aachen, and Habilitation at TU Darmstadt (Germany). He replaced Professorships at University of Cologne, and TU Chemnitz, Germany. At the Institute of Applied Mathematics, Middle East Technical University (METU), Ankara, Turkey, he was a Professor in Financial Mathematics and Scientific Computing, and Assistant to the Director, where he was also a member of five graduate schools, institutes and departments.

G.-W. Weber has affiliations with: University of Siegen (Germany), Federation University (Ballarat, Australia), University of Aveiro (Portugal), University of North Sumatra (Medan, Indonesia), Malaysia University of Technology, Chinese University of Hong Kong, KTO Karatay University (Konya, Turkey), Vidyasagar University (Midnapore, India), Mazandaran University of Science and Technology (Babol, Iran), Istinye University (Istanbul, Turkey), Georgian International Academy of Sciences. Within the International Federation of OR Societies (IFORS), specifically the Association of European OR Societies (EURO) he is Advisor to EURO Conferences. He is also a member of many national OR societies, honorary chair and past chair of some EURO working groups, section editor of the IFORS Newsletter, and member of IFORS Developing Countries Committee, Working Committee of Pacific Optimization Research Activity Group, as well as the International Activities Committee of INFORMS among others. G.-W. Weber is an IFORS Fellow.

G.-W. Weber has supervised many MSc. and PhD. students, authored and edited numerous books and articles, and given many presentations of theory, methods and practice of diverse areas. He was a member of many international editorial, special issue and award boards, participated in numerous research projects, and received various awards from students, universities, conferences and scientific organizations.

November 11, Friday

1030 - -1130

## Reengaging and Reenergizing your Students *and their Instructor* through Active Learning in the Modern Operations Research Classroom!

### ABSTRACT

We in the operations research community understand that Analytics (and specifically OR and Statistics) are inherently interesting, relevant, important, and enjoyable disciplines - unfortunately many of our students (particularly those in introductory Analytics courses) don't seem to share this understanding with us! So how do Analytics instructors help students appreciate that Analytics is interesting *and* relevant *and* important *and* enjoyable? Professor Cochran discusses several classroom cases and active learning exercises he has developed and regularly uses to accomplish this goal when teaching introductory Analytics courses.

Throughout this session Professor Cochran will emphasize his points with live demonstrations and discussions of several interesting and novel active learning exercises and cases. Card tricks, classroom versions of television game shows, and an exercise that utilizes children's toys will be featured. Because many of these exercises are easily transferable across topics, instructor/classroom styles, cultures, national borders, institutions, faculties, programs, and class sizes, it is very likely you will walk away from this session with ideas on how to improve your own teaching (indeed, Professor Cochran will be very disappointed if you don't!). Be prepared – audience participation is an integral part of this session, and Professor Cochran may call on *you* during the session!

***James J. Cochran***

*SPEAKER*



**James J. Cochran** is Professor of Statistics, the Rogers-Spivey Research Fellow, and Associate Dean for Faculty & Research with the University of Alabama's Culverhouse College of Business. He is also a Research Associate with the Alabama Transportation Institute. He has been a Visiting Scholar with Stanford University, the University of South Africa, the Universidad de Talca, Pôle Universitaire Léonard De Vinci, the University of Limpopo, and the University of Namibia. He holds honorary faculty appointments with the University of KwaZulu Natal and the University of Limpopo.

Dr. Cochran's research focuses on problems at the interface of statistics and operations research, and he has taught a wide range of statistics and

operations courses from the introductory undergraduate level through PhD seminars. He has published seventeen book chapters, over fifty research articles, and almost 100 other articles. He is coauthor of eight textbooks in statistics, operations research, analytics, and data visualization. He has served on the editorial boards for eighteen journals and as Editor-in-Chief of *INFORMS Transactions on Education* from 2007-2012.

Dr. Cochran is the founding Editor-in-Chief of the *Wiley Encyclopedia of Operations Research and the Management Sciences*, *Wiley Series in Operations Research and Management Science*, *Oxford Anthology of Statistics in Sports* series, and *INFORMS Analytics Body of Knowledge*. He has served as a consultant to a wide variety of corporations, government agencies, and not-for-profit organizations around the world.

Dr. Cochran established an international teaching effectiveness colloquium series and has organized these events in Uruguay, South Africa, Colombia, India, Tanzania, Argentina, Kenya, Nepal, Cameroon, Croatia, Cuba, Estonia, Fiji, Mongolia, Moldova, Bulgaria, Tunisia, Grenada, and Sri Lanka. He was a founding co-chair of Statistics without Borders and a founding committee member for the INFORMS Pro Bono Analytics initiative. He has delivered keynote addresses to conferences in twenty-seven nations.

Dr. Cochran has received the INFORMS Prize for the Teaching of OR/MS Practice, Mu Sigma Rho Statistical Education Award, Waller Distinguished Teaching Career Award, and Karl E. Peace Award for outstanding statistical contributions for the betterment of society. He is a two-time finalist for the Innovative Applications in Analytics Award. He is also a Fellow of both the American Statistical Association and INFORMS, and he has received both the American Statistical Association's Founders Award and the INFORMS President's Award.

November 11, Friday

1130- 1230

## **Blockbuster Shrinkage of Multiobjective ESG Portfolios Using Explainable AI for Asset Return Prediction**

### **ABSTRACT**

This talk focuses on the environmental, social, and governance (ESG) framework necessitated by the United Nation's sustainable development goals (SDGs) to create investment value. The ESG movement has grown from a simple social responsibility initiative launched by the UN in 2015 to a global phenomenon representing almost US\$30 trillion in asset management. We are now in what is called

the fifth industrial revolution (5IR), which is brought about new digitalization geared toward building a better society by delivering service to humanity.

Universally, portfolio managers and individual investors are now in quest of explainable AI (XAI) to improve the trust in the predictive performance of time-varying asset returns. The search for performance-enhanced specifications of asset returns is driven by asset managers seeking efficient portfolios defined by multiple and hierarchical goals (i.e., ESG prioritization). Fund managers who ex-ante seek to construct a market-neutral portfolio under the complexities of layered behavioral constraints may identify ex-post that the portfolio still possesses a significant exposure to the market, ESG, and other systematic risk factors. We summarize extant literature that finds established asset return estimation techniques fail to produce asset return estimates that contribute to delineating ESG market-neutral portfolios. More generally, the paper presents a novel approach to optimizing the behavioral portfolio management model in the presence of investor biases for ESG sustainability, loss aversion, and cognitive dissonance.

We extend the factor pricing literature by implementing a factor extraction protocol to identify three unique and pervasive ESG factors. After examining the factors' interconnectedness, machine learning methods are applied to a production-theoretic six-factor Fama and French model to predict individual asset returns. Enumeration of efficient asset allocations modified by a Blockbuster shrinkage estimator. The optimal allocations are obtained by solving a hierarchical multiobjective portfolio optimization model. Simulation results from solving alternate specifications of the layered goal ESG-driven model corroborate and extend emergent research on portfolio sustainability, network theory, and the interconnectedness of financial returns.

Additionally, we provide results to amplify the existence of a hump-shaped ESG efficiency frontier. The results provide new information about the trade-offs for resolving cognitive dissonance when investors are conflicted between holding 'green' versus 'brown' asset diversification plans.

The research was jointly conducted with Nina Kajiji from the University of Rhode Island and The NKD Group, Inc. USA.

***Gordon H. Dash***

SPEAKER

**Dr. Gordon H. Dash** joined the faculty of the College of Business (COB) in 1974. As a Full Professor, he holds appointments in Finance & Decision Sciences and the Interdisciplinary Neuroscience Program. He completed his undergraduate degree in business administration at Coe College (1968). He earned a master's and two-field Doctorate in Finance and Operational Research from the University of Colorado at Boulder (1978).



Dr. Dash has ongoing research projects that link traditional optimization

algorithms to neural network algorithms for classification and prediction. His research emphasizes the development of algorithmic extensions in combinatorial optimization and radial basis function neural networks. Using newly developed algorithms, Dr. Dash has produced a current research strain that spans topics such as the neuroeconomics of SMART cities, ethical AI and the determinants of chronic disease states (neuroethics), and sustainability in multiobjective behavioral portfolio optimization.

Dr. Dash's research is published in journals that target portfolio optimization and management, multi-objective optimization, complex decision analytics, energy management, and more. Research service includes serving as an associate editor for the International Journal of Applied Optimization Studies and co-chair of the European Working Group for Operational Research on Development ([EWG-ORD](#)). Since 2018 the annual EWG-ORD international meeting format has promoted the dissemination of recent research findings on the integration of operational research and the United Nation's seventeen sustainable development goals. Dr. Dash's research has been presented globally in over thirty countries spanning the continents of Europe, Africa, and Asia.

Besides contributing several book chapters to books in financial engineering, Professor Dash is the co-author of two e-books. His book on derivatives market valuation is titled "*Applied Risk Management: Valuation of Derivatives under AI and Data Science Technologies*" ([www.ARM DAT.com](http://www.ARM DAT.com)). The twenty-two-chapter text features valuation applications that draw upon his state-of-the-art algorithmic tools. His investment and portfolio management textbook is titled "*AI and Data Science in Applied Security and Investment Management*" ([www.aisimbook.online](http://www.aisimbook.online)). The textbook includes new valuation analytics to incorporate the latest in portfolio optimization and the use of neural networks to model key prediction targets such as corporate earnings.

Dr. Dash is a member RiskGroupAuth (Greece), an interdisciplinary research group (think-tank) specializing in developing risk assessment and management tools for modern energy systems. He remains a member in good standing of several honorary societies, including Beta Gamma Sigma, Phi Kappa Phi, and Delta Sigma Pi.

# *Closing Ceremonies*

## *Guest Speaker*

November 12, Saturday

1635 – 1640



**Fortunato T. de la Peña**  
*Secretary, Department of  
Science & Technology  
(2016-2022)*

The Honorable Fortunato T. de la Peña started his professional career at the then ESSO Standard Eastern as a cost and operations engineer in 1969 after graduating with a BS Chemical Engineering degree from the University of the Philippines (UP) that year. He then took up graduate studies in Industrial Engineering at the same university and earned an MS degree in Industrial Engineering. He joined the UP College of Engineering faculty as an Instructor in 1973 and rose to become Full Professor in 1988. He served UP in various capacities: as Chairman of the Department of Industrial Engineering & Operations Research, as Assistant to the Executive Director of the National Engineering Center, as Director of the Institute for Small Scale Industries, and as System Vice President for Planning & Development.

He was seconded to the National Science & Technology Authority (NSTA) which later became the Department of Science & Technology (DOST) three times: as Head of its Planning Service, as Director of its Technology Application & Promotion Institute and as Undersecretary for Scientific & Technical Services after which he retired in 2014. In 2016, he was appointed DOST Secretary. He led a number of professional organizations as its President. These are the Philippine Institute of Chemical Engineers, the Association of Management & Industrial Engineers of the Philippines, the National Research Council of the Philippines and the Philippine Association for the Advancement of Science & Technology. He also served as Chair of the UN Commission on Science & Technology for Development. He is also an ASEAN Engineer since 2013.

The awards he received include the Dangal ng Bayan Award from the Civil Service Commission, the Outstanding Career Executive Officer Award from the Career Executive Service Board, the Outstanding Professional Award from the Professional Regulations Commission, the UP Alumni Association Award for Public Service and the UP Alumni Engineers Most Distinguished Alumnus Award. In 2015, he was conferred the Doctor of Philosophy honoris causa by the Rizal Technology University, and in 2018 the Doctor of Laws honoris causa by the University of the Philippines. He taught in the Department of Industrial Engineering and Operations Research of the University of the Philippines Diliman for 43 years from 1973 to 2016.

# Parallel Sessions

## Schedule and Venue

Thursday, November 10

Session	Track	A	B
	<i>Venue</i>	<i>Room A</i>	<i>Room B</i>
1	1330-1430	COVID-19 Analytics	Supply Chain Planning and Marketing/Retail
	1430-1440	<i>Break</i>	
2	1440-1540	Public Health and Disease Control	Scheduling
	1540-1600	<i>Coffee Break</i>	
3	1600-1700	Marketing and Finance	Network Optimization

Friday, November 11

Session	Track	A	B
	<i>Venue</i>	<i>Room A</i>	<i>Room B</i>
4	1330-1430	Local Governance and Emergency Response	Inventory Management
5	1430-1530	Transportation: Freight and Fleet Management	Mathematical Modeling
	1530-1550	<i>Coffee Break</i>	
6	1550-1650	COVID-19 Response and Recovery	Analytics and Machine Learning

## Saturday, November 12

Session	Track	A	B
	<i>Venue</i>	<i>Room A</i>	<i>Room B</i>
7	0800-0900	Healthcare and Industry Management through New Normal Times	Finance and E-Commerce
	0900-0905	<i>Break</i>	
	0905-0925	Open Source Software Evolution: A Machine Learning Centric Approach	
8	0925-1025	National Contributions 1	
	1025-1045	<i>Coffee Break</i>	
9	1045-1145	National Contributions 2	
	1145-1245	<i>Lunch Break</i>	
10	1245-1345	National Contributions 3	
11	1345-1445	Youth Forum 1	
	1445-1505	<i>Coffee Break</i>	
12	1505-1625	Youth Forum 2	

# Parallel Sessions

Schedule, Venues, and Authors

Thursday, November 10

Session	Track	A	B
	Venue	Room A	Room B
1	1330-1430	<p><b>COVID-19 Analytics</b></p> <p><b>Epidemiology of COVID-19 Pandemic in Kerala, India, 2021-22: A Cross-Sectional Study</b> <i>Ajan Maheswaran Jaya</i></p> <p><b>A Framework of COVID-19 Transmission and Outbreak in the Workplace*</b> <i>Angelo Marasigan, Azra May Kabiri, Diane Carmeliza Cuaresma, Edd Francis Felix, Eleanor Gemida, Jomar Rabajante, Jonathan Mamplata, and Kyrell Vann Verano</i></p> <p><b>A Descriptive Analytics Study on Mass COVID-19 Testing Data for a Philippine Conglomerate</b> <i>Paolo Raphael Piedad and Andrei Triz Patupat</i></p>	<p><b>Supply Chain Planning and Marketing/Retail</b></p> <p><b>A Scenario-based Blending Optimization Digital Tool for Supply Chain Planning</b> <i>Anthony Mark Chan, Si-Yuan Zou, Kabir Soeny, and Alexander Hipolito</i></p> <p><b>A Supply Chain Collaboration Framework for the Promotion of Imperfect Produce and the Reduction of Food Loss*</b> <i>Boualem Rabta, Zsuzsanna Hauck, and Gerald Reiner</i></p> <p><b>Application of a Deep Learning-Decision Tree Model for Store Classification</b> <i>Ralph Villa</i></p>
		1430-1440	Break
2	1440-1540	<p><b>Public Health and Disease Control</b></p> <p><b>Sentinel Influenza surveillance among SARI / ILI cases in a Tertiary Care Hospital in Karnataka, India during 2021</b> <i>Anup Jayaram, Anitha Jagadesh, Prasad Varamballi, Ujwal Shetty, Naren Babu, Desmond Cardosa, and Chiranjay Mukhopadhyay</i></p>	<p><b>Scheduling</b></p> <p><b>A Study on Daily Shift Scheduling in Multi-task Call Centers</b> <i>Xiaodong Liu, Hanlin Liu, Cheng Li, and Yu Song</i></p>

\*Online presentation

		<p><b>Healthcare Associated Infectious Disease Control using Person-to-Person Contact Network*</b> <i>Yong-Hong Kuo, Chun-Hung Cheng, and Ziye Zhou</i></p> <p><b>A Multi-objective Optimization Model for Sustainable Outpatient Care Delivery and Service Fairness</b> <i>Soumyajyoti Datta, Rohit Kapoor, and Peeyush Mehta</i></p>	<p><b>An Implicit Modeling for Multi-task Call Center Shift Scheduling</b> <i>Hanlin Liu, Xiaodong Liu, Cheng Li, and Yu Song</i></p> <p><b>A Hybrid Heuristic Algorithm for the Resource Constrained Project Scheduling Problem</b> <i>Dean Ashton Plamenco, Justine Loi Domingo, Viq Ashley Alentajan, and Fernando Germar</i></p>
	1540-1600	Coffee Break	
3	1600-1700	<p style="text-align: center;"><b>Marketing and Finance</b></p> <p><b>The Interactions Among Corporate Sustainability, Investment, and Capital Structure</b> <i>Michi Nishihara</i></p> <p><b>A Comparison of Single-Feature and Multi-Feature Analysis for Stock Market Based on LSTM Model</b> <i>Cheng Li and Yu Song</i></p> <p><b>Optimized Web Scraping using NLP for Marketplace Websites</b> <i>Michael Brian Manuel, Ryhle Nodnylson Guinto, and Nathan Salud</i></p>	<p style="text-align: center;"><b>Network Optimization</b></p> <p><b>The Restricted Inverse Optimal Value Problem on Shortest Path under <math>l_1</math> Norm on Trees*</b> <i>Qiao Zhang and Xiucui Guan</i></p> <p><b>Combined Mixed Integer and Heuristic Approach to Public Transport Network Design*</b> <i>Joshua Rosentreter</i></p> <p><b>Spreadsheet Modelling for Supply Chain Route Planning</b> <i>Sanjay Choudhari</i></p>

### Friday, November 11

Session	Track	A	B
	<i>Venue</i>	<i>Room A</i>	<i>Room B</i>
4	1330-1430	<p><b>Local Governance and Emergency Response</b></p> <p><b>Performance of an Emergency Road Ambulance Service in Bhutan: Response Time, Utilization and Outcomes</b> <i>Tshokey Tshokey, Ugyen Tshering, Karma Lhazeen, Arpine</i></p>	<p><b>Inventory Management</b></p> <p><b>Economic Order Quantity with Supply Uncertainty</b> <i>Thomas Weber</i></p>

\*Online presentation

		<p><i>Abrahamyan, Collins Timire, Bikash Gurung, Devi Charan Subedi, Kencho Wangdi, Victor Del Rio Vilas, and Rony Zacharia</i></p> <p><b>Development of Resource Prepositioning Dashboard for Philippine Typhoon Emergencies*</b> <i>Angelo Ani, Simon Anthony Lorenzo, and Franz Christian Velasco</i></p> <p><b>Efficiency of Local Government Units in Northwestern Philippines as to the Attainment of the Sustainable Development Goals</b> <i>Milagros Baldemor</i></p>	<p><b>Multi-item Joint Replenishment Problem with Minimum Order Quantity Requirement*</b> <i>Jing Jiao</i></p> <p><b>Maximizing Gross Margin with a Bill of Materials (BOM) Strategy of a Simulated Muesli Company</b> <i>Edwin J. Loma and Danilo S. Mante</i></p>
5	1430-1530	<p><b>Transportation: Freight and Fleet Management</b></p> <p><b>Two Ethical Requirements for the Social Acceptance of Intelligent Vehicle Applications*</b> <i>Martin Aleksandrov</i></p> <p><b>Sexual Harassment Prevention in Taxi Allocations under Gender Preferences*</b> <i>Martin Aleksandrov and Tobias Labarta</i></p> <p><b>Optimize the Idle Freight for Flat Products Via Rail Network: Case Study in Steel Industry</b> <i>Pragya Bajpai and Rashmi Singh</i></p>	<p><b>Mathematical Modeling</b></p> <p><b>Equilibrium Markov Supernetworks*</b> <i>Jing Fu, Frank Page, and Myrna Wooders</i></p> <p><b>Profit Maximizing Integer Multicommodity Flow Problem*</b> <i>Shuvabrata Chakraborty</i></p> <p><b>Domination analysis of approximation algorithms for QUBO</b> <i>Abraham Punnen</i></p>
	1530-1550	Coffee Break	
6	1550-1650	<p><b>COVID-19 Response and Recovery</b></p> <p><b>Assessing PCR Laboratory Testing Scale Up in Nepal: An Analysis Based on COVID-19 Response*</b> <i>Hannah Bakker, Nadia Lahrichi, Govindakarnavar Arunkumar, Joaquim Gromicho, Krishnan</i></p>	<p><b>Analytics and Machine Learning</b></p> <p><b>What Consumers Say Affects Review Usefulness: Analysis using Topic Modeling and Sentiment Analysis*</b> <i>So Young Jun and Jong Woo Kim</i></p>

\*Online presentation

		<p><i>Parvathy, Fannie Côté and Victor Del Rio Vilas</i></p> <p><b>Optimal Allocation of Vaccines in Different Regions in the Philippines*</b> <i>Rodney Pino, Renier Mendoza, Erika Antonette Enriquez, Victoria May Mendoza, and Arriane Crystal Velasco</i></p> <p><b>COVID-19 and its Effects on the Supply Chains in the Philippines (A Systems Dynamics Perspective)*</b> <i>Vicente P. Reventar III</i></p>	<p><b>Movement Analytics and Optimisation*</b> <i>Reena Kapoor, Simon Dunstall, Rahman Ashfaqur, Peter Baumgartner, and Elena Tartaglia</i></p> <p><b>Implementation of Deep Learning to Classify Websites</b> <i>Ryhle Nodnylson Guinto</i></p>
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**Saturday, November 12**

Session	Track	A	B
	<i>Venue</i>	<i>Room A</i>	<i>Room B</i>
7	0800-0900	<p><b>Healthcare and Industry Management through New Normal Times</b></p> <p><b>Impact of ESG Management Activities to Corporate Performance in a Healthcare Industry*</b> <i>Peng Wang and Chang Won Lee</i></p> <p><b>Revenue Management During Post-COVID-19 Recovery Times*</b> <i>Vinaysingh Chawan</i></p> <p><b>Analytics for Generating Insight from Indoor Tracking Data in Manufacturing*</b> <i>Ashfaqur Rahman, Md Mashud Rana, and Daniel Smith</i></p>	<p><b>Finance and E-Commerce</b></p> <p><b>Building Micro-Fulfillment Center Networks in Metro Manila: Evaluation of Gas Retail Networks as Host Sites*</b> <i>Rowell Castro and Simon Anthony Lorenzo</i></p> <p><b>Active versus Passive Portfolio Management: A Comprehensive Study on Indian Mutual Fund Industry*</b> <i>Hariprasad B and Sony Thomas</i></p> <p><b>Application of Equilibrium Conditions of the n-Player Weightlifting Game to Micro-credit Insurance*</b> <i>Diane Carmeliza Cuaresma, Maica Krizna Gavina, Jomar Rabajante, Jerrold Tubay, Jin Yoshimura, Hiromu Ito, Takuya Okabe, and Satoru Morita</i></p>

\*Online presentation

	0900-0905	Break
	0905-0925	<p align="center"><b>Invited Paper on Machine Learning</b></p> <p align="center"><b>Open Source Software Evolution: A Machine Learning Centric Approach</b> <i>V. B. Singh</i></p>
8	0925-1025	<p align="center"><b>National Contributions 1</b></p> <p><b>Operations Research and Data Science for Hospital Emergency Department Operations*</b> <i>Yong-Hong Kuo, Jamal Nasir, Janny Leung, and Colin A. Graham</i> <i>Hong Kong</i></p> <p><b>Forecasting Dengue Cases and Deaths for Five Years in Kathmandu Valley, Nepal*</b> <i>Shital Bhandary and Govinda Tamang</i> <i>Nepal</i></p> <p><b>Utilizing Forecasts on Pandemic Restrictions and Infection Trends in the Optimization of Supply Chain Networks*</b> <i>Fernando Antonio, Juan Atayde, Martin Yamzon, and Charlle Sy</i> <i>Philippines</i></p>
	1025-1045	Coffee Break
9	1045-1145	<p align="center"><b>National Contributions 2</b></p> <p><b>Tripartite Evolutionary Game Model for Public Health Emergencies*</b> <i>Zhiqi Xu, Yukun Cheng, and Shuangliang Yao</i> <i>China</i></p> <p><b>Optimal Investment Using the Baltic Dry Index and Interest rates in 12 Industrialized countries*</b> <i>Jihye Yang, Soonbong Lee, and Seongmoon Kim</i> <i>South Korea</i></p> <p><b>Systematic Study of Operations Research Methods in Long-Term Mine Planning*</b> <i>Nurul Asyikeen Binte Azhar, Aldy Gunawan, Shih-Fen Cheng, and Erwin Leonardi</i> <i>Singapore</i></p>
	1145-1245	Lunch Break
10	1245-1345	<p align="center"><b>National Contributions 3</b></p> <p><b>A Superlinearly Convergent Exact Penalty Method for Constrained Optimization*</b> <i>Nezam Mahdavi-Amiri and Hani Ahmadzadeh</i> <i>Iran</i></p>

\*Online presentation

		<p><b>Multi Objective Energy Efficient Street Lighting: AMOSA based Framework*</b> <i>Pragna Labani-Sikdar, Samarjit Kar, and Parag Guhathakurta</i> India</p> <p><b>Optimization Model for the Line Planning Problem of the Urban Transit Bus Route Network Design*</b> <i>Adibah Shuib, Siti Nur Liyana Amiruddin, and Zuraida Alwadood</i> Malaysia</p>
11	1345-1445	<p style="text-align: center;"><b>Youth Forum 1</b></p> <p><b>Optimizing Healthcare Logistics and Mobility for Non-emergency Patients*</b> <i>Jamal Abdul Nasir and Yong-Hong Kuo</i> Hong Kong</p> <p><b>Review And Gap Analysis On Mathematical Programming Models For Urban E-Grocery Delivery Before, During And After Covid-19 Pandemic*</b> <i>Adibah Shuib, Nur Hazimah Basir, and Zati Aqmar Zaharuddin</i> Malaysia</p> <p><b>Philippine Eagle Optimization Algorithm and Applications*</b> <i>Erika Antonette Enriquez, Renier Mendoza, and Arriane Crystal Velasco</i> Philippines</p>
	1445-1505	Coffee Break
12	1505-1625	<p style="text-align: center;"><b>Youth Forum 2</b></p> <p><b>Value Function Gradient Learning for Large - Scale Multistage Stochastic Programming Problems*</b> <i>Jinkyu Lee, Sanghyeon Baea, Woo Chang Kim, and Yongjae Lee</i> South Korea</p> <p><b>Value Function Based Difference-of-Convex Algorithm for Bilevel Hyperparameter Selection Problems*</b> <i>Jin Zhang</i> China</p> <p><b>Full Consistent Logarithmic Percentage Change-driven Objective Weighting (F-LOPCOW) Model: Applications in Sustainable Transportation*</b> <i>Sanjib Biswas, Aparajita Sanyal, and Samarjit Kar</i> India</p> <p><b>A Practical Approach for On-Demand Ride-Matching with Order Cancellation*</b> <i>Dongling Rong, Xinyu Sun, and Meilin Zhang</i> Singapore</p>

\*Online presentation

# Abstracts

## 1A COVID-19 Analytics

### 1 Epidemiology of COVID-19 Pandemic in Kerala, India, 2021-22: A Cross-Sectional Study *Ajan Maheswaran Jaya*

Kerala, India's southern state, reported the first case of COVID-19 in India in Thrissur district on 30 January 2020. Since then, the state has experienced a slightly different COVID-19 pandemic than the rest of India. We analyzed the COVID-19 data from daily COVID-19 bulletins and two other Kerala health information systems to understand the epidemiology and characterization of various public health interventions. This study reported on epidemiological characteristics of the COVID-19 pandemic between January 2021 and June 2022. A case patient was defined as a person with laboratory confirmation of COVID-19 irrespective of clinical signs and symptoms. We analyzed the time, place, and person distribution of confirmed COVID-19 cases. We estimated other COVID-19 indicators such as test positivity, case fatality ratio, doubling time, the trend in bed occupancy in field hospitals, hospitals for severe disease, intensive care units, and mechanical ventilation and cases per million. Around 6 million COVID-19 cases and around 70,000 COVID-19 deaths were reported during the study period. After an initial rise in cases during the first quarter of 2021, the highest number of cases were reported during May 2021, followed by a surge in cases during August and September 2021. This contrasts with India, which experienced a single peak in May 2021. Again, in January 2022, Kerala and India witnessed a sharp rise in cases during the Omicron wave globally. The demographic profile of cases aligned with the previous surge periods. Reported COVID-19 deaths were higher from May 2021 onwards, in line with case numbers. But from October 2021 till February 2022, it showed a disproportionate increase reflecting changes in definitions of COVID-19 deaths. Males showed a significantly higher case fatality than females, which increased with increasing age groups and varied between districts ( $p < 0.001$ ). Population mortality rates were also highest among those above 80 years of age (25,536 per million). Of the COVID-19 deaths, around 90% had comorbidities, with diabetes mellitus and hypertension being the commonest comorbidities (45%). Trends in bed occupancy mirrored the different phases of the pandemic. Comparing the two peaks during May 2021 and January 2022, Hospitalization rates decreased by around three times. COVID-19 vaccination initiated during January 2021 progressed well and covered 100% with the first dose and around 90% with the second dose. The monitoring system in Kerala has captured certain aspects of the pandemic, which also benefited from various IT platforms introduced during the period. The high case reporting among the Indian states and lesser mortality reflects the good performance of public health surveillance and hospital care.

\*online presentation

## 2

### **A Framework of COVID-19 Transmission and Outbreak in the Workplace\***

*Angelo Marasigan, Azra May Kabiri, Diane Carmeliza Cuaresma, Edd Francis Felix, Eleanor Gemida, Jomar Rabajante, Jonathan Mamplata, and Kyrell Vann Verano*

The Philippines, as with many other countries, was put on tight lockdown in March 2020 to curb the spread of COVID-19, and many industries were required to hold a work-from-home set-up. Some companies were allowed to revert to the face-to-face set-up several weeks later to ease the impact of the pandemic on the economy. However, without a definite cure and vaccine for the disease back then, anxiety loomed for those required to report back to the office. Thus, it has become important to assess the risk of spread of infection and disease outbreaks in a given company. While this did not help cure the disease, it was a good way to curb the spread of the disease.

In this study, an instantaneous infection rate model is constructed. This model calculates the probability that an employee will be infected in a given period of time and the expected number of infected employees during that given period. Moreover, it incorporates the risk classification of the employees (low-, medium- and high-risk) based on specific aspects such as nature of work and level of interaction with colleagues or other stakeholders. The model has three main components— average contact rate, transmission probability, and progression probability. First, an assumed average contact rate is assigned to any two interacting employees, depending on their risk classifications. Then, an infected employee can transmit the disease based on a probabilistic function of the physical distance from another employee. Last, a probabilistic function predicts if the exposed employee contracts the disease after interacting with the infected employee. The model also captures risk from external factors, which other predictors do not explain, and the observance of preventive measures, such as wearing a mask and frequently washing hands. Note that these assumptions are contextualized during the early parts of the pandemic. Hence, the analysis has not yet included recent developments such as vaccination.

This study also explores a method to calculate an outbreak threshold defined as the number of infected employees that would cause an outbreak in a company. A key to the calculation is estimating the projected number of infected individuals with inputs: population density of each floor of a company's office, the average number of interactions among employees within floors, and the nature of work. The results may be used to aid in deciding how many employees can come to work such that the probability of an outbreak is low.

## 3

### **A Descriptive Analytics Study on Mass COVID-19 Testing Data for a Philippine Conglomerate**

*Paolo Raphael Piedad and Andrei Triz Patupat*

When the COVID-19 pandemic hit in March of 2020, San Miguel Corporation was challenged to continue producing essential goods while ensuring the health and safety of its employees. And so, the corporation established a COVID-19 Testing Laboratory and mandatory testing policies for its employees. Data from the mass testing effort was used for a descriptive analysis to guide management decision-making. Analyses included were a time series model comparison between the company testing results and the Philippine government testing results, testing positivity rate analysis using gender, age group, business unit, role, and provincial location.

\*online presentation

**1**

**A Scenario-based Blending Optimization Digital Tool for Supply Chain Planning**

*Anthony Mark Chan, Si-Yuan Zou, Kabir Soeny, and Alexander Hipolito*

FMCG company (FMCGCo) is a leading global fast-moving consumer goods manufacturer. Pandemic era challenges revealed some issues with their current planning processes and the need for more agile and responsive decision-making. A key area of opportunity involved improving the quality and consistency of finished goods with more optimal decisions on how to combine raw materials, which vary in quality and costs over time. FMCGCo's legacy tool and processes had historically been used to recommend blends that would meet quality requirements. However, performance issues and increases in complexity made the legacy solution unfit for future use.

The paper describes a custom-built digital tool to replace FMCGCo's legacy system. The new tool enhances a classical blending optimization model --- recommending recipes based on measures of raw material quality and quantity to produce finished goods with the required qualifications at minimum cost --- with supply chain planning considerations to generate weekly procurement plans for raw materials, allocation and distribution plans from raw material storage to production plants, and production plans using optimal recipes based on on-hand inventory and expected receipts. At the same time, the mathematical programming model balances operational considerations on demand fulfillment (on-time versus late), inventory targets, and potential finished goods quality adjustments. Finally, a scenario-based optimization approach driven by user-defined changes on finished goods demand and raw material costs and availability creates better usability, agility, and responsiveness.

The digital tool was developed using the Python scripting language and leveraged both an open source modeling language (Pulp) and a commercial LP solver (Gurobi). The built-in scenario capability generated more meaningful reports and provided insights that lead to cost improvement opportunities (through shadow price results) and empowered users to take more ownership of the results. The digital tool has become a critical component of FMCGCo's tactical and operational planning processes (weekly raw material procurement, raw material allocations and transfers, and blend formulation plans) as it allows the company to be more cost-efficient and more agile and responsive to changes in supply and demand, creating significant bottom-line impact.

**2**

**A Supply Chain Collaboration Framework for the Promotion of Imperfect Produce and the Reduction of Food Loss**

*Boualem Rabta, Zsuzsanna Hauck, and Gerald Reiner*

According to previous studies, large quantities of agricultural production are discarded from the supply chain while perfectly edible because of cosmetic requirements including color, blemish, shape, or size. Products in this category are referred to as ugly, sub-optimal, or imperfect produce. Many ideas to reduce food loss have been proposed and increase the salvage value of discarded products. For instance, utilizing unharvested produce to supply food assistance programs, marketing produce that is cosmetically imperfect, and utilizing secondary markets to make products such as juice, dried produce, or ingredients for processed products. In this regard, the collaboration between supply chain partners and related industries is required. It is also important to understand the consumer's behavior in terms of purchase intentions and willingness

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to pay for imperfect products. This information facilitates the decision-making process at different stages of the food supply chain.

In this work, we propose a framework for supply chain collaboration for food loss reduction with a focus on keeping imperfect food in the supply chain. First, we conduct a structured literature review to identify the “correct” drivers that influence consumer purchase intentions of imperfect products. Second, we build mathematical models for the food supply chain under different collaboration schemes where demand is dependent on the consumer’s perception of quality. We provide analytical solutions and simulation results.

The results provide incentives for companies to adopt collaboration as well as for policymakers to adopt the regulations in this regard. It is shown that collaboration maximizes supply chain profit while it contributes to food loss reduction as well. However, the impact of consumer behavior is considerable and therefore, must be well understood.

### 3 Application of a Deep Learning-Decision Tree Model for Store Classification

*Ralph Villa*

A multi-modal approach consisting of deep learning and conventional machine learning was developed to solve the problem of classifying retail stores based on their store type. Store images were first classified using a convolutional neural network (CNN) classifier. Tabular data containing the stores’ product inventories was concurrently used to train a decision tree model. The predictions from both the CNN classifier and decision tree model were then combined to create a tabular decision support system.

## 2A Public Health and Disease Control

### 1 Sentinel Influenza Surveillance among SARI / ILI Cases in a Tertiary Care Hospital in Karnataka, India during 2021

*Anup Jayaram, Anitha Jagadesh, Prasad Varamballi, Ujwal Shetty, Naren Babu, Desmond Cardosa, and Chiranjay Mukhopadhyay*

Influenza virus is a moving target causing severe illness in approximately 3-5 million cases and 250,000 to 500,000 deaths annually in the world. Though India has an Influenza surveillance programme, data generated is scanty and mostly urban based. Here we describe the findings from a routine influenza surveillance carried out in a tertiary level hospital in south India. Kasturba Medical College, hospital Manipal is a 2000 bedded hospital which attracts referred patients from neighboring states such as Kerala and Goa in addition to patients from various districts of Karnataka. All the cases satisfying SARI/ILI case definition were included for this analysis. The throat/ nasal swabs collected from SARI/ILI cases were tested for Influenza viruses A(H1N1) pdm09 and Influenza A(H3N2) and Influenza B using Real Time PCR. Data was analysed on demographic characteristics and seasonality. From January 2021 through December 2021, we have tested 562 SARI/ILI cases. Of that 159 (28.3%) tested positive for Influenza Viruses. While 89 (55.9%) were positive for Influenza A(H1N1) pdm09, 32 (20.1%) were Influenza A(H3N2) and 38 (23.9%) Influenza B virus. The median age and the inter-quartile range was 33 (20-63.5), with little variation among the three viruses. 80 (50.3%) were females. Their clinical spectrum included cough (92.5%), fever (54.7%), sore throat (52.8%), breathlessness (47.2%), coryza (33.3%), myalgia (27%), vomiting (13.8%), and diarrhea (5.7%). The year 2021 coincided with second wave of covid-19 in India. There was a major reduction in samples tested

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for Influenza during January to August. Towards the last quarter of the year covid-19 activity had subsided and Influenza A(H1N1) pdm09 activity was at its peak with November month reporting maximum cases. However, activity of Influenza A(H3N2) peaked in varied months of September to December. The Influenza B virus was predominant during September to December with October month reporting maximum cases. This study documents that influenza is prevalent throughout the year.

## **Healthcare Associated Infectious Disease Control using Person-to-Person Contact Network\***

2

*Yong-Hong Kuo, Chun-Hung Cheng, and Ziyue Zhou*

Our research is motivated by the rapidly evolving outbreaks of rare and fatal infectious diseases, for example, COVID-19 and severe acute respiratory syndrome (SARS). This presentation will be based on two of our studies on this topic.

In many of the infectious disease outbreaks, main transmission routes were healthcare facility-associated and through person-to-person contact. While a majority of existing work on modelling of the spread of infectious diseases focuses on transmission processes at a community level, we propose a new methodology to model the outbreaks of healthcare-associated infections (HAIs), which must be considered at an individual level. Our work also contributes to a novel aspect of integrating real-time positioning technologies into the tracking and modelling framework for effective HAI outbreak control and prompt responses. Our proposed solution methodology is developed based on three key components – time-varying contact network construction, individual-level transmission tracking and HAI parameter estimation – and aims to identify the hidden health state of each patient and worker within the healthcare facility. We conduct experiments with a four-month human tracking data set collected in a hospital, which bore a big nosocomial outbreak of the 2003 SARS in Hong Kong. The evaluation results demonstrate that our framework outperforms existing epidemic models for characterizing macro-level phenomena such as the number of infected people and epidemic threshold.

An effective approach to containing epidemic outbreaks (e.g., COVID-19) is targeted immunization, which involves identifying "super spreaders" who play a key role in spreading disease over human contact networks. The ultimate goal of targeted immunization and other disease control strategies is to minimize the impact of outbreaks. It shares similarity with the famous influence maximization problem studied in the field of social network analysis, whose objective is to identify a group of influential individuals to maximize the influence spread over social networks. This study aims to establish the equivalence of the two problems and develop an effective methodology for targeted immunization through the use of influence maximization.

## **A Multi-objective Optimization Model for Sustainable Outpatient Care Delivery and Service Fairness**

3

*Soumyajyoti Datta, Rohit Kapoor, and Peeyush Mehta*

Outpatient care delivery is one of the key revenue sources of a hospital which plays a salient role in timely care delivery. The key purpose of the study is to propose a multi-objective simulation-based decision support model that considers the cost of care delivery and patient dissatisfaction as its two key conflicting objectives. Patient dissatisfaction considers service fairness. Patient idiosyncrasies such as no-show, unpunctuality and balking have been considered in the model involving multiple classes of patients.

Data have been collected from field investigations and queuing theory has been used. In the first stage, discrete event simulation and genetic algorithm have been used to solve the scalarized problem and obtain

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actionable insights. Additionally, non-dominated sorting genetic algorithm (NSGA-II) has been involved to achieve the Pareto-optimal fronts considering equal priority of the two objectives.

Given the various complexities involved in the outpatient care delivery, numerical experiments have been performed to help hospital administrators, patients, doctors, and clinic organizers gain insights in tactical decision making.

The study is one of the early works that helps to improve the care delivery process by taking into consideration the environmental factors as well as service fairness. The study demonstrates the usage of simulation-based multi-objective optimization to provide a more sustainable patient centric care delivery.

## 2B Scheduling

1

### A Study on Daily Shift Scheduling in Multi-task Call Centers

*Xiaodong Liu, Hanlin Liu, Cheng Li, and Yu Song*

Staff scheduling problem in call centers is very important, since effective staffing can not only improve work efficiency, but also reduce costs, and provide sufficient service for customers. In this research, we deal with the daily shift scheduling (rostering) problem in call centers with multiple tasks. It is known that the set covering model can be applied to obtain the optimal solution for this kind of problems. However, the size of the model increases explosively as the numbers of staff, shifts, and tasks increase, because it requires to enumerate all combinations of shifts and tasks.

This study aims to propose some effective heuristic algorithms reduce the number of combinations, and obtain the optimal solution or sub-optimal solution effectively.

2

### An Implicit Modeling for Multi-task Call Center Shift Scheduling

*Hanlin Liu, Xiaodong Liu, Cheng Li, and Yu Song*

An effective shift scheduling system can greatly reduce the waste of human and material resources, make the operation of enterprises more efficient, and also give people great convenience. This research studies the multi-task daily shift scheduling problem in call centers. The traditional set covering model is widely used to solve such problems, but in practice, the increase in the size of model reduces computational efficiency and may even be impossible to solve with current technology.

In this study, we propose an implicit modeling to obtain the daily shift schedule and numerically test the efficiency of the proposed model.

3

### A Hybrid Heuristic Algorithm for the Resource Constrained Project Scheduling Problem

*Dean Ashton Plamenco, Justine Loi Domingo, Viq Ashley Alentajan, and Fernando Germar*

The critical path method and project evaluation and review technique are incapable of considering the resource constraints in a project where resources are limited. In this study, discrete-time model is used to

formulate the resource constrained project scheduling problem (RCPSp) and a hybrid heuristic algorithm is developed to solve the RCPSp. Combinations of priority and resource loading rules were used to generate the activity lists while a hybrid implementation of genetic algorithm and simulated annealing genetic algorithm were used to search for the optimal schedule. Using cases experiments, the results of the performance analysis showed that the model could obtain high-quality and near-optimal solutions for the RCPSp within a relatively short amount of time.

## 3A *Marketing and Finance*

### 1 **The Interactions Among Corporate Sustainability, Investment, and Capital Structure**

*Michi Nishihara*

This paper develops a real options model in which a firm invests in either sustainable or unsustainable project. The sustainable project requires a high investment cost and yields cash flows perpetually, while the unsustainable project requires a low investment cost and yields cash flows till a random maturity (regulation). In the model, the optimal project choice and investment timing are analytically derived. Higher regulatory risk, growth rate, and volatility increase the firm's incentive to choose the sustainable project, while higher discount rate and access to debt financing decrease the incentive. An economic downturn can cause the unsustainable project investment. A more sustainable firm has lower leverage and credit spread.

### 2 **A Comparison of Single-Feature and Multi-Feature Analysis for Stock Market Based on LSTM Model**

*Cheng Li and Yu Song*

In real life, collecting data at a long or short time is a common activity. There is a large amount of time series data in research fields such as agriculture, medical, military and finance. It is of great theoretical significance and practical application value to analyze these data in order to forecast long-term trends or perform other forms of analysis. For stock market prediction, the traditional methods include linear regression, exponential smoothing, ARIMA model, etc. In the current hot artificial intelligence, machine learning methods such as SVM, RNN and other deep learning methods can also be used for predicting stock market index.

In this study, we utilize the trading data of Nikkei 225 index and some individual stocks as data set. Based on the historical stock index, we calculate and analyze technical indicators and then establish a LSTM model to predict the future trend of stock prices. We combine historical trading data and some technical indicators as feature engineering, then adjust network structure and hyperparameters to achieve this from single-feature prediction to multi-feature prediction. Experimental results show that although RMSE does not decrease linearly with the increase of the number of features, the RMSE in the case of multiple features with long-term training data is smaller than that in the case of single feature with short training data.

### 3 **Optimized Web Scraping using NLP for Marketplace Websites**

*Michael Brian Manuel, Ryhle Nodnylson Guinto, and Nathan Salud*

Web scraping is a process of extracting large amount of data from websites, however this process may be prone to extracting data that is irrelevant to the criteria specified by the user. To address this issue, the

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group utilized a model that was trained to classify relevant or irrelevant items through Natural Language Processing (NLP). This model would be implemented together with the web scraper in order to reduce the number of irrelevant data extractions, thereby reducing the amount of storage space needed, time consumed, and odds of encountering scraping errors brought about by website security protocols.

## 3B Network Optimization

### 1 The Restricted Inverse Optimal Value Problem on Shortest Path under $l_1$ Norm on Trees\*

*Qiao Zhang and Xiucui Guan*

We consider the restricted inverse optimal value problem on shortest path under weighted  $l_1$  norm on trees (RIOVSPT1). It aims at adjusting some edge weights to minimize the total cost under weighted  $l_1$  norm on the premise that the length of the shortest root-leaf path of the tree is lower-bounded by a given value  $D$ , which is just the restriction on the length of a given root-leaf path  $P_0$ . We devise a polynomial time algorithm for the problem based on some important properties and the solutions of a series of subproblems followed by some numerical experiments to show the efficiency.

### 2 Combined Mixed Integer and Heuristic Approach to Public Transport Network Design\*

*Joshua Rosentreter*

Public transport network planners have many aspects to consider when designing a network, these include, route design, frequency setting, timetable creation, vehicle allocation and driver scheduling. In this paper, a new method is proposed that incorporates the route design problem and the frequency setting problem. This method uses a heuristic to pick the routes to use based on their perceived value, and then iteratively adds these to form a network. The routes and networks are processed and evaluated using a mixed integer programming approach. The MIP model is also novel as it discretises frequency for realism and does not calculate transfers in model to save time, these are pre-calculated. With this method and model, comparable results to existing literature have been obtained.

### 3 Spreadsheet Modelling for Supply Chain Route Planning

*Sanjay Choudhari*

We develop the spreadsheet model for automating the process of developing the routes in 36 districts for the livestock development board (LDB), a separate autonomous wing in the state of India. It helps the livestock development board (LDB) to prepare routes for the distribution of the liquid nitrogen in the supply chain given the vehicle capacity and time constraints. The key objective of this work is the uses of the vehicle routing planning (VRP) concept and demonstrating the applicability of the Operation Research (OR) model in the agriculture industry to solve the real-life problem automatically at a large scale and helps the practitioners to develop the cost-efficient supply chain.

The contribution of our work is the user-friendly spreadsheet model that helps LDB without much technical VRP model and minimum training. However, only one challenge faced by LDB as an input for the model was

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the efficient way of preparing the distance matrix. Nonetheless, LDB is now able to explore different route options within a short time which was very difficult before implementing such a model.

## 4A Local Governance and Emergency Response

### 1 Performance of an Emergency Road Ambulance Service in Bhutan: Response Time, Utilization and Outcomes

*Tshokey Tshokey, Ugyen Tshering, Karma Lhazeen, Arpine Abrahamyan, Collins Timire, Bikash Gurung, Devi Charan Subedi, Kencho Wangdi, Victor Del Rio Vilas, and Rony Zacharia*

An efficient ambulance service is a vital component of emergency medical services. In Bhutan, ambulance services can be availed by everyone free of cost and available round the clock. Although countries may have their own targets, there are no international standards for ambulance performances especially in the developing countries including Bhutan. We determined the emergency ambulance response and transport times and ambulance exit outcomes in Bhutan.

A cross-sectional study involving real-time monitoring of emergency ambulance deployments managed by a central toll free (112) hotline was carried out for three months, between 20th October 2021 to 20th January 2022. Data was collected by emergency medical responders, health staff on medical escorts and/or ambulance drivers using ambulance trip sheets.

Of the 5,092 ambulance deployments during the study period, 4291 (84%) were inter-hospital transfers and 801 (16%) were for emergencies. Of the latter, 703 (88%) were for non-pregnancy related (medical, surgical and accidents) while 98 (12%) were pregnancy related emergencies. The medians for ambulance response and patient transport times were 42 (IQR 3-271) and 41 (IQR 2-272) minutes respectively. The median round-trip distance travelled by ambulances was 18 km (range 1-186 km). For ambulance exit outcomes that were pregnancy related (n=98), 89 (91%) reached the health facility successfully, eight delivered prior to ambulance arrival at the scene or in the ambulance during transport and one had no outcome record. For the remaining 703 non-pregnancy deployments, 29 (4.1%) deployments were deemed not required or refusals and 656 (93.3%) reached the health facility successfully, 16 (2.3%) died before ambulance arrival at scene and 2 (0.3%) were not recorded.

This first countrywide real-time operational research showed acceptable ambulance exit outcomes in Bhutan. The response time was under one hour and over 90% of the deployments had favorable outcomes. This average response time may be incomparable with developed country targets but inferences are difficult without an international bench mark. Improving ambulance response and transport times might reduce morbidities and mortalities further. However, other factors such as ambulance availability, functionality and location, road conditions, temporal variations, individual health care seeking behavior and public awareness on ambulance services may influence ambulance response time significantly and need deeper assessment. Non-emergency inter-facility referral of patients accounted for 84% of all ambulance deployments. These referrals may engage much of the available ambulances making them unavailable for emergency services impacting response time. In critical situations, helicopter ambulances (limited but provided free upon fulfilling the criteria) should be utilized and awareness of the public on the procedures to avail this service is critical. Improving and widening the scope of onsite medical care through emergency medical responders may result into controlling unnecessary transfer of patients to hospitals and overcrowding at the hospital.

## 2 **Development of Resource Prepositioning Dashboard for Philippine Typhoon Emergencies\*** *Angelo Ani, Simon Anthony Lorenzo, and Franz Christian Velasco*

Being located in the Pacific Typhoon Belt, the Philippines is one of the world's most exposed countries to tropical storms. Storms are likewise cited as the most prevalent natural hazards in the country, contributing to about 55% to the total from 1970 to 2000. Appropriate preparations must be made in order to mitigate the impact of this natural disaster to the population. A decision support system, visualized meaningfully in a dashboard, can help actors in disaster preparedness to act in a timely, cost-efficient, and service-oriented manner.

In this paper, an integer linear programming model was developed to optimize last mile transportation of relief items based on various prepositioning decisions. The transportation model considers costs of transportation and penalty for non-satisfaction of requirements. Constraints were included to incorporate equity among locations. The model was implemented in one of the Philippine regions frequented by typhoons. Several relief pre-positioning strategies were tested for a variety of potential storm track forecasts. Key insights were derived from the results of model runs.

## 3 **Efficiency of Local Government Units in Northwestern Philippines as to the Attainment of the Sustainable Development Goals** *Milagros Baldemor*

This study determined the performance of the four (4) provinces and nine (9) cities in Region I or Northwestern Philippines, vis-à-vis their efficiency along the seventeen (17) Sustainable Development Goals (SDGs) for 2019-2021. It utilized the non-parametric approach Input Oriented Multi - Stage Data Envelopment Analysis (DEA) Constant Returns-to-Scale (CRS) Model in decision making units (DMUs) to evaluate and compare the efficiency of the local government units (LGUs). The local government units were considered as the DMUs. Furthermore, it determined the peer groups and weights of the LGUs with best practices, the virtual inputs/outputs or potential improvements of the DMUs to be in the efficient frontier, the input and output slacks (input excesses and output shortfalls) needed in the different indicators and the best practices to be considered by the inefficient and weak efficient DMUs. The "best practice" in the frontier is the basis to calculate the adjustments necessary for the LGUs. Different indicators showed varied performance levels of the different provinces and cities in the different years but there are best practices from the "efficient" local government units which could be adapted by the "weak efficient" and "inefficient" ones.

## **4B Inventory Management**

### 1 **Economic Order Quantity with Supply Uncertainty** *Thomas Weber*

A key reason for holding inventory is to spread a fixed ordering cost over time. This is accomplished optimally only when the weekly expense of keeping an extra item in stock is equal to the additional capital savings from allocating the ordering cost to a longer interval. This logic was formulated by Harris (1913) resulting in the "economic order quantity" (EOQ) as solution to the deterministic problem of minimizing the average

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cost of serving a constant flow of demand. The underlying dynamic optimization problem can be solved in a quasi-static manner because at the end of an order cycle, when all the initial inventory is used up, the system returns to its initial state. The renewal logic carries over to situations with (stationary) uncertainty. Indeed, shipments from suppliers may get lost resulting in a complete write-off; alternatively, they may be partially spoiled or contain defective parts (or both), so that in practice supply uncertainty may be substantial. This paper deals with such supply uncertainty under the basic premise that the distribution of on-spec deliveries “increases” (in the sense of first-order stochastic dominance) when a larger order quantity is chosen. We first introduce the “stochastic EOQ problem” aimed at determining an order quantity which minimizes long-run average cost in the presence of supply uncertainty. The solution to this problem is described using three types of elasticities, related to the sensitivities of write-offs, average on-spec deliveries, and the dispersion of these deliveries, to changes in the ordered amounts. Second, we show that the stochastic economic order quantity may well be smaller than the deterministic EOQ solution whenever average on-spec deliveries are sufficiently insensitive to changes in the order quantity, as would be the case for a supplier with capacity constraints. Third, we characterize the comparative statics for all standard parameters of the stochastic EOQ problem, including ordering cost, holding cost, input cost, and demand, and show that for all but one of them the standard monotonicity of the solution can be reversed, in addition to a generic dependence of the solution on the input cost, much unlike the deterministic EOQ solution which does not depend on the price of the ordered parts. We then turn our attention to comparing the absolute cost and show that a first-order stochastically dominant improvement of supply uncertainty may have an ambiguous impact on cost. Yet, the latter is (under mild conditions) minorized by the optimal cost in the presence of a loss-free perfect-quality supply. Finally, we discuss various applications of the model, including resilience, diversification, delivery targets, learning about performance, as well as quality testing.

## 2

### Multi-item Joint Replenishment Problem with Minimum Order Quantity Requirement\*

*Jing Jiao*

We consider a continuous review multi-item inventory system for retailer. The retailer sells multiple items from one supplier. Dual to economies of scale, the retailer faces a minimum order quantity requirement from the supplier. If the summation of the order quantities for all items meets the minimum order quantity requirement, the supplier will deliver the order to the retailer for free. Otherwise, the order cannot be delivered.

We suppose that the demand of each individual item is stochastic, with a known distribution function. The replenishment lead time is constant. Demands not covered immediately from inventory are lost. We also assume that at most one order is outstanding. The retailer faces linear inventory holding cost and linear shortage cost. Since the delivery of orders is managed by the supplier, we assume that there is no fixed cost of each order for the retailer.

We derive a closed-form expression to minimize the long-run average total cost per unit time. The minimum order quantity requirement is treated as a constraint. We propose a heuristic policy which we name as wait-and-order policy. The policy works as follows. firstly, we calculate the reorder point and the order-up-to level for each item. Secondly, we collect all the items that need to be replenished. We sum up the total order quantity for these orders. If this total order quantity meets the minimum order quantity requirement, the order is placed to the supplier. Otherwise, we wait and do the calculation again the next day.

Numerical experiments have been made according to a real commercial background. We find that, the average length of the order interval shortens if the class of items from one supplier goes higher or the demand for at least one item goes higher. At the same time, the safety inventory of each item goes lower,

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and the average inventory cost lowers, too. The reason might be that, when the class of items from one supplier goes higher or the demand for at least one item goes higher, the minimum order quantity requirement would be easier to meet. Then the order interval shortens, and the uncertainty of demands goes lower. For this reason, the retailer should order more item classes from one supplier other than many suppliers.

### 3

#### **Maximizing Gross Margin with a Bill of Materials (BOM) Strategy of a Simulated Muesli Company**

*Edwin J. Loma and Danilo S. Mante*

SAP's Manufacturing Extended simulation game is composed of four (4) rounds with 20 minutes allotted per round, where one (1) round is equivalent to 20 days. The game uses Company Valuation, a financial ratio based on total profit and company risk rate, as the measure for ranking. To increase total profit, competitors are allowed to change the Bill of Materials (BOM) of each of the twelve (12) products. The amount of the ingredients of each product may be adjusted subject to minimum weight requirements.

The company has six (6) types of products, Nut, Blueberry, Strawberry, Raisin, Original, and Mixed. Each product is packaged in two (2) sizes, a kilogram and half a kilogram. There are six (6) ingredients available, wheat, oats, nuts, raisins, blueberries, and strawberries. The twelve (12) products have initial selling prices and are used in this study. The cost of each ingredient varies every day, which is one (1) minute in the simulation game. The mean costs are computed based on past games and are used in this study.

The 72 variables (12 rows x 6 columns) were computed with four (4) sets of constraints. Excel Solver was used to arrive at a maximum average gross margin of 3.59 euros.

## **5A Transportation: Freight and Fleet Management**

### 1

#### **Two Ethical Requirements for the Social Acceptance of Intelligent Vehicle Applications\***

*Martin Aleksandrov*

In 2017, the German Ministry for Traffic and Digital Infrastructure appointed Ethics Commission to regulate automated and connected vehicle technologies. They released 100 million Euros for this purpose. In 2020, the European Institute of Innovation and Technology in Hungary released 400 million Euros to encourage society to use electric vehicles. More recently, the 2022 EU Strategy for Sustainable and Smart Mobility called for future personal mobility that involves the preferences of individuals, and the 2022 International Transport Forum called for future public transport that includes diverse societies. In our work, we respond to these efforts scientifically.

We propose an innovative research intersection of four domains: Vehicle Routing Problems, Computational Social Choice (COMSOC), Constraint Satisfaction Problems (CSPs), and Geographic Information Systems (GIS). We refer to it as Social Vehicle Routing Problems (SVRPs). SVRPs are multidisciplinary in nature. COMSOC problems can be from fair division, voting theory, or judgment aggregation. CSPs can be from scheduling, loading, or search domains. GIS problems can be from navigation, mapping, or sensing domains. The combinations of features from these problems form a variety of SVRPs.

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As an initial step, we combine the VRP with fair division and give new two-step algorithms, which first return a feasible matching between drivers and customers, and then a minimal plan for routing the vehicles through their matched locations. We give matching algorithms for achieving subjective fairness for drivers (FEF1, FEFX), objective fairness for drivers (FEQX), objective efficiency for drivers (FSWmax), as well as objective fairness and efficiency for customers (FSWmin). We also give fixed-parameter tractable routing algorithms for service fairness (maxTRAVEL) and service efficiency (totTRAVEL).

Currently, we are evaluating our algorithms in the lab. In the future, we will also evaluate them in the real world as part of the Smart City Mobility Bamberg project (<https://smartcity.bamberg.de/>), whose main goal is to promote the usefulness of autonomous vehicle stops among commuters who live further from the existing public transportation stops. We believe that fairness and efficiency can help us achieve this goal because they are identified by the European Commission as two of the critical ethical requirements for the social acceptance of future mobility applications.

## 2

### **Sexual Harassment Prevention in Taxi Allocations under Gender Preferences\***

*Martin Aleksandrov and Tobias Labarta*

According to Statista.de, in 2020, 89% of people with female gender identity and 88% of people with diverse gender identity experienced sexual harassment. Especially, at the night, a taxi ride is supposed to be the safest travel option for many passengers. Unfortunately, sexual harassment takes place even there. Thus, when even the safest travel option feels unsafe for endangered passengers, it is essential to enhance existing options with sexual harassment prevention mechanisms. In fact, there are some initial efforts in this direction.

For example, the Taxi and Limousine Commission in New York established the Office of Inclusion, where drivers and passengers can report sexual harassment. We propose to use the reports and, thus, rank drivers and passengers based on their behavior. Thus, a given driver will receive a lower rank if a greater number of claims of unwanted behavior were submitted against them. Similarly, a given passenger will receive a lower rank if a greater number of offenses were submitted against them.

In this paper, we use these sexual harassment rankings in combination with gender preferences. In particular, we extend the classical 2-sided matching setting, in which drivers have profit preferences for passengers and passengers have estimated-time-of-arrival preferences for drivers, by adding an additional layer of gender preferences to each side of the problem. This gives rise to two natural extensions of the classical Gale-Shapley (GS) matching algorithm that use the sexual harassment rankings of drivers and passengers.

The extended algorithms produce matchings that are (nearly) stable for both sides of the problem with respect to their two-layered preferences. We also conduct experiments with these algorithms. In the experiments, we collect a pool of matchings returned by these algorithms and select a matching from this pool that penalizes drivers and passengers proportionally to their ranks. Thus, a driver of a lower rank gets a lower profit from passengers and a passenger of a lower rank waits longer for a driver.

Finally, supposing that the Office of Inclusion informs taxi operators regularly of the behavior of their drivers and passengers, the taxi dispatchers can use our algorithms to penalize unwanted behavior from both sides of the problem by assigning fewer passengers to bad drivers and making bad passengers wait longer for

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drivers. Thus, we involve the Office of Inclusion, the taxi companies, the drivers, and the passengers in one mechanism for reducing sexual harassment.

### 3 **Optimize the Idle Freight for Flat Products Via Rail Network: Case Study in Steel Industry** *Pragya Bajpai and Rashmi Singh*

In this article, the real-time problem of TATA steel is considered to determine loading locations of the coils on train railcars. This is a classical problem of an optimization technique specifically for aluminum, iron and steel industry but it is rarely studied in the literature. The actual scenario of the TATA steel is captured here with the help of integer programming mathematical model based on the data received from the transportation department. The google OR tool is used to solve this optimization problem.

## **5B Mathematical Modeling**

### 1 **Equilibrium Markov Supernetworks\*** *Jing Fu, Frank Page, and Myrna Wooders*

We model the structure and strategy of social interactions prevailing at any point in time as a directed network and we address the following open question in the theory of social and economic network formation: given the rules of network and coalition formation, preferences of individuals over networks, strategic behavior of coalitions in forming networks, and the trembles of nature, what network and coalitional dynamics are likely to emerge and persist. Our main contributions are to formulate the problem of network and coalition formation as a dynamic, stochastic game and to show that: (i) the game possesses a stationary Markov bang-bang equilibrium (in network and coalition formation strategies), (ii) together with the trembles of nature, this stationary equilibrium determines an equilibrium Markov process of network and coalition formation, and (iii) this endogenous Markov process possesses a finite set of ergodic measures, and generates a finite, disjoint collection of nonempty subsets of networks and coalitions, each constituting a basin of attraction. Moreover, we extend to the setting of endogenous Markov dynamics the notions of path dominance core (Page-Wooders, 2009) and pairwise stability (Jackson-Wolinsky, 1996). We show that in order for any network-coalition pair to emerge and persist, it is necessary that the pair reside in one of finitely many basins of attraction. As an example, we consider a dynamic noncooperative game of club network formation and we demonstrate conditions ensuring that, even if multiple club memberships are allowed, there exists a pure stationary equilibrium where the only club networks which emerge and persist are those where players are members of a single club.

### 2 **Profit Maximizing Integer Multicommodity Flow Problem\*** *Shuvabrata Chakraborty*

The study addresses the origin-destination integer multicommodity flow problem in which the objective is to maximize the profit collected from the routed demands. The linear version of the problem which has received much of the attention so far allows the demand of the commodities to be splitted along multiple paths. However, for many applications arising especially in telecommunications, transportation and production planning, the demand of a commodity is required to be routed along a single path in the network.

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Video teleconferencing does not allow call splitting. Similarly, a set of packages to be shipped between the same origin and destination is often expected to be assigned to a single path for operational efficiency and customer satisfaction. The profit maximizing integer multicommodity flow problem is defined on a network with given capacities along its edges and a set of commodities which are characterized by a source node, a destination node, a demand quantity and a profit that is obtained only if the demand is routed. The objective is to find a subset of commodities to be routed simultaneously without exceeding the capacity constraints along the edges so that the total profit collected is maximized. The most important constraint here is that the entire flow of each commodity must follow a single path from its origin to destination node. This last requirement makes the problem an integer programming problem and as the size of the problem increases, the difficulty in solving it increases exponentially. The profit maximizing version of the problem has received even limited attention from the management science community as most of the works in literature on the problem are in the context of approximation algorithms. In this study, we therefore attempt to design a Variable Neighborhood Search based metaheuristic to solve larger instances of the problem efficiently. The proposed metaheuristic makes use of the underlying structure of the problem to arrive at good solutions quickly. Extensive computational experiments are conducted to compare the results obtained using the heuristic with those obtained using a state-of-the-art and off-the-shelf MILP solver that solves the problem using the branch-and-bound approach.

3

### **Domination analysis of approximation algorithms for QUBO**

*Abraham Punnen*

The quadratic unconstrained binary optimization problem (QUBO) seeks binary vector that maximizes a quadratic objective function. QUBO received considerable attention recently, particularly because of its applications in quantum inspired computing. QUBO is known to be strongly NP-hard its general form is not approximable. In this paper we discuss various approximation algorithms for QUBO and establish performance guarantees for them using average based analysis as well as domination analysis. Some related open problems will also be discussed.

## **6A COVID-19 Response and Recovery**

1

### **Assessing PCR Laboratory Testing Scale Up in Nepal: An Analysis Based on COVID-19 Response\***

*Hannah Bakker, Nadia Lahrichi, Govindakarnavar Arunkumar, Joaquim Gromicho,  
Krishnan Parvathy, Fannie Côté and Victor Del Rio Vilas*

The spread of the SARS-CoV-2 virus led to a sudden increase in the demand for PCR-based testing leading several countries, including Nepal, to make significant investments to rapidly expand their diagnostic capacities. Two years into the pandemic, there is a need to assess the effectiveness of these investments in providing the population with diagnostic tests. Besides the accessibility of laboratories in a geographical sense, a comprehensive assessment would include the availability of sufficient capacity to process incoming test samples in a timely manner.

Based on data collected by Nepal's Ministry Of Health and Population (MOHP), we investigated the status and performance of the diagnostic network in Nepal during the COVID-19 outbreak in 2021. The analysis

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covered several key components of the diagnostic network. On an operational level, the performance inside individual laboratories was assessed by means of a discrete event simulation (DES) model. Amongst others, special emphasis was put on identifying bottlenecks in the processing of COVID-19 samples at the laboratory. The analysis shows that failure to place the right people at the right time is the major limiting factor in providing test results in a timely manner. In addition, increased automation, especially of the sample registration process, would be a valuable investment as it has the potential to dramatically decrease the average time to retrieve test results.

On a strategic level the accessibility to laboratories by populations throughout the country was investigated using coverage models from mathematical programming. These models took into account road infrastructure and relative wealth. Despite all efforts, the accessibility to laboratories is still very heterogeneous. A metropolis such as Kathmandu is very well served, while more remote areas are not. To highlight the value of good data and analytics in strategic planning we compare the current level of coverage to that achieved by optimized network designs that could have been chosen in 2021 or potentially in the future.

Lastly, the degree to which coordinated transfers of test samples can help to cope with temporally and locally confined disease outbreaks that cause sudden increases in the demand for testing capacity at a local level was analyzed. Combining considerations regarding individual laboratory processing capacity and accessibility to laboratories, different strategies for cooperation under different scenarios were evaluated by means of simulation. The results show that simple cooperation between one or two stakeholders suffices to prevent most congestion.

As a joint work, our analysis has been able to draw a comprehensive picture of the current status and the capabilities of the diagnostic network in Nepal, both on an operation level inside the laboratories as well as on a strategic level of public health administration. Our findings identify important bottlenecks and challenges, along with ways to address them, and thus provide important lessons for improving the performance of disease testing for this and future pandemics.

## 2

### **Optimal Allocation of Vaccines in Different Regions in the Philippines\***

*Rodney Pino, Renier Mendoza, Erika Antonette Enriquez,  
Victoria May Mendoza, and Arriane Crystal Velasco*

In this work, we propose an approach to schedule the allocation of COVID-19 vaccines to the different regions in the Philippines according to the brands and suitability of the vaccines to certain age groups. A linear programming problem is formulated so that the total number of infections is minimized. The waning of immunity induced by vaccines, breakthrough infections, primary doses, and booster shots are also included in the objective function. Constraints on vaccine supply, eligible population, weekly vaccination rate, and the interval between doses are considered. Vaccine effectiveness against the current most dominant variant, Omicron, is used. The results of this study can be used to identify regions and age groups that should be prioritized to minimize infections.

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## COVID-19 and its Effects on the Supply Chains in the Philippines (A Systems Dynamics Perspective)\*

*Vicente P. Reventar III*

The Philippines has learned to be resilient in times of disasters (typhoons, massive floods, even earthquakes and volcano eruptions) but nothing prepared the country for the effects of this COVID-19 global pandemic. Most disasters involve disruptions, and in the case of local typhoons and massive floods, we have at least 2-5 days lead-time to prepare since most given a global weather tracking system that monitor weather disturbances in real-time. Forecasting has been very accurate with the infrastructure setup by PAGASA to provide possible trajectories of the typhoons giving disaster agencies (including local government units and the DSWD reliant on local producers and their supply chains for relief goods) sufficient time to prepare for a quick response via pre-positioning of relief items.

This pandemic caught everyone by surprise. The national government never took the threat seriously until infected cases began showing its dangerous “exponential” growth. Although we have disaster management agencies, there are geared toward a different type of disaster, not for a possible widespread health bound disaster. Because of COVID-19, the immediate reaction of the Philippine government was to implement an Enhanced Community Quarantine (ECQ) designed to limit mobility of people by restricting them through a “stay-at-home” directive and thus minimizing the “contact-rate” of people through social distancing.

These 2 directives were aimed at “flattening” the exponential curve till newly infected people daily decreased progressively to acceptable levels. These policy directives which are still in effect right now had several “unintended consequences.” This paper will examine 4 system dynamics models that can aid in understanding and guide policy makers. Private and government agencies are forced to shut down except for a very few exceptions. This resulted in impairment of incomes for most employees. The shutdown also affected the manufacturing and the agricultural sector and its distribution systems. Most of our supplies today are current inventories of goods before the declaration of the ECQ. One could only speculate how long these inventories will last. Most local companies have designed a “lean” and JIT (just-in time) supply chain to minimize handling and carrying cost of inventories.

Although suppliers may still have inventories and “safety stocks” the local logistic companies are having a difficult time in moving the finished goods and raw materials because of strict protocols in the checkpoints all around Luzon and the other areas in the Philippines. We also have to contend with perishable goods like vegetables and seafood that have limited shelf life even with refrigeration.

This video clip discusses several simulation models (COVID-19 models, supply chain models, both using system dynamics and agent-based modelling). These models try to “approximate” reality but in the end, the basic insight and “take away” is that all these systems are interlinked, and we should recognize these “tightly-coupled” interdependencies whenever we make policy decisions that could affect a major segment of society.

An example of this policy decision is the government policy which imposed the ECQ, the government will probably decide at some point to lift (partially?) the restrictions allowing the flow of goods and services, and for employees in critical sectors (health, manufacturing, agricultural and transport sectors) to go back to work. The objectives are the replenishment of critical inventories and creating money flow in the system to provide relief to consumers wanting to buy basic goods. We all know that lifting the ECQ on the other hand, does come with a risk that the infection rates might go up again, putting the general population at peril. This may really qualify as a “vicious” problem.

What can we do today and in the future to “immunize” our local supply chains in cases of partial disruptions? Most supply chain experts recommend to reconfigure the current supply chains by increasing production and inventory capacities. Other recommendations also include repositioning some inventories in certain regions or facilities under quarantine. Any segment in the supply chain (plant, distributor, wholesaler, retailer, “last-mile” -customer) will be subjected to disruptions affecting the integrity of the whole chain. The critical issue is the ability of individual “segments” time-to-recover when a disruption occurs. Ensuring a “fast” time-to-recover will go a long way in ensuring the performance of the supply chain.

Two supply chain organizations are the Supply Chain Management Association of the Philippines (SCMAP) and the Philippine Institute of Supply Management. It is recommended that they be part of any government policy effort in managing the effects of COVID-19 in the flow of goods and services.

## 6B Analytics and Machine Learning

### 1

#### What Consumers Say Affects Review Usefulness: Analysis using Topic Modeling and Sentiment Analysis\*

*So Young Jun and Jong Woo Kim*

In this paper, we analyzed how topics mentioned in online reviews affect review helpfulness and the moderating effect of review sentiment on the relationship between topic and review helpfulness. First, as a generalized topic framework for various product categories of e-commerce platforms, we considered the formal text dimension of online consumer reviews with a total of 10 topics. Next, we analyzed product review data from Amazon, an e-commerce platform. After preprocessing the review text, we extracted the semantic similarities for each topic using Top2Vec, a topic modeling method. The sentimental probability was measured using the pre-learning model BERT. Review helpfulness, a dependent variable, was defined as the number of votes for the review compared to the total number of votes for each product. In addition, variables related to review format (verification status, elapsed time, review length, number of images, etc.) were used as control variables. Finally, we confirmed through hierarchical regression analysis whether the semantic similarities of each topic in the review significantly affected review helpfulness and whether the review sentiment had a moderating effect.

As a result of the study, we found that nine topic similarities, except for product quality, significantly correlated with review helpfulness. However, the impacts of the independent variable had different directions due to the limitations of the data for various product categories. Furthermore, adding review sentiment as a moderator had a significant effect compared to the model with only similarity by topic as an independent variable. We confirmed that more negative review sentiment was related to higher review helpfulness. The moderating effect of review sentiment had different results depending on the topic. Specifically, reviews closer to the topic of seller trustworthiness or product aesthetics increased review helpfulness, and more positive review sentiment was related to higher review helpfulness.

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2

### **Movement Analytics and Optimisation\***

*Reena Kapoor, Simon Dunstall, Rahman Ashfaqur, Peter Baumgartner, and Elena Tartaglia*

Data-driven decision-making is becoming a crucial part of how the industries improve their efficiency to produce high-quality items for their customers. IoT-based and other forms of object tracking are emerging tools for collecting many different kinds of data, including data on the state and action of objects/entities during their trajectories over space and time, i.e., movement data. We define movement analytics as using analytical techniques to turn the movement data into valuable information for industrial management and decision-making. We review the current work state for different movement analytics techniques and the various industries that benefited from it. We survey relevant work from both a theoretical perspective and a practical perspective. We note that Logic, ML, and Optimisation techniques are used in making the correct inferences from movement data/information regarding the status of the different entities; however, there is a scope for hybridizing these techniques while making the decisions that movement data can impact. Here we explore the venues where optimisation can enhance the existing techniques for movement analytics.

3

### **Implementation of Deep Learning to Classify Websites**

*Ryhle Nodnylson Guinto*

With the emergence of Artificial Intelligence in the corporate setting, the need for automation has been increasingly favored as it can resolve problems in time and budget. The annual growth rate of the artificial intelligence market size is predicted to be 38.1% from 2022 to 2033. Time and budget are vital in the industry. In order to mitigate these problems, deep learning models predict the relevance of websites according to natural language processing and image classification. This paper discusses the developed deep learning models that classify ecommerce websites whether it is an ecommerce or non-ecommerce website (blogsites, reviews, price comparisons). The first model classifies ecommerce websites by utilizing the keywords that are found within the website and the second model classifies ecommerce websites by utilizing images of the homepage of the website. The model was implemented in Laptops and Smart Mobile Phones categories. Websites from the Philippines, Singapore, Malaysia, Indonesia, and Japan were used to train our classes.

## **7A Healthcare and Industry Management through New Normal Times**

### **Impact of ESG Management Activities to Corporate Performance in a Healthcare Industry\***

1

*Peng Wang and Chang Won Lee*

This study is to present an impact of ESG (Environment, Social, and Governance) activities to corporate performance in a healthcare industry. Regression method will be utilized to examine the impact of ESG to corporate performance in a healthcare industry. The data has been collected from the secondary dataset. Relevant hypotheses are developed and tested with regression analysis. Findings are derived from the results. Concluding remarks suggest strategic insights for decision-makers to improve better decision-making in a corporate setting. These findings are easily applicable to other healthcare sectors and other similar settings.

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## 2

### **Revenue Management During Post-COVID-19 Recovery Times\***

*Vinaysingh Chawan*

The hospitality industry was adversely affected due to the COVID-19 pandemic. Though economic activity has started across the world, there is a looming threat of subsequent COVID waves. The next few years will have an additional risk of any unpredicted localized closures and lockdowns. Such uncertainty is a big problem for the hospitality industry, where Revenue Management is mainly dependent on demand forecasts. During the post-COVID-19 recovery times, demand forecasting is almost impossible, mainly due to highly uncertain future events and also due to the absence of any reliable post-COVID demand data. So, Revenue Management problems now need to be re-looked as decision making problems under uncertainty.

We look at the problem of Revenue Management in the face of uncertain future scenarios. The same is modeled as demand coming from different scenarios: a worst-case scenario, a best-case scenario, and a most probable scenario. We model the three demand scenarios as coming from three distributions to represent the three scenarios, out of which one scenario will finally occur. The decision makers task is to formulate a Revenue Management policy: capacity allocation to different price segments. We consider different policies and evaluate their revenue earning potential in this simulation-based study.

We consider the case where the decision maker can assign subjective probabilities to the future scenarios and propose a Revenue Management policy based on expected revenues. Next, we consider the case of complete uncertainty and evaluate the robustness of the previous results to extreme outcomes. Finally, a max-min policy is proposed that can ensure minimum revenues in the face of extreme outcomes.

The post-pandemic recovery period is characterized by extreme demand uncertainty and the main issue for the hospitality industry is about capacity commitment. Customers are undecided about their travel needs, and hence would value cancellation options even more. The traditional tool in the Revenue Management toolbox relied mainly on demand forecasts, something that is not possible in the immediate post-pandemic world. This paper discusses the challenges for Revenue Management in the post-pandemic recovery phase and proposes some solutions for the hospitality industry.

## 3

### **Analytics for Generating Insight from Indoor Tracking Data in Manufacturing\***

*Ashfaqur Rahman, Md Mashud Rana, and Daniel Smith*

COVID pandemic has made significant changes to the way businesses operate every day. Social distancing in workplaces has become a norm to avoid workers becoming ill and loss of workforce and productivity. Manufacturing plants have made changes to layouts and operating procedures and made policies to create a safe work environment. It is however hard to monitor whether such policies are properly adhered to. Indoor tracking of objects (e.g., workers, vehicles, trolleys etc.) can assist in this regard. Indoor tracking is mainly developed to understand operational efficiency and take strategic decisions based on tracking data. It can, however, assist to understand health and safety risks and avoid workforce/productivity loss for businesses.

We have developed some data analytics methods to infer useful information from indoor tracking data. Inferred information include (i) percentage of time a worker interacted with other workers (i.e. co-located), (ii) percentage of time worker spent at different work areas, and (iii) to what extent a worker deviated from their intended workflow. The above information can be used for strategic/operational decision making as well as understand HSE risks. For example, the metric 'percentage of time worker spent at different work areas' can be used to understand the utilization of a resource (the worker) i.e., the proportion of time a

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worker spent in work areas beyond their workflow. At the same time, this metric can be used to compute the risk of spreading COVID (based on zones visited) if that worker is infected. In terms of method development, the raw trajectory data was first converted into zone transition diagrams based on a clustering method. The zone transitions are then used as a basis to compute the above metrics.

We applied our methods on a tricycle assembly setup (publicly available data set) and generate the metrics above to get insight into their operation. The tricycle assembly line consists of six workers operating on six rigs. There is one additional refill rig. Two different commercial tracking systems were used during data collection and in this experiment, we used tracking data only from the MoCap (Motion Capture System). The workers were monitored for three hours and during that time they produced three tricycles. Tracking data from all the six workers are available and was used in the analysis. There is a defined workflow on how finished components from each worker moves to different rigs. The results from analytics methods showed high level interactions between workers as will be presented in the paper.

## 7B Finance and E-Commerce

### 1

#### **Building Micro-Fulfillment Center Networks in Metro Manila: Evaluation of Gas Retail Networks as Host Sites\***

*Rowell Castro and Simon Anthony Lorenzo*

After an accelerated global growth of the e-commerce industry, the Philippines crafted a roadmap which envisions to put up one million e-commerce businesses by the end of 2022. To support this expansion, existing supply chain and logistics networks will have to be re-evaluated. Furthermore, new solutions may have to be put in place as consumer behavior shifts to various order fulfillment modes like deliveries and curbside pick-ups. Of particular importance in this endeavor is ensuring that the demand of the National Capital Region (NCR) is met. With a population of more than ten million, the capital serves as the primary consideration in the development and modification of logistics networks.

This paper explores the possibility of using existing gas retail networks in NCR as host sites for micro-fulfillment centers (MFCs). These MFCs can be activated by e-commerce enterprises via feasible business models (e.g. subscription-based) to reduce last mile costs and shorten delivery lead time.

A dynamic vehicle routing problem (DVRP) is used to model the delivery of goods to stochastic demand around the network. Time-dependent demand arrivals and delivery lead times are considered, with the goal of maximizing the proportion of orders that are completed within a set of target times. Lead times as fast as ten (10) minutes are also considered to explore the possibility of the network's capacity to cater to hyper-fast deliveries. To solve the DVRP, a simulation model was developed and utilized using randomly generated demand data and forecasted actual travel times.

The model and its subsequent results will serve as important inputs in the logistical decision-making of public and private organizations operating in the e-commerce space.

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2

**Active versus Passive Portfolio Management:  
A Comprehensive Study on Indian Mutual Fund Industry\***  
*Hariprasad B and Sony Thomas*

Active vs passive investing is an evergreen research area in portfolio management. The literature across different markets shows that the proportion of actively managed funds outperforming passively managed funds is lower for large investment horizons. This study extends the debate to the Indian mutual fund industry. The study explores the performance of active and passive funds in the Indian context over varying investment horizons. The results show that the proportion of actively managed funds outperforming passively managed funds decreases with larger investment horizons. This outperformance is prominent for broad-based indices. Large-cap stocks are almost efficient, and it is very difficult for the active fund to outperform large-cap mutual funds. However, outperformance with better risk-adjusted returns is possible in the broad-based category if one cap picks up the right mutual fund. Fourth quartiles of active funds provide better risk-adjusted returns. Lower quartiles of active funds underperform the index with lower risk-adjusted returns. Hence, selecting funds is very important for active long-term investing. For a long-term investor with limited knowledge of mutual funds, passive investing is the best option.

3

**Application of Equilibrium Conditions of the n-Player Weightlifting Game  
to Micro-credit Insurance\***

*Diane Carmeliza Cuaresma, Maica Krizna Gavina, Jomar Rabajante, Jerrold Tubay,  
Jin Yoshimura, Hiromu Ito, Takuya Okabe, and Satoru Morita*

In developing countries, such as the Philippines, microcredit loans, which do not require collateral, are popular. Microfinance institutions offer these loans to jointly liable groups, for example, cooperatives. Since these loans do not require collateral, future loans are often conditioned on the repayment of loans of the whole group. As such, the members of the group act as collateral for each other's loans. If a member defaults on the loan, the group members may pay it back for the whole group to be allowed to loan again. Microinsurance is offered to cover the loan amount in case of illness or other financial disasters to ease the burden of paying back loans. One type of such insurance requires the whole group to enroll, and each member is offered the same premium. However, this system opens free-riding opportunities as some members may depend on others to pay the premium. Hence, setting the premium price such that it is acceptable to all the members of the cooperatives is one way to avoid free-riding and promote participation.

The recently developed n-player weightlifting game can be applied to this problem. This game is an extension of the two-player weightlifting game, which unifies under a single game structure all types of two-by-two games (prisoner's dilemma, chicken game, stag hunt game, C-dominant and D-dominant trivial games). The weightlifting game only has two strategies, cooperate or defect. Players can either succeed or fail in lifting the weight. All players receive the benefit of successful weightlifting. However, weightlifting has a cost that is only paid by those who cooperate. The conditions expressed in terms of success probabilities and the cost-to-benefit ratio for pure strategy equilibria have been found. The n-player weightlifting game offers insights into behavioural cooperation in a large group.

Here, we show how cooperation in paying the premium for microinsurance can be encouraged using the equilibrium conditions of the n-player weightlifting game. We consider a cooperative with  $n$  members, with each member taking up a loan amount of  $L$  and invest this money at an interest rate of  $r$ . To be allowed to take a loan, all members of the cooperatives must take insurance with premium  $A$ . Some members of the cooperative may decide to cover the premium of the other members to be able to get the loan. This situation

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can be modelled using the weightlifting game. The successful event is the ability to take up the loan and earn the interest, while the cost is paying the insurance premium. Thus, the benefit is  $L(1+r)$  while the cost of cooperation is  $An/i$ , where  $i$  is the number of members that agrees to pay the premium of other members. The pay-off for the players is a function of the cost, benefit, and the probability that the  $i$  members can cover the entire premium of the group. We find the threshold for the insurance premium  $A$  for which all members or most of the members cooperate in paying the premium.

## INVITED PAPER ON MACHINE LEARNING

### Open Source Software Evolution: A Machine Learning Centric Approach

*V. B. Singh*

Open source software is evolved through an active participation of the users in terms of reporting of issues (bugs, new features and feature improvements). Software repositories (such as source control repositories, bug repositories, archived communications, deployment logs, and code repositories) contain a wealth of valuable information regarding the evolutionary history of a software project. By mining such historical information, we can develop techniques, classifiers and approaches by using Machine Learning techniques namely – K Nearest Neighbor (KNN), Naïve Bayes (NB), J48, Random Forest (RF), Condensed Nearest Neighbor (CNN), Multinomial Logistic Regression (MLR), Decision Tree (DT), Deep Learning (DL) and Neural Network (NNet) to assist software developers by predicting various important bug attributes namely Bug severity, Bug Priority, Bug Fix time, and Bug Assignee Prediction. The various prediction in cross project context also assists where historical data of the projects are not available. The classifiers will also support software managers by predicting the occurrence of faults and estimating when a software is ready for release.

## 8 National Contributions 1

1

### Operations Research and Data Science for Hospital Emergency Department Operations\*

*Yong-Hong Kuo, Jamal Nasir, Janny Leung, and Colin A. Graham*

*Hong Kong*

In this talk, we will present our applications of operations research and data science techniques for managing operations in a hospital emergency department (ED) in Hong Kong. There are three main applications to be presented.

The objective of the first application is to apply machine learning algorithms for real-time and personalized patient waiting time prediction. We also aim to introduce the concept of systems thinking to enhance the performance of the prediction models. We found that machine learning algorithms with the utilization of the systems knowledge could significantly improve the performance of waiting time prediction. Waiting time prediction for less urgent patients is more challenging.

In the second application, we use simulation to analyze patient flows in the ED. When developing the simulation model, we faced the challenge that the data kept by the ED were incomplete so that the service-time distributions were not directly obtainable. We propose a simulation-optimization approach (integrating

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simulation with meta-heuristics) to obtain a good set of estimate of input parameters of our simulation model. Using the simulation model, we evaluate the impact of possible changes to the system by running different scenarios.

In the third application, we investigate an ED staff scheduling problem with two types of patient groups: patients with serious (life-threatening) health conditions and those with stable health symptoms. We employ a chance constraint-based minimum staffing level parameter in our staffing and scheduling optimization model that guarantees the service start for priority patients within a given amount of time during each time interval. A heuristic framework is also proposed that utilizes the transient analysis results to solve the optimization model in order to find the right staffing levels against each time period. The results of the heuristic framework demonstrate the effectiveness of our approach as staffing levels are determined by respecting the service start time guaranties and rush hours in the ED.

## 2

### Forecasting Dengue Cases and Deaths for Five Years in Kathmandu Valley, Nepal\*

*Shital Bhandary and Govinda Tamang  
Nepal*

Dengue, the most rapidly spreading mosquito-borne infectious disease, has emerged as a global public health concern. This is particularly challenging as there is no available treatment for or effective vaccine against Dengue. In addition, genetic variability (serotype and genotype) of the dengue virus adds another aspect of the public health threat because of the increasing risk of severity of the disease (secondary and tertiary infection). Currently, dengue has spread over 129 countries, with annual 400 million infections and 40,000 deaths. The endemic regions of tropical and subtropical countries (South East Asia and South Asia) account for 70% of the actual dengue burden.

Under changing climate due to global warming, dengue is expected to spread more into regions with immunologically naive populations in sub-Saharan Africa, parts of Europe and northern USA and lowland areas of the Western Pacific and Eastern Mediterranean regions. Low and middle-income countries (LIMCs) with higher population density, poor healthcare systems and rapid unplanned urbanization, and global warming-induced changing climatic factors are particularly vulnerable to dengue. Due to multiple risk factors, South Asian countries including Bangladesh and Nepal are experiencing successive major dengue outbreaks in recent years.

In Nepal, the first case of dengue was reported in 2004, with gradually increasing cases since then. Since 2010, smaller outbreaks of dengue have been noted in various parts of the country although they have not been that widespread. In the initial years, dengue has been reported from the districts in the low-lying Terai plains in the southern part of the country with an altitude ranging from 80 to 300 meters. The densely populated districts of the Terai plains such as Jhapa, Chitwan, Sunsari and Rupandehi with large urban areas have borne the biggest brunt of the outbreaks between 2012 and 2017.

Nationwide, in the year 2017 there were 811 cases of dengue and in 2018 there were 3424 cases. In 2018, for the first time, dengue was reported from a relatively higher altitude of the hilly Kaski district whose main city Pokhara is situated at an altitude of over 800 meters. There was a notably large outbreak of dengue in 2019 in Nepal with 17,992 reported dengue cases and six recorded deaths. They were reported from 68 districts in all seven provinces including from the Kathmandu Valley which is located at an altitude above 1300 meters. In 2022, there has been ongoing dengue outbreak with 40,029 dengue cases with 48 verified dengue related deaths as of 15th Oct, 2022. The unofficial cases may be three or four times more than this official reports. Dengue has added a double burden of infectious disease along with the COVID-19 in Nepal.

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This paper will present the results of forecasting of dengue cases and deaths for 2023-2028 in Kathmandu Valley using official and unofficial data. It will use time series decomposition models, exponential smoothing models, Autoregressive Integrated Moving Average (ARIMA) models and Neural Network models to find the best model to make necessary plans, policies and programs in the country.

3

### **Utilizing Forecasts on Pandemic Restrictions and Infection Trends in the Optimization of Supply Chain Networks\***

*Fernando Antonio, Juan Atayde, Martin Yamzon, and Charlle Sy  
Philippines*

The COVID-19 pandemic has challenged global supply chains with constraints on labor and capacity. As a result, supply chain leaders now see the importance in creating a balance between agile and lean systems. Movement restrictions and lockdowns represented one of the largest supply chain disruptions in the past years. This study then looks into how supply chains could better withstand and prepare for these uncertainties.

A mixed integer nonlinear programming (MILP) model for supply chain design under a pandemic scenario has been developed. The MILP model underscores the presence of government imposed restrictions that depended on infection trends observed in a given area. Forecasts are made based on the infection trends, which are in turn used to optimize operational capacity and facility connections. The model also examines the interdependency of infection trends, uncertainties in restriction levels and customer demand. The model was subjected to scenario analysis that encapsulated changing infection trends and their subsequent effect to the degree of restrictions imposed on the network. The numerical experiments demonstrated the importance of hedging and anticipating against disruptions. The model dealt with these by choosing to operate additional facilities even if these led to higher operating costs. The facilities would serve as buffers on the event of a reduction in operating capacity, abrupt lockdowns and spikes in customer demand.

## **9 National Contributions 2**

1

### **Tripartite Evolutionary Game Model for Public Health Emergencies\***

*Zhiqi Xu, Yukun Cheng, and Shuangliang Yao  
China*

Public health emergencies are more related to the safety and health of the public. For the management of the public health emergencies, all parties' cooperation is the key to preventing and controlling the emergencies. Based on the assumption of bounded rationality, we formulate a tripartite evolutionary game model, involving the local government, the enterprises and the public, for the public health emergency, e.g. COVID-19. The evolutionary stable strategies under different conditions of the tripartite evolutionary game are explored and the effect from different factors on the decision-makings of participants for public health emergencies are also analyzed. Numerical analysis results show that formulating reasonable subsidy measures, encouraging the participation of the public and enforcing the punishment to enterprises for their negative behaviors can prompt three parties to cooperate in fighting against the epidemic. Our work enriches an understanding of the governance for the public health emergency and provide theoretical

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support for the local government and related participants to make proper decisions in public health emergencies.

2

### **Optimal Investment Using the Baltic Dry Index and Interest rates in 12 Industrialized countries\***

*Jihye Yang, Soonbong Lee, and Seongmoon Kim  
South Korea*

This study suggests improved investment strategy based on Markowitz's portfolio selection model reflecting the two economic indicators: Baltic Dry Index (BDI) and interest rate. We propose BDI portfolio selection model and IR portfolio selection model reflecting the BDI and the interest rate respectively, which are based on the Markowitz's model. First, the two portfolio selection models actively adjust the total proportion of capital invested in risky assets conservatively or aggressively on the rebalancing date depending on the BDI growth rate and the interest rate, respectively. Next, the two models actively adjust the proportion of capital invested in each risky asset, depending on the BDI sensitivity of each stock and the interest rate sensitivity of each stock. We empirically evaluate the performance of the proposed models in 12 different stock markets using historical stock return data. During the 11 years investment period from 2009 to 2019, the proposed BDI portfolio selection model and IR portfolio selection model outperformed the classic Markowitz's portfolio model for all performance measures. This paper is differentiated from previous literature on portfolio selection models in that we propose the new portfolio selection models reflecting the BDI and the interest rate, which are the leading macro indicators but has not been covered in the previous literature.

3

### **Systematic Study of Operations Research Methods in Long-Term Mine Planning\***

*Nurul Asyikeen Binte Azhar, Aldy Gunawan, Shih-Fen Cheng, and Erwin Leonardi  
Singapore*

A key Operations Research (OR) problem in mine planning is the strategic or tactical long-term production scheduling problem (LTPS). It maximizes the net present value of profits (NPV) through the sequencing decisions of extraction and processing of ores throughout the entire life of mine. The LTPS continues to garner interest due to its NP-hard nature; it is rife with variables, constraints, time periods (decades) and uncertainties. The methods to address the LTPS have also expanded across the years. Hence, this study examines the trends in OR solution methods in the recent decades at open pit and underground mines. It considers the mine-related components (factors, uncertainties, and sustainability elements) formulated into the LTPS and the efficiency and efficacy of the various methods. The research methods used were classified into four of exact, (meta) heuristic, hybrid and machine learning. They were then further classified into either deterministic or stochastic approaches. Our study also highlights that more real-world components can be included into the LTPS formulation for simultaneous optimization such as commodity market or operations uncertainty, and sustainability elements.

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### 1 **A Superlinearly Convergent Exact Penalty Method for Constrained Optimization\***

*Nezam Mahdavi-Amiri and Hani Ahmadzadeh  
Iran*

Non-monotone filter successive quadratic programming (SQP) approaches have been recently adopted for solving large constrained optimization problems. To speed up the iterations, we have recently made use of inexact solutions of the SQP sub problems in the context of an exact penalty merit function. Significant roles are played by two search directions, the so-called steering and predictor directions. In a global iteration, with an infeasible iterate at hand, both directions are computed. The steering direction is computed as a minimizer of a linear approximation of the constraint violation over a trust region. This direction is used to construct a convex feasible quadratic sub-problem for computing the predictor direction, which serves to be a descent direction for the penalty function. A combined steering and predictor direction is also determined as a descent direction for the constraint violation. By properly updating of the penalty parameter, this direction is also made to be descent for the penalty function. In a local iteration, with a feasible iterate at hand, an inexact solution of a convex quadratic model is computed to serve as a descent direction for the objective function. We also make use of a non-monotone filter strategy to avoid the Maratos effect in local iterations. The proposed algorithm is shown to have a superlinear local rate of convergence under standard assumptions. Competitiveness of the approach is demonstrated in a comparative testing of an implementation of the algorithm on a collection of available test problems in the literature.

### 2 **Multi Objective Energy Efficient Street Lighting: AMOSA based Framework\***

*Pragna Labani-Sikdar, Samarjit Kar, and Parag Guhathakurta  
India*

Nowadays, several energy-efficient advanced techniques have been approved for fulfilling the efficiency requirement of the lighting system. However, the implementation of street lighting is more complex in reality as it usually involves multiple issues related to street conditions. According to the guidelines from International Commission on Illumination (CIE), the installation of street lights is characterized by various geometrical parameters along with the distribution of the luminaries. To obtain an improved lighting installation in terms of energy efficiency, the power required to acquire that efficiency and the distribution of luminaries, various parameters related to the lighting installation can be contradictory. For example, maximizing the energy efficiency of the street lighting system affects the minimum requirement of uniform distribution in the lighting illuminance. Hence, to resolve the complex issues concerning energy planning, several researchers have opted for multi-objective evolutionary algorithms (MOEAs) to install streetlights.

An archived multi-objective simulated annealing (AMOSA) based energy-efficient street lighting framework is proposed to maximize the system's energy efficiency and uniformity while minimizing the luminaries' power requirement. Here, the inputs are considered inter-distance between two consecutive street lights, luminary height, road width and average illuminance. The initial population is generated in terms of the combination of these input parameters. Subsequently, the crossover is used to obtain another population to check the domination status between the earlier and the new one. The clustering is applied to the obtained Pareto optimal (PO) solutions to reduce an excessive amount of possible solutions generated which in turn can lead to a better diversity of the PO solutions. The proposed AMOSA based energy-efficient approach facilitates two additional significances over other alternative MOEAs, such as the amount of domination and clustering of PO solutions.

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The outcome of the proposed approach is compared with the other MOEAs, such as nondominated sorting genetic algorithm II (NSGAI), and Pareto archived evolution strategy (PAES). In this context, the convergence and the diversity of the obtained solution set are evaluated by four performance metrics, Generational Distance (GD), Inverted Generational Distance (IGD), minimal-spacing, and purity for the MOEAs. An approximated front is obtained for evaluating the performance measure of the solution sets achieved by the three MOEAs. These MOEAs are used for various combinations of the lighting classes and subclasses recommended by CIE. Furthermore, the lighting classes are considered for one-sided and two-sided street configurations. Significant comparative results with respect to the performance metrics are shown to highlight the convergence and the diversity of the MOEAs, to emphasize the energy efficiency in the street lighting framework. The result obtained from the proposed approach amidst others, in terms of convergence and diversity, is validated using DIALux to ensure the recommendation for standardization in different aspects. The improvement obtained by the proposed work over other existing approaches is shown in terms of various facets.

3

### **Optimization Model for the Line Planning Problem of the Urban Transit Bus Route Network Design\***

*Adibah Shuib, Siti Nur Liyana Amiruddin, and Zuraida Alwaddood  
Malaysia*

Solving urban transit route network design problem (UTRNDP) is essential in designing a sustainable and efficient urban public transportation system. This paper presents our study that concerns with solving the line planning problem (LPP) in UTRNDP, which determines transit bus routes and associated frequencies that satisfies demand based on origin-destination matrix for urban road network. LPP-Mixed Integer Goal Programming (LPP-MIGP) model was formulated which involves multiple objective functions, which are, to maximize total demand served under accessibility consideration, to minimize total in-vehicle time of all travelers, to minimize total operation costs, and to minimize total amount of Carbon Dioxide (CO<sub>2</sub>) emissions of vehicles. The aim is to establish optimal strategies for the public transit bus route network that reflect passengers' preferences satisfaction and costs minimization. The model was solved using preemptive goal programming method based on two sets of data, preliminary routes (by random setting) and strategized routes (by maximal flow network problem approach). Results based on LPP-MIGP model show that optimal solution for total demand served and total in-vehicle time for both sets of data are the same. However, for total operation costs and total amount of CO<sub>2</sub> emission, the LPP-MIGP model produced better solutions based on strategized routes.

## **11 Youth Forum 1**

1

### **Optimizing Healthcare Logistics and Mobility for Non-emergency Patients\***

*Jamal Abdul Nasir and Yong-Hong Kuo  
Hong Kong*

Maintaining a long-term, accessible, and effective healthcare system is a big challenge all over the world. Similarly, healthcare facility availability and accessibility are critical factors of healthcare delivery. The main emphasis of our healthcare service delivery research is on non-emergency patients and the elderly. Home-based healthcare (HHC) and Non-emergency Patients' Transportation (NEPT) services are especially crucial

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nowadays because of the aging population and eruptions of infectious diseases (e.g., Covid-19 and SARS). This research presentation provides a general overview of our research and discusses the two research problems in detail. (1) Besides the requirement of typical HHC services (provided by a Nurse\caretaker), most HHC patients also need home delivery of medicines, pickup service for blood samples, delivery of test reports, and home meal delivery service. Our recently published article presents a decision support framework to make schedules simultaneously for the HHC staff and home delivery vehicles under the requirements of synchronization between HHC staff and home delivery vehicles' (HDVs) visits, multiple visits to patients, multiple routes of HDVs and pickup/delivery visits related precedence. The ultimate goal is to provide a solution that ensures that isolated elderly receive all kinds of home deliveries in the presence of a caretaker. The research problem is based on a realistic case study in Hong Kong. CPLEX is used to solve the mathematical model, and an efficient Hybrid Genetic Algorithm (HGA) is constructed to address real-world situations. Experimental results show that the suggested algorithm performed well even as the number of necessary synchronized services increased, and the heuristic strategies let the HGA deliver better-quality solutions in a substantially shorter period. (2) Shared mobility for NEPT through non-emergency ambulances is an important aspect of healthcare accessibility. We developed a Mixed Integer Linear Programming (MILP) formulation to model the NEPT problem. This MILP model contributes to the existing literature by not only including the patient inconvenience measures in the weighted objective function but also assists to identify a better trade-off among different performance measures thanks to its real-life characteristics and modified formulation. A clustering-based iterative heuristic framework is developed to tackle problems of practical sizes in order to overcome the related computational complexity. The suggested framework distinctively uses the problem-specific characteristics of the considered NEPT problem in a novel way to augment and improve the clustering mechanism by constantly adjusting the cluster centers. The computational tests on 19 realistic problem instances demonstrate the effective implementation of the solution method and show the applicability of our approach. The extensive sensitivity analysis implemented to explore the behavior of the MILP model reveals that the penalty value for user inconvenience measures is minimum when operating costs are given a weightage of 0.05 in the objective function, and the penalty value for the same measures is maximum when the weightage value for operating costs is changed between 0.8 and 1.0. This study can support decision-makers in balancing operational costs and patient inconvenience during transportation to improve service quality.

## 2

### **Review And Gap Analysis on Mathematical Programming Models for Urban E-Grocery Delivery Before, During And After Covid-19 Pandemic\***

*Adibah Shuib, Nur Hazimah Basir, and Zati Aqmar Zaharuddin  
Malaysia*

Online grocery shopping or e-grocery has becoming more relevant nowadays when consumers' shopping habit changed due to pandemic COVID-19 while e-Commerce rapidly transformed consumers' lifestyle and buying behaviour in recent years, Consumers' expectation for faster, better and cheaper delivery put e-grocers under rising pressure to improve delivery speed, achieving environmentally friendly delivery methods and addressing issue of making profit. There have been studies worldwide on development of more efficient e-grocery delivery system. However, studies concerning e-grocery delivery in Malaysia are still lacking especially on those utilizing mathematical programming models for delivery optimization. Our study focuses on the formulation of mixed integer goal programming models for vehicle routing problem with time windows for homogeneous and heterogeneous fleet of vehicles. This paper presents a structured review of past studies and gap analysis on some selected mathematical programming models. The review and gap analysis provide vital information on main characteristics for models of our study. Results presented would be useful for studies that concern with finding optimal solutions, innovative approaches and the most

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practical techniques for urban e-grocery deliveries. These strategies could lead to time and costs savings and enhance the effectiveness and efficiency of delivery operations that benefits both e-grocers and consumers.

3

**Philippine Eagle Optimization Algorithm and Applications\***  
*Erika Antonette Enriquez, Renier Mendoza, and Arriane Crystal Velasco*  
*Philippines*

We propose a novel, metaheuristic, and population-based optimization algorithm inspired by the hunting and flying behaviors of the Philippine Eagle, called the Philippine Eagle Optimization Algorithm (PEOA). From a random population of eagles in a search space, the best eagle undergoes a local food search using the interior point method as its means of exploitation. The population is then divided into three subpopulations, and each subpopulation is assigned an operator which controls the exploration. The best eagle is then updated and conducts a local food search again. After multiple iterations, the food searched by the final best eagle is the optimal solution in the search space. PEOA is tested on a varied set of benchmark test functions and compared to other optimization algorithms. To further validate the effectiveness of PEOA, it is implemented in several real-world applications. These include image reconstruction in electrical impedance tomography, which has many uses in biomedical sciences. We also apply PEOA in the parameter identification of a neutral delay differential equation model. Furthermore, we apply PEOA in solving COVID-19 vaccine allocation problems in the Philippines. Applications in engineering are also presented.

**12 Youth Forum 2**

1

**Value Function Gradient Learning for  
Large-Scale Multistage Stochastic Programming Problems\***  
*Jinkyu Lee, Sanghyeon Baea, Woo Chang Kim, and Yongjae Lee*  
*South Korea*

A stagewise decomposition algorithm called “value function gradient learning” (VFGL) is proposed for large-scale multistage stochastic convex programs. VFGL finds the parameter values that best fit the gradient of the value function within a given parametric family. Widely used decomposition algorithms for multistage stochastic programming, such as stochastic dual dynamic programming (SDDP), approximate the value function by adding linear subgradient cuts at each iteration. Although this approach has been successful for linear problems, nonlinear problems may suffer from the increasing size of each subproblem as the iteration proceeds. On the other hand, VFGL has a fixed number of parameters; thus, the size of the subproblems remains constant throughout the iteration. Furthermore, VFGL can learn the parameters by means of stochastic gradient descent, which means that it can be easily parallelized and does not require a scenario tree approximation of the underlying uncertainties. VFGL was compared with a deterministic equivalent formulation of the multistage stochastic programming problem and SDDP approaches for three illustrative examples: production planning, hydrothermal generation, and the lifetime financial planning problem. Numerical examples show that VFGL generates high-quality solutions and is computationally efficient.

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2

## Value Function Based Difference-of-Convex Algorithm for Bilevel Hyperparameter Selection Problems\*

*Jin Zhang*  
*China*

Existing gradient-based optimization methods for hyperparameter tuning can only guarantee theoretical convergence to stationary solutions when the bilevel program satisfies the condition that for fixed upper-level variables, the lower-level is strongly convex (LLSC) and smooth (LLS). This condition is not satisfied for bilevel programs arising from tuning hyperparameters in many machine learning algorithms. In this work, we develop a sequentially convergent Value Function based Difference-of-Convex Algorithm with inexactness (VF-iDCA). We then ask: can this algorithm achieve stationary solutions without LLSC and LLS assumptions? We provide a positive answer to this question for bilevel programs from a broad class of hyperparameter tuning applications. Extensive experiments justify our theoretical results and demonstrate the superiority of the proposed VF-iDCA when applied to tune hyperparameters.

3

## Full Consistent Logarithmic Percentage Change-driven Objective Weighting (F-LOPCOW) Model: Applications in Sustainable Transportation\*

*Sanjib Biswas, Aparajita Sanyal, and Samarjit Kar*  
*India*

Transportation is an integral part of all aspects of human life. Social well-being and trade and business largely depend on transportation systems. For the last many decades, global warming has been one of the top priorities for the common people, organizations, and country leaders. To safeguard lives and livelihoods it is imperative to reduce carbon emissions and the greenhouse effect. Quite understandably, sustainable city planning to achieve net zero is emphasized by countries (especially the countries having rapid industrialization and urbanization) across the globe as a long-term strategic action. In this regard, transportation is a major focus area as it contributes significantly to the total carbon emission. To reduce the CO<sub>2</sub> footprint for ensuring better air quality, electric vehicles (EVs) have emerged as future alternatives for sustainable transportation planning. Designing EV is a distinguished area today. EVs are environment friendly (emit less amount of CO<sub>2</sub> and other toxic gasses) and do not use fossil fuels. To this end, the present paper intends to apply a Multi-Criteria Decision Making (MCDM) based framework for comparing leading electric cars (EC) used in India. MCDM models are widely used in comparing decision alternatives (DA) subject to their performance determined by a set of features or criteria to figure out the best possible solution. There has been a plethora of MCDM models developed by researchers to work with objective and subjective information. In this paper, we use objective information available widely to compare 20 popular ECs. Among the models working with objective information, the Logarithmic Percentage Change-driven Objective Weighting (LOPCOW) model has been developed very recently to provide the advantages (over its counterparts) like the ability to deal with a large number of criteria and negative performance values, the ability to withstand variations in the performance values and providing considerably even distributions in the criteria weights. On the other hand, the Full Consistency Method (FUCOM) has the inherent capability to ensure consistency in the outcome and provides robust and consistent solutions. The current study combines the benefits of both these methods to develop a full consistent LOPCOW (F-LOPCOW) model for criteria weight calculation and subsequently, use it for comparing the ECs. We perform the comparative analysis of the F-LOPCOW model with other widely used MCDM frameworks and observe a significant correlation among the rankings. Further, the sensitivity analysis and the value of deviation from full

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consistency (DFC) confirm the stability of the solution. The present work extends the growing strand of literature on sustainable transportation by providing a new framework for the decision-makers.

#### **A Practical Approach for On-Demand Ride-Matching with Order Cancellation\***

*Dongling Rong, Xinyu Sun, and Meilin Zhang*  
*Singapore*

4

With the prevalence of smart mobile phones today, Ride-hailing or Mobility-on-Demand (MoD) platforms, such as Uber, Lyft, and Didi, have made personal transport more efficient. These platforms meet the growing needs of on-demand transportation by promptly dispatching available drivers to requesting passengers. The efficiency of such systems primarily hinges on how to combat uncertainties from both supply and demand sides spatially and temporally. One important problem for improving this MoD efficiency is how to dispatch real-time orders or match idle drivers to open trip orders, especially considering order cancellations. To address such an issue, we analyze the order cancellation dynamics from real data, and the empirical findings show the prevailing cancellations when pick-up times exceed passengers' waiting thresholds. In contrast to existing revenue maximization or pick-up distance minimization, we develop a practical online matching policy so that order fulfillment within the customized service targets can be achieved with the largest probability in the dynamic environment, which in turn helps to improve the customer service. The customized service targets are built upon various aspects, such as order rewards and system service capacity, which takes the form of the Cobb-Douglas production function. We provide a tractable approximation for the largest probability model, which can be solved efficiently and appropriately for industrial-scale deployments. The numerical simulations using real data from an online ride-hailing platform further demonstrate the benefits of our approach in relevant metrics, such as order fulfillment rate, platform revenue, and capacity utilization. The improvements are more pronounced when facing uncertain travel speeds of vehicles, frequent order cancellation, and imbalanced distribution of supply and demand, which often reflects real environments.

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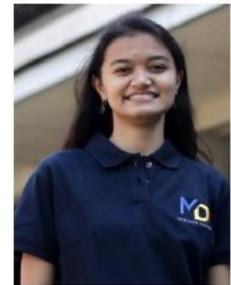
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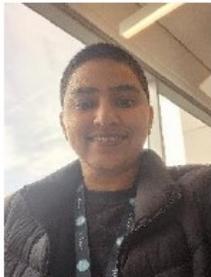
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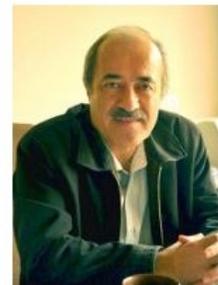
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Vic is currently a lecturer at the Department of Quantitative Methods and Information Technology department at the John Gokongwei School of Management at the Ateneo de Manila University. He teaches System Dynamics, and Decision Making Using Business Simulations, IT Trends, and Project Management Fundamentals. He also teaches solution methods for large-scale optimization models using Algebraic Modeling Languages.

## 45 *Rosentreter, Joshua*

Joshua is a Ph.D. student at the Queensland University of Technology in Australia. He started his research in 2021, on a project to improve the public transport in his city. With a broader interest in systems that improve processes, his previous work has included an optimisation tool for volunteer rostering.



46

*Shuib, Adibah*

Assoc. Prof. Ts. Dr. Adibah Shuib, FIMA is an Associate Professor in the Faculty of Computer and Mathematical Sciences (FSKM) of Universiti Teknologi MARA (UiTM), Malaysia. She is currently the Deputy Director (Research & Education) of Malaysia Institute of Transport (MITRANS), UiTM. She is also the President of the Management Science / Operations Research Society of Malaysia (MSORSM) and the Treasurer of the Asia Pacific Operations Research Society (APORS). She is a FIMA or Fellow of the Institute of Mathematics and its Applications (IMA), United Kingdom, an Associate Fellow of the National Council of Professors, Malaysia and a Professional Technologist (Ts) recognized by the Malaysia Board of Technologists (MBOT). Her research interests are in mathematical programming models and optimization in various applications.

47 *Singh, Rashmi*

Dr. Rashmi Singh received her Master & Ph.D. degrees from Indian Institute of Science (IISc), Bangalore. During her Ph.D., she mainly focused on scheduling problems that arise in semiconductor manufacturing industries. Prior to this, she received the Bachelor of Engineering (BE) degree in Electronics & Communication Engineering from Birla Institute of Technology, Mesra, Ranchi. She also had industrial experience while working with Wipro Technologies, Bangalore. She is currently working as an Assistant Professor in the Department of Management Studies at Indian Institute of Technology (ISM) Dhanbad. Her research interests mainly include simulation & modeling, scheduling, data analytics, and optimization. She has published various articles in the reputed journals & conferences. She has received several grants by the Department of Science & Technology, Gol. for carrying out research for the societal driven activity. She has recently received excellent rating for successful execution of externally funded project from National Council of Science & Technology Communication, Government of India.





V.B. Singh is currently working as Professor and Associate Dean in the School of Computer and Systems Sciences, Jawaharlal Nehru University, India. He received his M.C.A. degree from M. M. M. Engineering College, Gorakhpur, U.P., India and Ph.D. degree in Software Reliability from University of Delhi. He has published more than 90 research papers. His research interests include mining software repositories, empirical software engineering and software reliability engineering. He has co-authored a book “Essentials of Computer Network Database and Internet Technology” from NAROSA Publishing India. He has also received an award from Society for Reliability Engineering, Quality and Operations Management for contribution as a promising author and Researcher in the field of computer Science. He has completed research projects from University Grants Commission, Department of Science and Technology Government of India and University of Delhi. He is member of Society for Reliability Engineering, Quality and Operations Management and Association of Computing Machinery (ACM).

Dr. Yu Song was born in China. He earned his Ph.D. at Tohoku University, Japan. Currently, he is a professor at Department of Systems Engineering, Fukuoka Institute of Technology, Fukuoka, Japan.



50

*Tshokey, Tshokey*

Dr. Tshokey is a Clinical Microbiologist and an Assistant Professor of Microbiology in Bhutan's National Referral Hospital and the medical university. He received his medical education in Myanmar (MBBS) and Sri Lanka (MD), followed by his research training in Australia (PhD). He is a clinician, a researcher and an academician in laboratory medicine, public health, infectious diseases and operational research. He has diverse research interests with about 35 publications to his credit. He also serves as a technical expert to several national programs in the Ministry of Health including tuberculosis, immunization, polio, infection control, antimicrobial resistances, zoonoses and COVID-19 responses.

51

*Velasco, Franz Christian*

Franz Christian S. Velasco is an instructor at the Department of Industrial Engineering at the University of the Philippines Los Baños.



52

*Weber, Thomas*

Thomas A. Weber is Professor of Operations, Economics and Strategy at the Swiss Federal Institute of Technology in Lausanne (EPFL). Earlier he was a faculty member in Management Science and Engineering at Stanford University, and a senior consultant with the Boston Consulting Group. He holds a Ph.D. from the Wharton School of the University of Pennsylvania, as well as graduate degrees in Electrical Engineering and Computer Science and Technology and Policy from MIT. Professor Weber's research interests include the economics of information and uncertainty, stochastic optimal control, nonlinear systems, and corporate strategy. With over 100 academic papers in economics and management science, he is also the author of the monograph "Optimal Control Theory with Applications in Economics" (MIT Press, 2011).

## 53 *Yang, Jihye*

Jihye Yang is a PhD student of Management Science in Yonsei School of Business at the Yonsei University, Republic of Korea. Her research interests include nonlinear programming, portfolio optimization, and financial engineering.



## 54

*Zhang, Jin*



Jin Zhang earned a Ph.D. in applied mathematics from University of Victoria in 2014. After working in Hong Kong Baptist University for four years, he arrived at Southern University of Science and Technology as a tenure-track assistant professor in January 2019. His broad research area is comprised of optimization and variational analysis, as well as their applications in economics, engineering and data science. He was awarded the Junior Research Award from Operations Research Society of China (ORSC) in 2020, and Excellent Young Investigator Grant from National Science Fund of China (NSFC) in 2022.

## 55 *Zhang, Meilin*

Dr. Meilin Zhang is a senior lecturer in the Analytics Program of Singapore University of Social Science, where she has been teaching data analytics, artificial intelligence, business technologies and digital marketing to undergraduate, graduate and executive programs since 2017. Meilin received her B.S. and M.S. degree in Computer Science from China and her Ph.D. in Decision Science from NUS Business School in 2015. Her research is in the areas of supply chain management, robust optimization, healthcare analytics, sharing economy, large-scale computation and machine learning. She has also published her work in top tier business journals: Management Science, Operations Research and Manufacturing & Service Operations Management (MSOM).



## 56

*Zhang, Qiao*



Qiao Zhang is a lecturer of Changzhou University in China. She is a recent graduate from Southeast University with a major in Operations Research and Cybernetics under the supervision of professor Xiucui Guan. Her research interest includes the inverse combinatorial optimization, network interdiction problems and algorithm design and analysis, etc. She has published 4 SCI indexed papers on combinatorial optimization.

# APORS

## *Member Societies*

### Australia



The Australian Society For Operations Research (ASOR) was founded on 1st January, 1972 and has about 200 members nationwide. ASOR, like other OR societies in other nations, is affiliated to the International Federation of Operational Research Societies (IFORS).

ASOR's objectives are to:

- Foster the development of the science of Operations Research.
- Foster the application of Operations Research wherever appropriate.
- Foster the widest possible exchange of information and ideas on Operations Research and related subjects.
- Define standards of knowledge in and to further the study of Operations Research.

### China



In April 1980, the Operations Research Branch of the Chinese Mathematical Society was established. This has undoubtedly played a great role in promoting the development of operations research in the country. In 1991, the China Operations Research Society was established.

The Operations Research Society of China actively organizes operations research workers and conducts extensive academic exchange activities at home and abroad. Through these years of fruitful efforts, a batch of new academic talents have emerged in the Chinese operations research field, and operations research itself has undergone qualitative changes in China from scratch, from naive to mature.

While focusing on its own development, the Operations Research Society of China has also actively carried out exchanges and cooperation with the international operations research community. status. The Operations Research Society of China is standing on the international science and technology stage with a mature attitude.

## Hong Kong

The Operations Research Society of Hong Kong (ORSHK) is located in Dept. of Mgmt. Sciences, City Univ. of Hong Kong, Tat Chee Ave., Kowloon, Hong Kong.

## India



The Operational Research Society of India was founded in 1957 with its headquarters at Delhi. In 1971, it was shifted to Kolkata. It provides a common forum for the Operations Research Specialists-theoreticians and practitioners – to widen their horizon by exchange of knowledge and application techniques. They may work in academia, in industry or in public service, teaching, conducting research or consulting by developing and applying OR methods. It is the professional discipline that deals with application of scientific methods to decision-making.

## Iran



The Iranian Operations Research Society (IORS) was established in 2005 by approval of its constitution by the Ministry of Science, Research, and Technology in Tehran, Iran. The Society officially was approved to join IFORS as the 50th national member on December 16, 2009.

The activities of the Society are summarized below:

- Enhancing scientific and cultural research at national and international levels among the researchers and experts who deal with Operations Research.
- Cooperating with administrative, scientific, and research agencies in evaluating and reviewing plans and programs related to education and research issues concerning the society's interests.
- Promoting researchers and distinguishing successful researchers by honoring them.
- Rendering educational and research activities.
- Publishing books and international journals.
- Organizing scientific gatherings at national, regional, and international levels by holding regular internal seminars and international conferences.

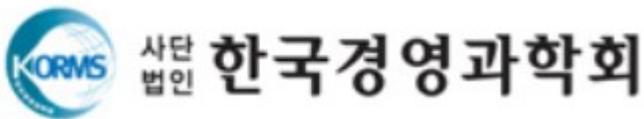
## Japan



The Operations Research Society of Japan (ORSJ) was established on June 15, 1957. After its foundation in 1957, ORSJ immediately joined IFORS in 1960. The first IFORS President from Asia, Takehiko (Bill) Matsuda of ORSJ, took office in 1973. ORSJ organized the seventh IFORS Triennial conference in Tokyo and Kyoto in 1975, the International Symposium on Mathematical Programming in 1988, and the 1994 Association of Asian-Pacific Operational Research Societies (APORS) conference in Fukuoka.

In addition to such pursuits as research on OR theory and the development of methodologies, the ORSJ explores the practical use of methods applicable to specific problems occurring in the world of business and government offices. It also actively promotes exchanges of information among its members as well as interaction on an international level.

## South Korea



The Korean Operations Research and Management Science Society (KORMS) is the professional organization in Korea for individuals and organizations interested in the fields of Operations Research (OR) or Management Science (MS). The society was established on June 23, 1976 and incorporated as a nonprofit organization on June 28, 1977 under the jurisdiction of the Ministry of Science and Technology.

- The objectives of the Society are as follows.
- To promote the study and application of OR/MS.
- To disseminate knowledge through the publication of research results and informal exchange of information.
- To contribute to the advancement of the fields of OR and MS, as well as system analysis, cybernetics, and related disciplines.

## Malaysia



The Management Science/Operations Research Society of Malaysia (MSORSRM) was registered as a

professional society under Section 7 Societies Act of Malaysia 1966 on 19 July 1986, and its registration number is 3935/86 (Selangor). It was inaugurated on 5 October 1986.

The Management Science/Operations Research Society of Malaysia (MSORSM) is the 36th national member of the International Federation of Operational Research Societies (IFORS), the 9th national member of the Asian Pasific Operational Research Societies (APORS), and a member of the Confederation of Scientific and Technological Associations in Malaysia (COSTAM).

## Nepal



The Operational Research Society of Nepal (ORSN) was established on February 1, 2007 by a team that consisted of: founding President Prof. Dr. Sunity Shrestha, Vice Peresident Prof. Pushkar Kumar Sharma General Secretary Govinda Tamang, Secretary Basant Dhakal, Treasurer Krishna Nakarmi. Kabita Bade Shrestha, Sunil Amatya, Raju Manandhar and Binod Manandhar. These officers officially registered ORSN with the Office of the Nepal Govern-ment in Kathmandu.

ORSN, a non-profit, public welfare, and social institution, has the following objectives:

- Orient and advocate the importance and need of operational research in Nepal
- Collect and publicize the materials related to operational research to strengthen operational research science
- Conduct research, conferences, workshops, trainings, discussions for the personnel associated with operational research area
- Provide operational research consultancy services to the organizations
- Develop coordination and expand national and international network of operational research science

## New Zealand



The ORSNZ was founded in 1965 by staff at the Applied Maths Division of the DSIR (Department of Scientific and Industrial Research), a government department based primarily in Wellington. The Operations Research Society of New Zealand (ORSNZ) is a nationwide not-for-profit registered charity comprising academics and public servants, consultants and people in industry. The primary aim of the Society is to promote Operations Research and Management Science in New Zealand in both academic and industrial aspects.

## Singapore



Operational Research  
Society of Singapore

The Operational Research Society of Singapore (ORSS) was registered as a professional association on 21st November, 1975. The society was formed in response to the need for such an association to promote the field of Operational Research in Singapore.

The objectives of ORSS are as follows:

- To propagate the knowledge of Operational Research in Singapore.
- To promote the use of Operational Research techniques in industry, commerce and public administration.
- To foster, in the broadest sense, training and education in Operations Research.
- To promote the exchange of information and co-operation through its association with kindred societies.
- To contribute to the development of Operational Research in general.
- To promote theoretical and applied research in Operational Research.

*The host society: Operations Research Society of the Philippines  
Celebrates 35 Years*



Operations Research  
Society of the Philippines

A Member of  IFORS

The formation of the national OR society of the Philippines was an initiative of the private sector with the full support of the academe. The San Miguel Corporation's Operations Research Department (awarded the 1992 ORSA Prize for consistent and sustained OR/MS support to decision making at all levels of the organization) hosted a dinner dubbed "A Toast to OR Professionals" in December 1986. This culminated in the official recognition of the Operations Research Society of the Philippines in February 1987.

Its very first symposium which featured OR applications in various sectors metamorphosed into quarterly technical forums on such issues as Traffic, Agriculture, Environment, Energy, Business Logistics, Health, Sustainable Development, and Finance. Regular workshops on the use of spreadsheets, various simulation software were held. Its annual general membership meeting coincides with the annual national conference where professionals from all over the country discuss directions for the society, present their technical papers, and get updated on local and international OR developments.

ORSP became a member of the International Federation of Operational Research Societies (IFORS) in 1990. In 2007, one of its founders, Elise del Rosario, assumed the Presidency of the international body. ORSP organized its first international conference, the 1990 International Conference on OR/MS in the same year the first issue of the *Philippine Journal of Operations Research* appeared soon after the ORSP Newsletter was published and its website [www.orsp.org.ph](http://www.orsp.org.ph) put up.

In 1997, ORSP hosted the second ICORMS jointly with the IFORS' annual International Conference on OR in Development (ICORD), followed in 2004 by the *IFORS Workshop for Teachers in Developing Countries*, then in 2006, by the Association of Asia Pacific OR Societies (APORS) Seventh Conference. In this meeting, Philippine President Gloria Arroyo acknowledged the contribution of OR in development and challenged ORSP to help the government in some of its programs.

At that time, the ORSP Committee on OR for Public Service (ORSP Corps) had been well established. With a mission to help in nation building through the use of OR, the committee has helped such government agencies as Philippine Ports Authority, Bureau of Customs, Commission on Elections, and National Power Corporation since 1999. Prior to this, the organization had links with the Department of Science and Technology, which sponsored its forums on public sector applications and had two Philippine Presidents grace its Annual General Membership meetings.

ORSP does not lose sight of the future OR professionals: the students. Early on, ORSP laid down the foundation for the formation of student chapters and inducted its first one in 1989. It has since accredited more than twenty, which comprise the ORSP Federation of Student Chapters. The Federation actively sponsors get-togethers, and an annual Student Congress, lectures, Inter-University OR Quiz and Case Competitions.

The ORSP-organized technical forum and workshops served the professional development needs of its members from practice and the academe. During the pandemic years, ORSP sponsored quarterly webinars which attracted a good number of members, as various local and international speakers shared their papers and experiences on such themes as Logistics, Agriculture, Poverty, and Cryptocurrency. ORSP has continued to deal with analytics topics as one of its main areas.

Selected to host the 2021 APORS International Conference, ORSP organized the 2020 pre-APORS virtual conference in view of the decision to have the IFORS conference (which was to be held in the Asia Pacific region) moved to 2021. Thus, APORS Manila was moved for this year, 2022, right on its 35<sup>th</sup> birthday!

# Local Organizing Committee



## Conference Chair

*Francis Miranda*

## Overall Coordinator

*Elise del Rosario*

## Technical Program

*Malu de Guzman U & Iris Ann Martinez*

## Sponsorships & Communication

*Marie Shella Mariscal & Edwin Loma*

## Logistics & Publicity

*Juanito Chan & Nestley Sore*

## Papers & Tokens

*Dennis Cruz & Vic Reventar*



Francis is the Global Senior Head of Web Scraping Solutions, and Asia Pacific Quality and Data Science Director at GfK ([www.gfk.com](http://www.gfk.com)). He has more than 25 years of experience in various companies including Coca-Cola, Zuellig Pharma and Nielsen IQ doing operations research, market research, data science and analytics. He has a BS degree in Industrial Engineering from De La Salle University-Manila, and a MS degree in Industrial Engineering from Purdue University. He completed his Advanced Management and Leadership Programme (OAML P) at Oxford University in 2022. He is the International Federation of Operational Research Societies (IFORS) Vice-President representing Asia Pacific. He is also the immediate Past President of the Association of Asia Pacific Operational Research Societies (APORS), and the Operations Research Society of the Philippines (ORSP).

**Conference Chair**

*Francis Miranda*

Elise is Past President of the International Federation of Operational Research Societies (IFORS) and a founding member of the ORSP. Upon retirement from San Miguel Corporation as Vice President in charge of Operations Research, Elise went into consulting – mostly pro-bono work with the Philippine government – through the ORSP Committee for Public Service. Currently, she is the CFO of her family’s One Small Step Forward Foundation, dedicated to uplifting Philippine public elementary school education. On the OR side, she still actively speaks at local and international conferences and acts as editor for various scientific publications. She obtained her BS degree in IE from UP, her Master's degree in IE & Mgt from Asian Institute of Technology, Bangkok and was an International Research Fellow at the Stanford Research Institute, USA. She is an IFORS Fellow.



**Overall Coordinator**

*Elise del Rosario*



**Malu** is a lecturer of Operations Research at the John Gokongwei School of Management, Ateneo de Manila. She also taught OR and Applied Math at the University of Asia & the Pacific, and Mathematics at UP Diliman. She previously worked in Dallas as a supply chain analyst, implementor, and trainer, consulting in different U.S. and Asia Pacific cities. She obtained her Ph.D. in Industrial Engineering from Purdue University where she specialized in optimization. Her dissertation entitled “Experiments with Nonlinear Discriminants in the Analysis of Fine Needle Aspirates” won First Place, 1999 Pritsker Doctoral Dissertation Award, given by the U.S. Institute of Industrial Engineers (IIE). She finished MS Applied Mathematics major in Operations Research at UP Diliman, and BS Mathematics at the Ateneo de Manila.

**Technical Program**

*Malu de Guzman U*

Iris Martinez is Professor 12 of the UP Department of Industrial Engineering and Operations Research. She is the holder of the Fortunato T. dela Peña Professorial Chair for Productivity Engineering. For more than 20 years, she has been helping the academe, government agencies and industries of food, personal care, healthcare and utilities improve production and service operations and supply chain management.



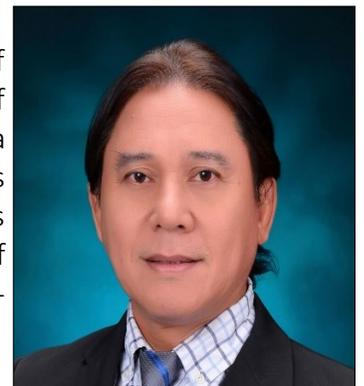
**Technical Program**  
*Iris Ann Martinez*



Shella is the Data Analytics & Operations Research Manager of the Data and Analytics Group at San Miguel Corporation.. She has a BS degree in Industrial Engineering (minor in Mechanical Engineering) from De La Salle University. She has completed the Leadership and Management Development Program in Ateneo de Manila University with Academic Citation, completed the Basic Management Program in the Asian Institute of Management with Superior Performance, and taught at the De La Salle University.

**Sponsorships & Communications**  
*Marie Shella T. Mariscal*

Jed is the Marketing Director of NU Asia Pacific College, after serving as the Head of its Master in Management program. He is also the VP Business Development of Great People Learning Laboratories, an educational technology company. He has a BS in Management Engineering and Master in Business Administration degrees from the Ateneo de Manila University, and is a candidate for a Doctor in Business Administration degree at De La Salle University. He is a member of the board of directors of Next-Gen University Alliance of the Philippines, formerly the SAP University Council of the Philippines.



**Sponsorships & Communications**  
*Edwin J. Loma*



Nestley, a certified Professional Industrial Engineer, is currently the Director of Office for Programs and Standards in Adamson University. She obtained her BS in Industrial Engineering from Adamson University and her Master's degree in IE from UP Diliman. She had also been affiliated with PAASCU, CHED, and Philippine Technological Council (PTC) as an assessor and accreditor. Nestley received the title of ASEAN Engineer last December 2012 during the 30th Conference of the ASEAN Federation of Engineering Organizations (CAFEO) held in Phnom Penh, Cambodia.

**Logistics & Publicity**

*Nestley Sore*

Jacky is a workplace-based professor at the Ateneo Graduate School of Business, handling Applied Mathematics, Business Statistics, Management Decision Models, Operations Management and Lean Six Sigma courses. He was guest professor at Taiz University, Delft (an affiliate of Delft University of Technology, Netherlands), where he taught OR. A freelance consultant on Business Process Improvement, Operations Research, Quality Engineering and Lean Six Sigma, he is a registered ASEAN Engineer of the ASEAN Federation of Engineering Organizations (AFEO).



**Logistics & Publicity**

*Juanito Chan*



Dennis is an Assistant Professor in the Industrial Engineering Department of De La Salle University. He is a former Associate Dean of DLSU Gokongwei College of Engineering. He obtained his Bachelor of Science degree in Industrial Engineering Minor in Chemical Engineering from De La Salle University and his Master of Science degree in Industrial Engineering from the same university. His areas of interest include Supply Chain Management, Facilities Planning, Mathematical Modelling, and Optimization. He is presently pursuing his Doctor of Philosophy degree in Industrial Engineering in De La Salle University.

**Papers & Tokens**

*Dennis Cruz*

Vic is currently a lecturer at the Department of Quantitative Methods and Information Technology department at the John Gokongwei School of Management at the Ateneo de Manila University. He teaches System Dynamics, and Decision Making Using Business Simulations, IT Trends, and Project Management Fundamentals. He also teaches solution methods for large-scale optimization models using Algebraic Modeling Languages.



**Papers & Tokens**

*Vic Reventar*

# **APORS**

## *Scientific Advisory Board*

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**Mike O'Sullivan**

*Operations Research Society of New Zealand (ORSNZ)*

**Marie Shella T. Mariscal**

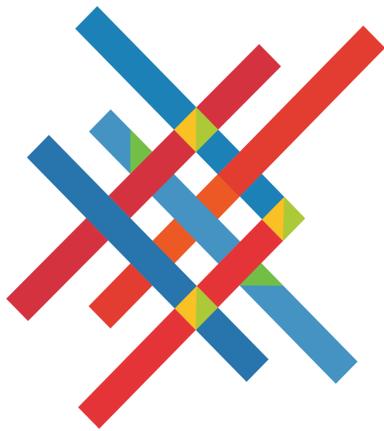
*Operations Research Society of the Philippines (ORSP)*

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## SCHOOL OF COMPUTING & INFORMATION TECHNOLOGIES

### BS Computer Science

*SPECIALIZATIONS:*

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- Software Systems

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*SPECIALIZATION:*

Mobile & Internet Technologies

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- Full Stack Development Track

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BS Civil Engineering

BS Electronics Engineering

BS Computer Engineering

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BS Architecture

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BS Business Administration

BS Management Accounting

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- Financial Management
- Marketing & Advertising
- Business Management

BS Tourism Management

BS Tourism Management

*SPECIALIZATION:*

- Hotel & Restaurant Operations

*SPECIALIZATION:*

- Business Analytics

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(Online CFE - College Freshmen Enrollment)

### FRESHMEN

- Original copy of Grade 12 report card (Form 138) with the applicant's eligibility for admission to college duly signed by the school principal of his/her previous school
- Original copy of Certificate of Good Moral Character
- Original copy of PSA Birth Certificate
- Two (2) 2x2 ID pictures
- Photocopy of vaccination card/certificate

### GRADUATE SCHOOL/JURIS DOCTOR

- Original Transcript of Records
- Original Transfer Credentials/Honorable Dismissal
- Original Certificate of Good Moral Character
- Original PSA Birth Certificate
- 2pcs 2x2 Pictures (white background)
- Photocopy of vaccination card/certificate

For students who graduated abroad under an international curriculum, all documents must be duly authenticated (apostille) by the Philippine Embassy or the consulate of the country where his/her school is located

### TRANSFEREES AND DOCTOR OF PHARMACY

- Original True Copy of Grades (TCG) Transcript of Records (TOR)
- Original copy of Honorable Dismissal/Transfer Credentials
- Original copy of Certificate of Good Moral Character
- Original PSA Birth Certificate
- Two (2) 2x2 ID pictures
- Photocopy of Vaccination card/certificate



## REQUIREMENTS FOR INTERNATIONAL STUDENTS

• **Letter of Application** addressed to the University Registrar indicating the course that the applicant intends to enroll and name of the school s/she last attended

• **Five (5) copies** of the student's Personal History Statement (PHS) duly signed by him/her, both in English and his/her native alphabet, accompanied by his/her seal, if any among others, his/her left and right thumbprints and a 2x2-sized photograph in plain white background taken not more than six months prior to submission

• **Official Transcript of Records/ Scholastic Records duly authenticated by the Philippine Embassy or Consulate** in the student's country of origin or legal residence

NOTE: A "Seen and noted" stamp is not considered as an authentication and is thereby invalid

• **Police Clearance duly authenticated by the Philippine Embassy or Consulate** in the student's country of origin or legal residence

• **Notarized Affidavit of Support with proof of adequate financial support** stating the means to cover expenses for the student's accommodation, subsistence, school dues and other incidental expenses, **duly authenticated by the Philippine Embassy or Consulate** in the student's country of origin or legal residence

• **Photocopy of passport data page** (page containing students' full name, date and place of birth, passport number and photo), must be duly authenticated by the Philippine Foreign Service Post

• Photocopy of **Quarantine Test** (Medical Examination Result)

• Four (4) copies of 2x2 ID. pictures in white background

• Php10,000.00 **Acceptance Fee** (onetime payment)

• Php5, 000.00 **Foreign Fee** (every semester)

• University Entrance Examination Fee

• Photocopy of vaccination card/certificate

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**Admissions and Student Recruitment Office**  
**900 San Marcelino St., Ermita Manila, 1000 Philippines**  
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Bachelor of Science in Architecture

## COLLEGE OF BUSINESS ADMINISTRATION

Bachelor of Science in Accountancy

Bachelor of Science in Business Administration major in:

- Financial Management
- Marketing Management
- Operations Management

Bachelor of Science in Customs Administration

Bachelor of Science in Hospitality Management

Master of Business Administration

Master of Business Administration major in

- Customs Compliance
- and Supply Chain Management

Doctor of Philosophy in Management

## COLLEGE OF ENGINEERING

Bachelor of Science in Chemical Engineering

Bachelor of Science in Chemical Process Technology

Bachelor of Science in Civil Engineering

Bachelor of Science in Computer Engineering

Bachelor of Science in Electrical Engineering

Bachelor of Science in Electronics Engineering

Bachelor of Science in Geology

Bachelor of Science in Industrial Engineering

Bachelor of Science in Mechanical Engineering

Bachelor of Science in Mining Engineering

Bachelor of Science in Petroleum Engineering

Bachelor of Science in Mechanical Engineering,

major in Mechatronics (Dual Degree)

Master of Engineering, major in:

- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Electrical Engineering
- Electronics Engineering
- Industrial Engineering
- Mechanical Engineering

Master of Science in Management Engineering

Master of Science in Civil Engineering, major in

Geotechnical Engineering

Master of Science in Construction Management

## COLLEGE OF NURSING

Bachelor of Science in Nursing

## COLLEGE OF PHARMACY

Bachelor of Science in Pharmacy

Doctor of Pharmacy

Master of Science in Pharmacy

## COLLEGE OF SCIENCE

Bachelor of Science in Biology

Bachelor of Science in Chemistry

Bachelor of Science in Computer Science

Bachelor of Science in Information Systems

Bachelor of Science in Information Technology

Bachelor of Science in Psychology

Master of Science in Chemistry

Master of Science in Biology

Master in Information Technology

Master of Arts in Psychology

with specialization in Clinical Psychology

Master of Arts in Psychology

with specialization in Industrial Psychology

Master of Arts in Psychology

with specialization in Developmental/

Educational Psychology

## COLLEGE OF EDUCATION AND LIBERAL ARTS

Bachelor of Elementary Education

Bachelor of Secondary Education, major in English

Bachelor of Physical Education

Bachelor of Science in Exercise and Sports,

major in Fitness and Sports Management

Bachelor of Arts in Communication

Bachelor of Arts in Political Science

Bachelor of Arts in Philosophy

Master of Arts in Education with specialization

in School Administration and Supervision

Master of Arts in Education with specialization

in Physical Education and Sports

Master of Arts in Communication

Doctor of Philosophy in Education

with specialization in Educational Leadership

Doctor of Philosophy in Education

with specialization in Physical Education and Sports

## COLLEGE OF LAW

Juris Doctor

## BASIC EDUCATION

Pre-School

Grade School

Junior High School

Senior High School (STEM, ABM, HUMSS)

## ST. VINCENT SCHOOL OF THEOLOGY

Doctor of Philosophy in Theology

Master in Pastoral Ministry (Non-Thesis)

Master of Arts in Theology, major in:

- Biblical Studies
- Liturgical Studies
- Systematic Studies
- Moral Studies
- Vincentian Studies

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CORPORATION**

As a leading Filipino company, we are committed to being a force for good for our country and people.

With the completion of our 18-km. Skyway 3 project, the dream of seamlessly linking North and South Luzon and easing Metro Manila traffic is now a reality.

Through investments and initiatives that generate jobs, opportunities, and improve the lives of more Filipinos, SMC is building a better world for our generation and the next.

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