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IFORS NEWS

International Federation of Operational Research Societies

FROM THE PRESIDENT

OPERATIONAL RESEARCH AND IFORS

Grazia Speranza <grazia.speranza@unibs.it>

This is my first editorial for IFORS News, as my term as IFORS President started in January. It is the right moment to try to provide my views on Operational Research (OR) and on the role of IFORS.

I fell in love with OR during my bachelor studies. I studied mathematics with a major in applied math. I had to choose whether to do my thesis in statistics or in OR. I chose OR because it was newer, because it was more interesting, more complex. Certainly more fascinating, more exciting. I saw OR as a bridge between math and practice. I have never regretted that decision. I learned that OR provides both general and application-dependent tools to support decision making. Over the years, I kept meeting new challenges and, whenever I had the impression that an area or a topic I had been working on was not exciting to me any more, I moved to a new one. There is so much one can do in OR, from theory to practice, from applications in production and supply chain management to others in health systems and finance.

OR is a very young discipline, especially when compared with geometry or algebra. It was born with computers and has been continuously evolving with the technological evolution. All disciplines evolve with time but for the young ones the evolution is faster and this is the case of OR. The relation between OR and technology is two-ways. On one hand, the decision challenges, for which OR provides support, depend on the technology available. For example, progress in hardware and software development has given rise to the information systems that in turn have been the basis for the development of research in more advanced modelling. Also, the Internet has stimulated research in several areas, for example in supply chain management. Mobile devices have created a variety of new research opportunities, for example in collaborative decision making. In other words, what OR does, what our community does depends on the technology available. Technology creates the ground for research in OR. On the other hand, the products of research in OR contribute to technological evolution when OR models and algorithms are implemented. OR is itself a technology, a soft rather than a hard technology.

OR is what is contained in the books and papers written by OR researchers, is what we do in our daily activities, and what we do is intertwined with technology. OR is a young and dynamic discipline and it will be key to its success that our community remains open and flexible.

The role of IFORS is to support the growth of the OR community all over the world. In many countries OR is a well-established discipline with a strong scientific society and many researchers committed to OR research and practice. Countries with few, if any, OR researchers until a few years ago have recently founded a scientific OR society that has become part of the IFORS family, that nowadays counts 54 members. IFORS is our scientific societies, our community. The role of IFORS is to make the existing OR societies stronger and to further increase the size of the IFORS family. It is also to implement actions to support the dynamic evolution of OR in the world and to share OR findings, while respecting the diversity of our community.

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CALL FOR AN EDITOR-IN-CHIEF AND ASSOCIATE EDITORS FOR THE IFORS NEWSLETTER

The aim of the IFORS Newsletter is to share news from OR groups and societies from all over the world. The newsletter appears quarterly. IFORS is currently seeking to recruit a number of new volunteers from the global OR community to help in the production of this publication. The current editor-in-chief of the Newsletter will continue in this role until a new editor is identified. Moreover, to make the job more manageable, we plan to have associate editors for each section of the Newsletter. Each associate editor, would need to identify and edit one article every three months. We need associate editors for the following areas: OR Impact, OR for Development, Association Governance and Management, and OR Society in Focus. To review past articles from each of these sections, please see http://ifors.org/category/newsletter/ . The editor-in-chief is responsible mainly for collecting the final articles from the associate editors and defining the order they will be presented within each issue.

WELCOME TO IFORS OFFICERS 2018-2020

I am very pleased to introduce the March issue of the IFORS Newsletter. The issue starts with an editoral from the IFORS President, Prof. Grazia Speranza, where she shares with us her view on Operational Research and on the role of IFORS. The issue also presents a call for an editor-in-chief and associate editors for the IFORS Newsletter, and we are are looking forward to receiving volunteers from the OR community!

Since January 2019 IFORS has new officers and we provide a short bio of each one of them. IFORS previous President Michael Trick now has the role of Past President; Karla Hoffman will have a second term as VP representing NORAM, while Richard Hartl will continue being the treasurer. All other faces are new. On behalf of the previous team, I wish a warm welcome to the 2018-2020 IFORS officers!

The issue includes short articles about: centralized admissions for engineering colleges in India; and service operations models for platform businesses in the industry 4.0. In the OR for Development section you will find a call for submissions to the IFORS Prize for OR in Development 2020, and this call is also available in the IFORS Webpage. In this section we also have an article introducing the Institute of Mathematics and Physical Sciences (IMPS), hosted in Benin/Africa. Last year an OR summer school was organized at the ISMP. Following on, you will find a review of the book Community-Based Operations Research – Decision Modeling for Local Impact and Diverse Populations by Michael P. Johnson, written by our collaborator Hans Ittmann. Few international conferences were organized in this period, but we report on the 1st International Conference on Computer Sciences and Applied Mathematics, hosted in Indonesia. Finally, we end the issue with a few words about Michel Balinski, who we report with deep sadness left us this year, aged 85 years.

Luciana Buriol, editor <buriol@inf.ufrgs.br>

THE IFORS OFFICERS FOR 2018-2020

M.Grazia Speranza, President 2019-2021

M.Grazia Speranza is Professor of Operations Research at the University of Brescia and currently serves as Vice Rector. She was Vice-President of IFORS in 2008-2009, President of EURO in 2011-2012 and President of TSL (Transportation Science and Logistics) society of INFORMS in 2014. Her main scientific interests are: mixed integer programming, transportation and logistics, portfolio optimization. She is author of more than 150 papers published in international journals. She has been plenary speaker at several international conferences and editor of scientific journals. She is currently co-editor of the series 'EURO Advanced Tutorials in Operational Research.

Michael Trick Past, President 2019-2021

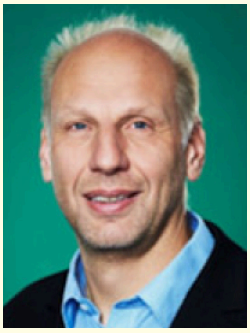
Mike Trick is faculty member at Carnegie Mellon's Tepper School of Business in Pittsburgh, where he also serves as Senior Associate Dean for Faculty and Research. His involvement with OR societies began when he became founding editor of INFORMS Online in 1995. After this, he served as President of INFORMS in 2002. He then served as NORAM Vice President from 2004-2009, generally taking a role in helping select conference locations and aiding local organizers in putting together the IFORS Triennial conferences. Notably, it was during these years that IFORS reached out and held its Triennial conferences in South Africa and in Australia. You can also follow him on twitter @miketrick and his blog at http://mat.tepper.cmu.edu/blog

"David" Chang Won Lee, Vice President

'David' Chang Won Lee is a professor of Operations and Service Management area and chair of Healthcare MBA program, Hanyang University, Seoul, Korea, and a director of Center for Tech Entrepreneurial Studies. He earned Masters of Mgmt Sci and PhD in OR and Healthcare from Saint Louis University, Missouri, USA. His studies appeared in Corp Soc Resp Env Ma, European J. of Operational Research(EJOR), Info & Mgmt, Intl J. of Info. Mgmt(IJIM), J. of Oper Res Soc(JORS), Supply Chain Mgmt: An Intl J.(SCM:IJ), Sustainability, Technol. Forecast. Soc. Change (TFSC) among others. He currently serves as presidents including INFORMS Korea, vice presidents, editors, associate editors, editorial board members, paper reviewers and other various acting roles in academic societies and journals. He had served as KORMS VP in International Activities, APORS Secretary and VP, APORS 2018 Kathmandu Meeting Program Chair (PC), IFORS 2020 Seoul Meeting Organizing Committee (OC) and IFORS VP representing APORS. He is a listee of Who's Who in World (2018-2019) and a recipient of 2018 Albert Nelson Marquis Lifetime Achievement Award.

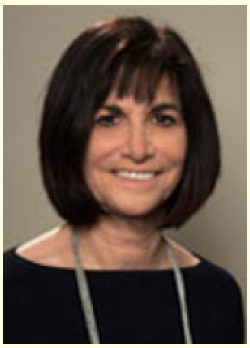
Richard Hartl, Treasurer

Richard Hartl has been full professor of production and operations management at the University of Vienna where he was also head of the Department of Business Administration. A Senior Extramural Fellow of the Center for Economic Research (CentER), University of Tilburg, he is associate editor of several top journals and has regularly received teaching awards while obtaining research grants for both theoretical and applied research. He was Austrian Society for OR (OEGOR) President. His main research areas involve the application of OR methods inproduction, logistics, and transportation.



Stefan Nickel, VP representing EURO

Stefan Nickel is a full professor at the Karlsruhe Institute of Technology – KIT (Germany) and one of the directors of the Institute of Operations Research. Since 2011 he additionally holds the positions of one of the directors of the Karlsruhe Service Research Institute (KSRI) and of the Research Center for Computer Science (FZI). From 2006-2015 he was editor-in-chief of Computers & Operations Research. He is editor-in-chief of Operations Research for Health Care since 2016. Stefan Nickel has authored or co-authored 5 books as well as more than 120 scientific articles in his research areas Locational Analysis, Supply Chain Management, Health Care Logistics, and Online Optimization. In addition, he conducted several industry projects with well-known companies.



Karla Hoffman, VP representing NORAM

Karla Hoffman is professor in the Department of Systems Engineering and Operations Research in the Volgenau Engineering School, George Mason University where she served as its Chair. She has received multiple research and teaching awards. Her primary research areas are combinatorial optimization, auction theory, and real-time scheduling and routing. She currently consults to the federal government on auctions and to the military and telecommunications industries on scheduling, manpower-planning and capital budgeting. Her research focuses on the development of new algorithms for solving large complex problems arising in industry and government. She served as INFORMS President and IFORS NORAM VP.

Rosiane de Freitas, VP representing ALIO

Rosiane de Freitas is a Brazilian computer scientist, associate professor at Institute of Computing of the Federal University of Amazonas (IComp/UFAM), with a Ph.D. in Computer Science and System Engineering from the Federal University of Rio de Janeiro (UFRJ), and UNICAMP. As Vice-President ALIO in the term 2016-2018 (member of the ALIO steering committee since 2014) and as Brazil's representative in CLEI (the Latin American Center for Computer Studies), she coordinates efforts across OR and CS societies within Brazil and Latin American. Her research interests include Combinatorial Optimization, Complexity, Scheduling, and Graph Theory, with several articles in the main international journals related to these areas, important applications in logistics, planning/production and forest dynamics, and.being an OR/CS consultant for different public and private organizations in Brazil and Latin American. She also acts strongly in advancing the careers and goals of women in STEM (Science, Technology, Engineering, and Mathematics).

Sunity Shrestha Hada, VP representing APORS

Sunity is professor of Management Science in the Central Department of Management of Tribhuvan University (TU) at Nepal where she also served as Assistant Dean for a decade. She had her Master of Science degree in Statistics from TU and MBA degree from Oklahoma City University (OCU), USA under Fulbright Scholarship. She also went to Indian Institute of Management at Ahmedabad, India (IIMA) for Faculty Development Program and earned her PH D degree in Finance from Faculty of Management Studies (FMS) of University of Delhi, India. She is the founder President of Operational Research Society of Nepal at 2007. She served as Chief-Editor and remained in the editorial board of International Journal of Operations Research of Nepal (IJORN) Sunity is also involved in the Network for Quality, Productivity and Competitiveness-Nepal (NQPCN). She is the member of Technical Committee in Quality Assurance and Accreditation Board (QAAB), and the member in 'Management Cluster Research Division' of University Grants Commission of Nepal. She is the founder Chairperson of Tribhuvan University Alumni Association of Nepal (TUAAN)

THE 1ST INTERNATIONAL CONFERENCE ON COMPUTER SCIENCES AND APPLIED MATHEMATICS AT LAKE TOBA, INDONESIA

Herman Mawengkang <hmawengkang@yahoo.com>

Small group photo at ICCSAM 2018. Professor Mawengkang: 4th person in the front row.

The 1st International Conference on Computer Sciences and Applied Mathematics (ICCSAM 2018; https://iccsam.org/) took place in collaboration with AMIK and STIKOM Tunas Bangsa Pematangsiantar, during October 11st-12th, 2018, in Parapat, North Sumatra, Indonesia. It was a collaborative effort between Bank Muamalat, Indonesian Mathematical Society (INDOMS), Ikatan Profesi Komputer dan Informatika Indonesia (IPKIN). This event was the first conference in this novel conference series. The topics of the conference were dedicated to the motto from Operational Research "Advancing Computability Innovation", which is of an increasing importance worldwide, especially, for an emerging nation like Indonesia with its young population.

This conference followed different aims: First, to bring together the scientists, engineers, researchers and practitioners, academicians, and civil society organization representatives in the scientific forum; second, to share and to discuss theoretical and practical OR knowledge about innovation in computer sciences and applied mathematics. Specifically, this conference became a scientific forum for accommodating discussion among young researchers that mostly originated from Indonesia in the field of Computer Sciences, Applied Mathematics and, especially, Operational Research.

There were five keynote speakers of the conference: Prof. Dr. Gerhard-Wilhelm Weber (Poznan University of Technology, Poland, and METU, Ankara, Turkey): "LiBerated Social Entrepreneur Using Business Metrics: Migport Refugee Big Data Analytics" on an OR-based "matching" support to both the vast amount refugees in Turkey and to its labor market, fostered also by advances in recruitment achieved in Poland; Prof. Dr. Abdel Salhi (Essex University, UK): "Data Privacy: An Optimisation Approach and a Case Study in Cluster Analysis"; Prof. Dr. Kamal Z. Zamli (Faculty of Computer Systems and Software Engineering, Universiti Malaysia Pahang, Malaysia); Prof. Dr. Saib Suwilo (University of North Sumatra, Medan, Indonesia), and Prof. Dr. Herman Mawengkang (University of North Sumatra, Medan, Indonesia).

ICCSAM-2018 became a great success event, attracting researchers from four countries and provide a great academic experience for the participants. It was attended by 120 participants, and there are more than 106 abstracts. Hope to see you again at The ICCSAM 2019.

CENTRALIZED ADMISSIONS FOR ENGINEERING COLLEGES IN INDIA

Surender Baswana <sbaswana@cse.iitk.ac.in>, **Sharat Chandran** <sharat@cse.iitb.ac.in>, **P.P. Chakrabarti** <ppchak@cse.iitkgp.ernet.in>, **Yash Kanoria** <ykanoria@columbia.edu> and **Utkarsh Patange** <up2139@columbia.edu >

History: *This work was selected as a finalist in the INFORMS 2018 Daniel Wagner Prize for Excellence in OR Practice. A fuller description of it will appear in the September/ October edition of INFORMS Journal on Applied Analytics (formerly Interfaces).*

Introduction. Among the most select universities in the world, the prestigious Indian Institutes of Technology (IITs) are considered the Ivy League of India. The schools have an admission rate of less than 1 percent for the 1.2 million annual applicants who, in many cases, have spent a small fortune on specialized coaching to gain admission. However, until recently, it was puzzling that about 6 percent of available seats at the IITs were consistently unfilled. This article describes some of the work the authors have undertaken over nearly five years to correct this problem via innovative changes to the allocation process.

Original process. One key reason for seats remaining vacant was as follows. From the 1960s to 2014, the admissions to IITs were conducted under one umbrella. Only slightly less sought after than the IITs are the non-IIT Centrally Funded Technical Institutes (CFTIs). These include the National Institutes of Technology (NITs), the Indian Institutes of Information Technology (IIITs), and other Government Funded Technical Institutes (referred to as Other GFTIs). The admissions to the non-IIT CFTIs (henceforth referred to simply as "non-IITs") were conducted under a separate umbrella, after completion of the IIT admissions. Each candidate was eligible to apply for a seat in each of the two sets of institutes, and several hundred candidates would indeed receive two offers, one at an IIT, and later, another one at a non-IIT. Each such candidate could use at most one of the seats, leaving a vacancy in the other seat; this would be noticed much later, in many cases after classes began. Such seats would either remain vacant or would be reallocated after classes began in an unregulated decentralized manner, leading to inefficiency in seat allocation in the form of unnecessary vacancies, and unfair allocation of seats. For example, a particular non-IIT seat could be offered to a candidate B, despite denying the same seat earlier to a candidate A with better rank, who had meanwhile taken an IIT seat and was no longer participating in the non-IIT process. Note that it is not permitted, in anticipation of attrition, to speculatively admit more students than the capacity.

Development of a new process. In 2015, the authors designed and implemented a new combined seat allocation process based on the Deferred Acceptance (DA) algorithm (Gale & Shapley, 1962). The process brings all the over 80 CFTIs (IITs + non-IITs) under one umbrella for admissions, with approximately 34,000 available seats and over 1.3 million applicants. Each candidate submits a single preference list over all available programs, and receives no more than a single seat from the system, based on her submitted preferences and her rank in each relevant Merit List. To compute the allocation the new process utilises an algorithm which allocates each candidate to seats in turn, applying their expressed preferences sequentially and rejecting applications in excess of capacity until all places are filled. There are hundreds of marketplaces where such a clearinghouse has been used. One of the earliest systematic implementations was for the National Residency Matching Program (NRMP) for physicians in America (Roth & Peranson, 1999).

Despite the benefit in theory of a combined process in terms of allocating each candidate only one seat, merging the two seat allocation systems introduces several challenges. Key among these is that the process must incorporate complex rules regarding multiple types of seat reservations for affirmative action (more than half of seats are reserved for particular groups of candidates, eg people with disabilities).

In addition, despite complexities, the process is required to be completely transparent, including public declaration of opening/closing ranks after each round of allocation (unlike many other college admissions mechanisms worldwide). The authors' new joint seat allocation process that addresses all these challenges has now been running successfully for four years (2015 to 2018), and has provably reduced vacancies at the IITs (who previously ran their admissions before the non-IITs), by nearly three-quarters.

Algorithmic innovations

The complex problem required a number of algorithmic innovations, several of which may be widely useful. These contributions (and others) are described in Baswana, Chandran, Chakrabarti, Kanoria, & Patange, 2018*. For example:

- **A practical heuristic for non-nested common quotas.** This was used to implement a quota which has 2 seats per institute (as opposed to some seats per program in the other quotas). >>

>> Despite the problem being NP-hard for a general non-nested common quota, the authors were able to design a heuristic that worked for small quotas and failed rarely. Failure could be handled by creating at most one seat. There were no failures in practice.

• **De-reservation with no software modification.** This was designed to implement "de-reservation" of unfilled reserved seats without making too many changes to the base software.

Process innovations
Three examples of process innovations are shown here:

• **Making the number of reserved category admissions predictable.** This method was useful for achieving a target fraction of female admissions with a low variance. It was tested using simulation experiments and achieved transparency (as required), fairness, and the target quota of female admissions.

• **Holding centralized special rounds** in the non-IITs ("special" because they were held after classes began with a different set of rules from those in the main rounds). As part of the ongoing effort to reduce vacancies, the number of special rounds was increased from one in 2017 to two in 2018.

• **Permitting candidates to withdraw** when they no longer wanted a seat they had earlier accepted, thus allowing these seats to be assigned to other candidates before classes began.

Impact of the research
The introduction of a combined process in 2015 resulted in a reduction in vacancies when classes began: by over 50% at the IITs (on a baseline of 587 vacancies in 9,784 seats in 2014, see Table 1) and by nearly 8% at the non-IITs (on a baseline of 5,596 vacancies in about 21,285 seats in 2014, see Table 2). Further significant reductions in vacancies (by over 70% at the IITs) followed in 2016 when the third process improvement described above was introduced. The reduction in vacancies at the IITs is shon Figure 1.

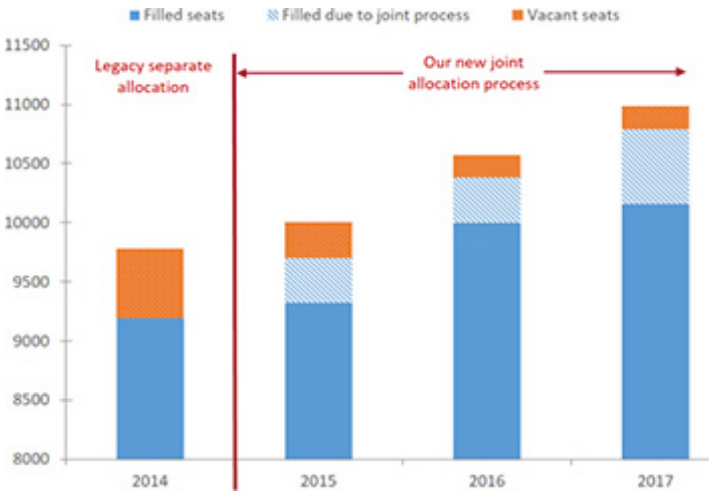
Table 1: Vacancies when classes began at the IITs in 2014 (separate seat allocation), 2015 (joint seat allocation introduced), 2016 (withdraw option introduced) and 2017. At the bottom, we make a comparison based on only the IITs that existed in 2014. IITs had a total of 9784 seats in 2014 across 17 IITs. This increased to 10988 seats in 2017 across 23 IITs.

IIT	2014	2015	2016	2017
Total vacancies	87	08	90	98
Totals for pre-2014 IITs	87	86	59	63
Reduction vs 2014		51%	73%	72%

Table 2: Vacancies when classes began across non-IIT CFTIs in 2014, 2015, 2016 and 2017. The bottom set of numbers excludes institutes that were not a part of the system (or did not exist) in 2014 for a fairer comparison.

NON-IIT CFTIs	2014	2015	2016	2017
NITs	3208	3209	2613	3244
IIITs	578	709	666	1292
Other GFTIs	1710	1779	1622	1974
Total vacancies	5596	5697	4901	6510
pre-2014 NITs	3208	3111	2530	3112
pre-2014 IIITs	578	444	347	528
pre-2014 Other GFTIs	1710	1632	1502	1740
Total vacancies	5596	5141	4379	5380
Reduction vs 2014		8%	22%	4%

Figure 1: Vacancies in the IITs before and after the implementation of our joint seat allocation process in 2015. Seats that would not have been filled under the legacy process (based on our counterfactual experiment) are shown separately for 2015 onwards (as "Filled due to joint process"). The option to Withdraw after accepting a seat was introduced in 2016, leading to further reduction in vacancies.



How can it be shown that the new process was the cause of the reduction in vacancies at the IITs? The authors rigorously quantified the benefits of the new process by conducting a careful counterfactual experiment. Based on the preferences filled by candidates in 2015, they simulated the allocation process as it used to happen until 2014 – i.e. first allot candidates to IITs, and then to non-IITs. Candidates who receive a better non-IIT seat vacate their IIT seat in the counterfactual.

Figure 1 displays the counterfactual-based estimated reduction in IIT vacancies in each year, resulting from the new joint seat allocation process. For example, in 2017, the IITs had only 198 vacancies under the new process but would have had 629 more vacancies under the legacy process. The new process was also able to give many candidates (3,672 candidates in 2017) more preferred programs than they would have got from the legacy process.

An additional benefit of the combined process was simplification of logistics for both colleges and students. Previously, IIT admissions would run until late July and admissions to non-IITs would happen only after that, often delaying the start of classes and continuing even after classes began. Now that the non-IIT admissions are conducted together with those of the IITs, the non-IITs are able to begin classes promptly in late July.

Persistent non-IIT vacancies.
Simply creating a joint seat allocation process was not expected to significantly reduce vacancies at the non-IITs, which previously ran their admissions after the IIT admissions were complete. As such it is unsurprising that the non-IIT vacancies have not substantially reduced since 2015 (Table 2). An analysis of the data reveals that it is typical for candidates to list non-IIT programs in their preference list and even accept such seats, only to surrender them in the last possible round (the penultimate round so far), often for reasons that could have been anticipated beforehand, e.g., wanting to take the exam again the following year. Also, during the last two rounds, ~70% of fresh allotments are rejected by candidates, severely limiting the system's ability to re-allot the vacated seats. The authors advocated strongly to the authorities to implement a rule preventing candidates who accepted a seat from reapplying next year regardless of whether they withdrew later, and to make other simple process changes in order to improve the efficiency of filling seats. Unfortunately, the authorities rejected the authors' suggestions, and so the number of vacancies remained similar in 2018 to that in 2017 as had been predicted (Kanoria, 2018).

*Baswana, S., Chandran, S., Chakrabarti, P. P., Kanoria, Y., & Patange, U. (2018). Centralized Admissions for Engineering Colleges in India.

Gale, D., & Shapley, L. S. (1962). College admissions and the stability of marriage. *American mathematical monthly,* pp. 9-15.

Kanoria, Y. (2018, July 12). *Why thousands of NIT and IIIT seats will be wasted again in 2018.* Retrieved from Medium: https://medium.com/@ykanoria/why-thousands-of-nit-and-iiit-seats-will-be-wasted-again-in-2018-ed7e48645f61

Roth, A. E., & Peranson, E. (1999, September). The Redesign of the Matching Market for American Physicians: Some Engineering Aspects of Economic Design. *American Economic Review, 89*(4), pp. 748-780.

TUTORIAL

SERVICE OPERATIONS MODELS FOR PLATFORM BUSINESSES IN INDUSTRY 4.0

Dohoon Kim <dyohaan@khu.ac.kr>

Background
The Fourth Industrial Revolution, or Industry 4.0 (Ind4.0), dismantles the existing production methods and breaks the boundaries between industries, thereby creating new demands and reshaping the markets. The new production systems in the era of Ind4.0 can be characterized by manufacturing-service synthesis or 'servicification' due to the underlying trend of integration of products and services. Furthermore, since the platform is at the heart of this change, the new value creation mechanism in the Ind4.0 could be further described as platform-based servicification. Indeed, many manufacturing firms are prone to fail in coping with cost increases when enriching the value creation by incorporating service features without the platform functions. As the platform actively involves in organizing resources and orchestrating the production system, however, the entire structure of the value creation mechanism departs from the traditional pipeline-style production, where the value is added up linearly as in Porter's value chain model.

Due to this structural difference, the existing analytical frameworks developed based on the linear value chain model are not able to adequately capture the value production mechanisms in the new era. Therefore, academia has been trying to develop new perspectives with novel analytical tools. One of the representative theoretical achievements is the notion of the business ecosystem organized by a multi-sided platform (Armstrong, 2006; Caillaud & Jullien, 2003; Eisenmann et al., 2006; Parker & van Alstyne, 2005; Rochet & Tirole, 2003). While the economic characteristics of multi-sided platforms and their ecosystems have been widely studied, the operations and their value creation mechanisms in these platform ecosystems have not been actively studied.

From this background, this tutorial introduces a couple of studies addressing important operational issues in multi-sided platform businesses. It includes a newsvendor model extended in the context of two-sided markets (Chou et al, 2012), service operations with shared resources (Kostami et al., 2017), and the nonlinear value creation mechanisms in value ecosystems (Kim, 2017).

These are just good examples with which this short tutorial demonstrates the service operations of platform businesses, focusing on demand modeling (in most multi-sided platform studies, the demand model constitutes the unique and essential part of the entire model). As the Ind4.0 grows and expands, we will observe more studies on this kind of service operations. For example, studies on demand-supply matching and capacity management in sharing economies or online platforms are actively underway: for example, de Matta et al.(2017), Zhang et al.(2016), etc. These are the extensions of traditional subjects such as resource complementarity and operational flexibility, of which prior studies have already existed in management sciences since the 1980s and 1990s.

Value Creation Mechanism and Dynamics in Platform Ecosystems

The indirect network externality (i.e., the network externalities between different groups) is the key characteristic of the multi-sided platform. This is the source of new value creation mechanisms which could not exist without a platform. Nonlinearity in the value creation mechanism opens up new dimensions of competition such as coordination capability and resource complementarity, which are entirely different from those in the traditional value chain (e.g. scale and cost efficiency).

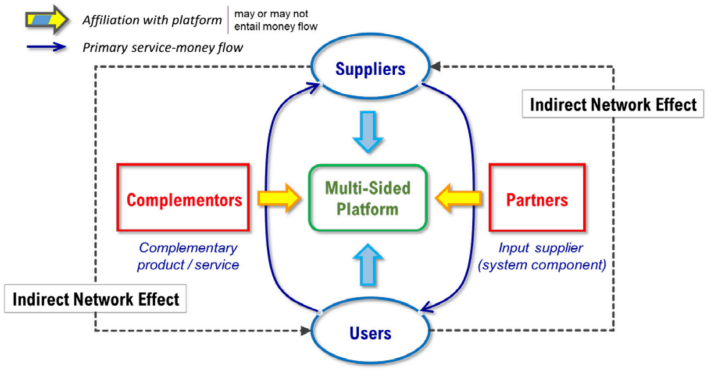


Figure 1: Business Ecosystem Architecture of a Multi-Sided Platform

In the distribution sector, for example, a shopping mall is a platform and a grocery store is a reseller. The latter focuses on products or services and generates a one- way revenue stream along the chain of traditional customer-supplier relationships (so-called 'linear value chain'). On the other hand, the former focuses on connections and generates multiple revenue streams through various relationships. As a result, while traditional linear firms seek to maximize profits by taking a product-centric viewpoint, platform companies strive to maximize connections from a network-centric perspective.

Unlike linear firms, a platform provider tries to maximize the total value of an ecosystem in a circular and feedback-driven process. In this context, once the platform estimates the size of its key participants (users and suppliers) in the next period, $u^e{}_{t+1}$ and $s^e{}_{t+1}$ Kim(2017) formulates the platform's behavior as follows:

$$\text{maximize}_{\zeta_t} \quad \Pi_t = a\,u^e{}_{t+1} + b\,s^e{}_{t+1} - c\,\zeta_t \quad \text{...} \quad \text{platform's decision at time } t \text{ (decision variable: } \zeta_t) \qquad ①$$

$$\text{subject to} \quad 0 \le \zeta_t \le B_t,$$

where a and b represent the benefits from (per) users & suppliers, respectively, and ζ_t is the level of investment (at time t) with c and B_t as the unit investment cost and the budget constraint at t, respectively. The platform's investment here in reducing the transaction costs for participants is key to fostering the ecosystem.

Users are heterogeneous based on their preferences $d(u)$ toward the scale of suppliers' contents, which is assumed to be proportional to the size of the suppliers. The types of users are assumed to be uniformly distributed over a certain range $[0,\ \bar{u}]$. Similarly, suppliers are also horizontally differentiated over $[0,\ \bar{s}]$ based on their production efficiencies (see the cost parameter of ,) $s \in [0, \bar{s}],\ q(s)$):

where r_t is the service fee that the suppliers charge on the

$$\mu(u) = d(u)\zeta_t s_t - r_t, \quad u \in [0,\ \bar{u}] \quad \text{...} \quad \text{user's utility function} \qquad ②$$

$$\pi(s) = r_t u_t - s_t q(s)/\zeta_t, \quad s \in [0, \bar{s}] \quad \text{...} \quad \text{supplier's payoff function} \qquad ③$$

users, which dynamically changes according to the demand-supply adaptive dynamics (see equations ④). In addition to the typical indirect network effects of the two-sided market studies, Kim(2017) incorporates a congestion effect (negative direct externality) on the supplier side, which is a common phenomenon observed in most online markets. Actual demands at t, u_t and s_t, are the reduced forms derived from the two equations above.

The framework also tracks down the dynamic behaviors of some key performance indicators of the platform-based business ecosystem (see equations ④, ⑤, and ⑥). For this purpose, he employs popular adaptive dynamics which guide the changes in participants' decisions (thereby, Δu_t and Δs_t) as well as in the budget constraint for the platform (ΔB_t).

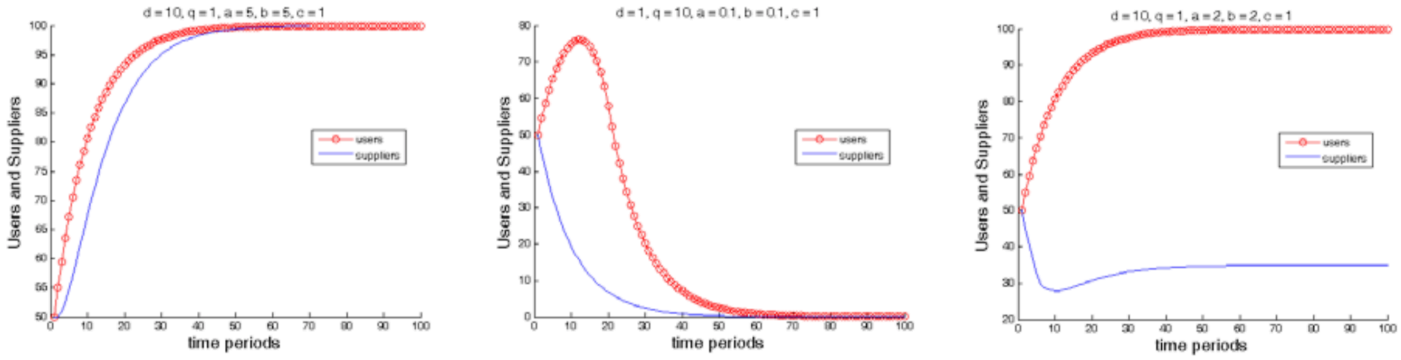
$$u_t \text{ and } s_t \quad \text{...} \quad \text{scale of active players} \qquad ④$$

$$\bar{\mu}_t \equiv \frac{1}{\int_0^{u_t}} \mu(u)du \text{ and } \bar{\pi}_t \equiv \frac{1}{\int_0^{s_t}} \pi(s)ds \quad \text{...} \quad \text{average payoffs of players} \qquad ⑤$$

$$\Pi_t \text{ and } \kappa_t \equiv \frac{\Pi_t}{\zeta_{t-1}} \quad \text{...} \quad \text{platform's profit and capital turnover rate (financial perf.)} \qquad ⑥$$

Due to the number of decision variables and the nonlinearity inherent in the model, it is almost impossible to derive equilibria in exact forms (indeed, this is a typical situation many previous studies face when analyzing multi-sided platforms). However, a precise equilibrium analysis for a couple of simple scenarios (e.g., homogeneity of the user group or the supplier group or both) is possible. Even in such simple scenarios, the model proves that there exist many types of equilibria (from system crashes to co-prosperity of all players). Therefore, it can be predicted that various equilibria are possible in general scenarios, and the experiment confirms this; it displays many cases where the system converges to multiple equilibria (see Figure 2).

The experimental analysis concludes that the performance of the platform ecosystem relies not only on resources and participants but also on reducing transaction costs and improving efficiency through platform investments. The participant scale is necessary (as many studies suggest) but somehow limited since the participants function not only as an idiosyncratic asset of a multi-sided platform but also as clients in the typical sense. Kim(2017) suggests that reducing the transaction costs seems to present the fundamental rationale of the existence of the platform, particularly when the congestion exists. These findings could be an answer to the 'chicken-and-egg problem' in the platform businesses (Caillaud & Jullien, 2003).



(a) (b) (c)

Figure 2: Sample Equilibria

The steady states of (u_t, s_t) are displayed and compared. Within a certain parameter range, the ecosystem may fully proliferate as in (a) or completely collapse as in (b) or asymmetrically grow as in (c).

Newsvendor Decisions in Multi-Sided Platforms

(Chou et al, 2012) deals with the pricing decision of a platform which needs to jointly determine the selling price of hardware platforms (e.g., game consoles) to consumers and the royalty charge to suppliers (e.g., game software developers). Two pricing decisions are interrelated since the demands for hardware and content are interdependent. The decision model is built upon the classic newsvendor problem (a pricing version) which focuses on the impact of pricing on demand and the optimal replenishment strategy when a platform's lead time for supply is longer than its selling season. The demand model of Chou et al(2012) below demonstrates the interrelations between two sides of the platform.

$$q_c(p_c, p_j, Y) = D_c(p_c, Y) + e_{jc}\, D_j(p_j) \quad \text{... consumer demand} \quad (7)$$

$$q_j(p_c, p_j, Y) = D_j(p_j) + e_{cj}\, D_c(p_c, Y) \quad \text{... supplier demand} \quad (8)$$

where $Y \sim F_Y(y)$ represents the random variable of consumers' demand (with $E_Y[Y] = 0$), $D_k(\cdot)$ is the generic demand ($k = c$ and j for consumer and supplier, respectively), and e_{st} represents the indirect network externality (or spill-over effect) of t due to s.

However, the demand model is somehow different from the 'typical' two-sided market model since the platform is in fact a seller of complementary products of its suppliers. In other words, the platform here does not serve as a broker mediating two 'distinct' markets. Thus, the entire model more similar to a system market where one component provider (platform here) plays the keystone role for the other components. When the platform is dedicated to brokerage or intermediary roles as in the typical multi-sided platform literature (e.g. the other sample models mentioned in this tutorial), the generic supplier demand should also be directly affected by Y (i.e. $D_j(p_j, Y)$) The positive aspect of this setup, however, is that it makes the model analytically tractable, which is rarely found in multi-sided platform studies.

Chou et al(2012) also employs $r \equiv \frac{\partial \bar{q}_j}{\partial p_c} \Big/ \frac{\partial \bar{q}_c}{\partial p_j}$, the ratio of spillover effects, which proxies the relative strength of the indirect network effects at the equilibrium $(\bar{q}_c, \bar{q}_j)$. Utilizing scenarios based on thresholds for r^* (at an equilibrium), they extend the well-known results of cross-subsidization in two-sided markets (e.g. Parker & van Alstyne, 2005). For example, with r^* close to either 0 or 1, the necessity for cross-subsidization based on the relative size of the cross-elasticity of demand is the same as in previous studies. However, the impacts of other factors such as supply chain costs may play a key role in determining optimal price structure when r^* falls into the middle (i.e. one side dominates the other side in terms of cross-elasticity or spill-over effect). In the latter, the platform could charge a surplus to 'both' sides to compensate for supply chain costs, despite an asymmetry in the indirect net externalities.

Pricing and Capacity Allocation in Service Systems with Platform Channels

(Kostami et al., 2017) deals with pricing and capacity allocation decisions of a service provider who serves two distinct customer classes (e.g., gold & silver memberships in health clubs, men & women in night clubs, etc.). Customers within each class are inherently heterogeneous in their willingness -to -pay for the shared services, but their utilities are also affected by the presence of other participants onf the platform (i.e., the indirect network externalities). The gross utilities of customer x (normalized index) in two distinct classes are determined as follows:

$$U_1(x, \lambda_1, \lambda_2) = x + b_1 \frac{\lambda_2}{\lambda_1 + \lambda_2} + c \frac{\lambda_1 + \lambda_2}{K} \quad \text{... user group 1 } (0 \le x \le 1), \quad (9)$$

$$U_2(x, \lambda_1, \lambda_2) = x + b_2 \frac{\lambda_1}{\lambda_1 + \lambda_2} + c \frac{\lambda_1 + \lambda_2}{K} \quad \text{... user group 2 } (a \le x \le 1 + a), \quad (10)$$

where λ_j is the number of customers in class j, K is the fixed capacity (given), a is the differentiation parameter (e.g. $a = 0$, means no differentiation between two groups), c is the strength of the crowding effect or negative externality within a group, and b_j is the indirect network externality.

The service provider with an alternative channel, like an online platform, needs to determine how to set prices and allocate capacities across two channels. Kostami et al.(2017) considers discriminate vs. single pricing as well as separate vs. pooling capacity, thereby presenting four strategy options. Since they employ the horizontal differentiation model for the user groups, the marginal customer (x_j^*) in each group determines the market size as in Kim(2017). Their approach, however, is far from the typical frame of the multi-sided platforms since it does not consider the supplier side of the service system (despite its incorporation of the indirect network effect).). Similar to Chou et al(2012), this setup makes the entire model analytically tractable. Accordingly, Kostami et al.(2017) can prove that it is the optimal strategy for the service provider to pool [separate] its capacity across different classes with discriminatory pricing if the indirect net externality is positive $(b > 0)$ [negative $(b < 0)$].

Furthermore, they also show that without the option of price discrimination, there exists a range of as a function of (), within which the process of separating or pooling the capacity becomes optimal. Thus, the service provider has the flexibility to allocate capacity even without the pricing discrimination.

Discussion and Conclusions

In the era of the Ind4.0, platforms facilitate the deployment of advanced service offerings not only in the service sectors but also in traditional manufacturing sectors. They present solutions to managing complexity and scalability through orchestrating external resources and capabilities. Subsequently, the platforms enable their business ecosystems to pursue both customizations and operational efficiencies.

The lack of research on nonlinear production systems in platform-based servicification demonstrates that we do not yet completely understand the fundamental issues related tothereby presenting four strategy options. Since they employ the horizontal differentiation ongoing changes in new value creation mechanisms. The studies introduced above address some important decision issues and the approaches to deal with them arising in the evolution of the production system driven by platform-based servicification. However, there are still many challenges to be addressed, and recent research suggests ideas on how to solve these problems. This tutorial focuses only on the capacity management and coordination of heterogeneous players in the business ecosystem. Management science will also significantly contribute to leveraging big data and business analytics and addressing risk management issues against new uncertainties in the platform business of the Ind4.0 era.

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OR FOR DEVELOPMENT

CALL FOR SUBMISSIONS TO THE IFORS PRIZE FOR OR IN DEVELOPMENT 2020

Mario Guajardo <mario.guajardo@nhh.no>

IFORS is pleased to announce that this long-standing Prize will be awarded again during its 22nd triennial conference to be held in Seoul, Korea, on 21-26 June 2020. The competition aims at promoting the practice of OR in developing countries. Past winners and finalists include works that have improved health, wellness, education, public investments and other issues in Africa, Asia and Latin America. Note the submission process has been simplified with respect to previous years. It will consist of two stages, where the first requires a short summary – more details given below.

• **First stage.** Entries should be submitted by email to the Chair of Judges by **1st October 2019.** Each entry should comprise a maximum 5 page summary of the work specifying title, authors and affiliations, and including the following sections: (i) *Context/ Problem description;* (ii) *Methodology/Solution approach;* (iii) *Results/Impact;* (iv) *Timeline* (when the project started, when the solution was implemented, how long it has been used, eventual future plans); (v) *Involvement of local researchers* (specifying the geographical region of the application if it has not been specified in previous sections); (vi) *Others,* if the authors would like to highlight something else, and a list of References if citations have been used through the text.

A verification/support letter from the client (i.e. the organization(s) benefitting from the work) is strongly appreciated and may be required, as well as other means of verification, during the evaluation process if not included in the submission.

It is expected that, to a large extent, the work must have been conducted after 18th December 2016 (deadline of the previous competition).

Submission format: pdf file, 11-point font text, A4 paper size, standard margins. Title, authors and affiliations can be specified in a cover page, so the 5 page limit applies only to the content of the following sections. 9-point font can be used for references and captions.

• **Initial Evaluation.** The evaluation of the entries will be carried out by an international panel of jury members, and entrants are expected to be notified of the outcome by late October. Evaluation will be based on the following criteria: problem definition, creativity and appropriateness of approach, MS/OR/Analytics content, stress on developmental issues, extent of involvement of local researchers, and impact.

• **Second stage.** Entrants who are successful in the *Initial evaluation* will be invited to submit, by 18th December 2019, a full-length manuscript of up to 25 pages describing their work in more detail. This may be based upon other reports or articles previously submitted or published but must include, at least, content about topics (i)-(vi) specified in the summary submitted for the first stage. Where appropriate, the relevance of the country's state of development to the study should be addressed. Manuscripts will be evaluated based on the criteria used in the *Initial evaluation,* as well as the manuscript organization and structure and quality of writing. A stress on developmental issues will be an important factor in the judging. Manuscripts of a purely technical nature, or those which have no relevance in the developmental context, will not be of interest.
Submission format: pdf file, 11-point font text, A4 paper size, standard margins. 9-point font can be used for references and captions.

• **Selection of finalists.** The panel is expected to complete the evaluation of manuscripts and select the finalists by late January.

• **Final stage.** Finalists will present their work in a special session of the competition at the IFORS Triennial conference (Seoul, Korea, June 21-26, 2020). The winner and runner-up will be selected based on the previous stages and their oral presentation. At least one author of each finalist team is expected to attend the IFORS conference banquet to receive their prizes.

• **Dissemination.** Abstracts of all finalist works, and a note about the winning work, will be published in the IFORS Newsletter. Material about the finalist works will also be uploaded to the *Developing Countries Online Resources* page of the IFORS' website. The presentations at the IFORS Triennial conference might be recorded and promoted in the IFORS website or other dissemination channels.

At any point of the competition, entries describing novel contributions will be encouraged to submit a full-length manuscript to the IFORS' journal International Transactions in Operational Research (ITOR), although this will not be a requirement to participate in the competition.

Inquiries and submissions should be sent by email to the Prize Chair:
Mario Guajardo
Associate Professor Department of Business and Management Science
NHH Norwegian School of Economics, Bergen, Norway
E-mail: **mario.guajardo@nhh.no**

Important Dates
Submission deadline summary (first stage): October 1, 2019
Submission deadline full paper (second stage): December 18, 2019
Finalists will be notified by: January 31, 2020
Date of oral presentation: June 22, 2020

INTRODUCING THE INSTITUTE OF MATHEMATICS AND PHYSICAL SCIENCES, DANGBO, BENIN REPUBLIC

Inès Zounnon <ines.zounnon@imsp-uac.org> **and Jules Degila** <jules.degila@imsp-uac.org>

The Institute of Mathematics and Physical Sciences (IMSP) is a graduate school of mathematics and physical sciences, located at the University of Abomey-Calavi in Benin Republic, mainly targeted at the French-speaking African region. Created in Benin with the support of the Professor Abdus Salam, Nobel Prize winner and former Director of the International Centre for Theoretical Physics (ICTP), in Trieste (Italy), to create and support poles of active research centers in developing regions, such as Sub-Saharan Africa, in order to enhance mathematical and physical training as well as research, to break the scientific isolation of those regions and to reduce brain migration.

The fundamental goal of IMSP is to promote mathematics, physics, computer sciences and applications in Africa, particularly in the French-speaking part of Sub-Saharan Africa, by selecting and training talented students for a PhD award in mathematics, physics, mathematical physics or computer science, in order to build a human resource capacity in Education, Research and Technology.

Prof. Thierry d'Almeida & participants, Analysis School, 2016

From five students, including two foreigners (Cameroonian and DRC) in 1988, IMSP now recruits more than 200 students every year, from some twenty African countries, through focal points that are essentially made up of alumnus from Benin, Algeria, Burundi, Cameroon, Chad, Congo, Congo Brazza, Burkina-Faso, Ivory-Coast, Ghana, Guinea, Madagascar, Mali, Niger, Nigeria, Rwanda, Senegal, Togo and Uganda.

Classrooms (at right) & auditorium (at left) of the IMPS

Uplifted since 1994 to the order of Center of Excellence by the African Mathematical Union (AMU), IMSP has been recognized as such by the German Academic Exchange Service (DAAD), the European Society of Mathematics and the Commission of the African Union. The faculty consists of permanent professors from the University of Abomey-Calavi and external collaborators from European and American universities. To build upon its excellent reputation, IMSP was awarded in 2014, the African Centers of Excellence in Mathematics Sciences and Applications Project (ACE-MSA), an 8 million dollar project funded by the World Bank. Through the ACE-MSA project, IMSP has enhanced the quality and diversified its programs to adapt them to the sub-region's needs in terms of Master and PhD programs, aimed at tackling the developmental challenges in the areas of fundamental mathematics, operations research, computer security, statistics with a particular focus on their applications in industry, in public health and social sciences.

IMSP in full expansion, thanks to the African Centers of Excellence Projects

In four years of its existence, IMSP has made noticeable progress:

• An exponential increase of more than 500% of the number of students in Masters and PhD programs;
• Enhanced partnerships with the best European and American universities for research and teaching;
• More than 50 guest faculties and lecturers every year;
• Two internationally accredited Master Programs by the HCERES;
• Nearly 850 merit-based scholarships to enrolled students;
• A rich catalog of practical continued education programs that meet international standards; geared towards local companies capacity building to support them in their growth and decision making processes;
• Many International Schools, Conferences and Scientific Seminars such as ORTASA school, Data Science School, Internet of things (IoT) workshop, etc.

Recent news with the ACE projects

IMSP is a very dynamic environment which is attracting more students from the neighboring countries. The last Operations Research Techniques and Applications School for Africa (ORTASA) and Data Science (DS) schools held respectively in November and December 2018, gathered 165 participants, of which more than 50% came from 13 other countries (Burkina Faso, Burundi, Cameroon, Congo, Ivory Coast, Ghana, Guinea, Kenya, Mali, Niger, Nigeria, Senegal and Togo), with experts from South Africa, France, Canada, Brazil and Namibia. The participants had various profiles: computer scientists, engineers, consultants and students from different research centers with the objectives of first, familiarizing themselves with concepts and techniques related to Operations research or Data Science, and second, learning best practices.

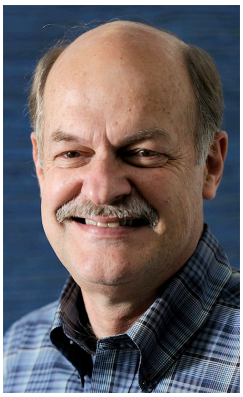
In terms of promoting Mathematics at the secondary schools level, IMSP organizes the annual National Championship of Mathematics and Physical Sciences (NCMPS) and the Miss Mathematics, Physics and Chemistry Contest (Miss-MPC). The latter is aimed at encouraging more young girls to embrace scientific studies. The awards ceremony took place this year on December 21, 2018, with a festive audience composed of parents, friends, teachers, 18 NCMPS laureates and 42 Miss-MPC laureates who received prize scholarships. Some of them received life-time scholarship from government institutions or philanthropic organizations and foundations.

Dr Karim Lawani having a learning session with IMPS students and Teachers at one of IMPS Wednesday seminar scientific, Jan 2019

483 students have received a Masters or PhD award from IMSP since 1988, and with 77 of these in 2018 only. IMSP is continuously looking at partnering with peer institutions, countries and enterprises to build upon the quality of their graduate and post graduate studies and research to impact development of the sub region. To that purpose, IMSP was recently awarded the African Center of Excellence Impact (ACE Impact) which is a four year project with a budget of five to six million dollars. This new project will start in September 2019 with an international scientific committee and an international industrial advisory committee composed of people with a broad range of experience from across Africa.

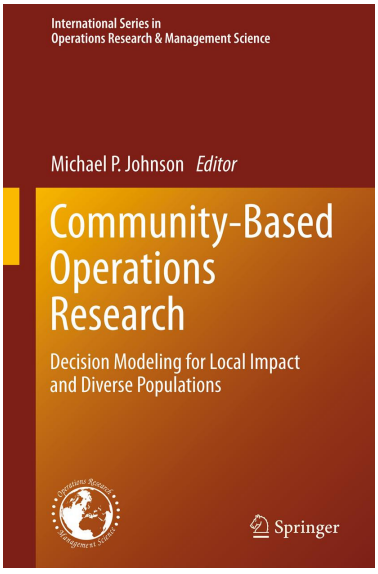
COMMUNITY-BASED OPERATIONS RESEARCH

Hans W. Ittmann <hittmann01@gmail.com>, University of Johannesburg



Community-Based Operations Research – Decision Modeling for Local Impact and Diverse Populations by Michael P. Johnson (Editor), 2012, Springer, pp. 340, ISBN 978-1-4614-0805-5 (Print) and e-ISBN 978-1-4614-0806-2 (eBook), 169.99 Euro (Hardcover), 142.79 Euro (e-book).

Operations Research (OR) had its formal roots in the military and, post-World War II, OR found its way into industry and business. It was not long before the need arose to apply the same OR approach, tools and techniques to address and resolve problems of a social nature and matters affecting quality of life. In response to the involvement with these types of problems the notion "Community Operational Research (OR)" was first coined in the United Kingdom (UK) in the mid-1980s. The perception existed, wrongly but possibly for good reasons, that community OR was exclusively practiced in the UK. However, OR practitioners in specifically the United States (US) were also doing similar things and some of the pioneering efforts included work in health, medical care, emergency response services, AIDS prevention and criminal justice work as well as public sector applications.



What differentiated these US applications was that, in line with the US tradition, this community development type work focused almost exclusively on quantitative modelling. It was in the context of this more constrained US definition that the term "Community-Based Operations Research" was coined by Johnson & Smilowitz (2007), a term that was largely inspired by, inter alia, an inner-city neighbourhood application and public sector involvement. Over time, with additional material, this led to the publication of the book **Community-Based Operations Research** in 2012, the first book on this topic published by operations researchers of the US.

In the book community-based operations research (CBOR) is defined, through examples, as follows: "it includes OR/MS applications that address provision of goods and services, or prescribe social policy actions, for which stakeholders are defined, in a spatial or social sense, as localized, or who are considered disadvantaged or underserved, or for which issues of equity or social influence are important considerations". There are three important implications of this definition. The focus here is on human stakeholders and specifically human resources; disadvantaged, underserved, or vulnerable groups with distinct social and political preferences but with limited influence on public policies, etc.; while model applications account for community-level characteristics such as socio-economic status.

The book is divided into four Parts, with each Part consisting of several chapters. There are 13 chapters with a total of 31 contributors.

Part I, consisting of four chapters, focuses on Models and Analytic Methods and the first two chapters present a comprehensive review of community-based operations research. Chapter two is a reproduction of Johnson & Smilowitz (2007), a tutorial produced by the Institute for Operations Research and the Management Sciences (INFORMS). There is an interesting outline of the historical context of CBOR and its role in OR/MS. The discussion in chapter one of the contrast between the US-style OR, an increasingly mathematical and problem-focused approach, and the alternative of traditional OR, championed by a few UK practitioners promoting the use of soft-OR, soft systems methodologies and problem structuring, is fascinating. The same holds for the section where important aspects of Community OR, as the antecedent to CBOR, is briefly summarized. Furthermore, a theory of CBOR is presented based on the following four analytical steps, distilled from the PR/MS and analytics processes, namely: problem identification, problem formulation, problem solution and implementation. Each step is elaborated on and it is put into proper context within CBOR.

Large components of chapter one as well as chapter two are mostly devoted to a review of the literature as it relates to CBOR. In chapter two CBOR examples and applications, from several different fields, are used to explain the concept. Operations management in community-based nonprofit organizations is the topic of chapter three while chapter four deals with modeling equity for allocating public resources. Equity is shown to encompass several disciplines, including OR, philosophy, political science, economics and anthropology. >>

>> The complexity of allocating public resources, where equity is but one criterion, is well described in chapter four.

The topic of Part II is Facility Location and Spatial Analysis. Entities such as schools, hospitals and libraries, are public facilities that provide vital services to local populations while their location and proximity should ensure broad accessibility. CBOR thus finds a natural home in this environment. All three chapters in Part II also touch on disadvantaged, underserved, or vulnerable groups. In chapter five the problem of restricting the residency of sex offenders, as per legislation, leads to location inaccuracies which then causes geographic uncertainties.

A few spatial models are described and the impact of the geographic uncertainties on spatial modelling is shown. In the next chapter a discrete multi-objective facility location model that is applied to planning of parks, green spaces and recreation, for example, in an urban residential area context is discussed. There are many decision criteria that need to be met in this planning process and it turns out to be complex. When children are exposed to low levels of lead it can have negative consequences and in chapter seven a model is outlined that measures levels of the childhood residential lead exposure. The spatial data plus geocode blood surveillance data is used for a regression model that can forecast lead exposure levels. By showing the results on a Geographical Information System (GIS) it provides public health and public policy insights..

The three chapters in Part III all focus on aspects related to Minorities and Disadvantaged Groups. These are groups within a population which are typically overlooked or neglected in the traditional public-sector OR/MS work. In chapter eight an outline is provided of a queuing model that is used in assisting hair care salons in African American communities to increase throughput and revenue, and reduce cost, in time and money, for patrons. The topic of chapter nine is the membership of gangs and the associated risks to the youth and communities. Using cause-and-effect diagrams to classify risk factors for street gang membership and creating risk factor hierarchies, the authors apply the value-focused thinking methodology to identify specific measures for individual-level risk factors. The ultimate goal is to design gang prevention programs. The focus of the next chapter is on minorities and persons of low income who are most likely to depend on mass transit for their transportation needs. Pricing schemes are proposed which can ensure that even those who do not purchase expensive multi-ride discount plans, pay little or nothing for additional rides that would have been free under transit pass schemes.

The focus of Part IV is on Service Delivery with the emphasis on public sector service delivery such as transportation, medical care and education. The applications discussed in the chapters consider the disadvantaged component of the population with an emphasis on equity as it relates to this group. Two of the chapters in the Part consider service delivery issues in medical and health care while the last chapter addresses issues in education. In chapter eleven an outline is presented of methods to improve the forecasting of calls for Emergency Medical Services. Uncertainty regarding the time and location of such calls is incorporated, giving better demand forecasts as well as decision models for deploying and re-deploying EMS servers. In chapter twelve a capacity planning application is described. An optimal control model was developed for allocation of elderly persons to alternative long-term care services: home and community-based services and institutional care. The final chapter is an application of data envelopment analysis to public education and specifically looking at educational costs and efficiency at schools.

The book Community-Based Operations Research was already published in 2012 but no review of the book could be found even though it presents a first US view of CBOR applications focused entirely on the under-privileged component of the US society mainly within communities. All the applications captured in the various chapters are excellent examples of CBOR and shows that CBOR is an important sub-discipline of OR/MS in the US. It also illustrates that there is a lot of commonality with what has traditionally been termed Community OR. Over time there is certainly going to be more and more cross fertilization between CBOR and Community OR and one can state with confidence that this will be evident in a follow-up publication with new, more recent, applications from the US. Community development, or community related, problems are largely similar in all countries and require similar approaches!

Johnson, M. P., & Smilowitz, K. (2007). Community-based operations research. In T. Klastorin (Ed.), Tutorials in operations research 2007. Catonsville, MD: Institute for Operations Research and the Management Sciences. doi: 10.1287/educ.1073.0035.

OBITUARY: MICHEL BALINSKI (1933-2019)

Grazia Speranza <grazia.speranza@unibs.it>

It is with deep sadness that we learned of the passing of our colleague Michel Balinski, aged 85, on February 3, 2019, following a long illness that he fought with quiet courage.

Michel Balinski, an IFORS Distinguished Lecturer, was a Williams graduate, who studied at MIT and Princeton. He taught at Princeton, Penn, CUNY Graduate Center, Yale and SUNY, Stony Brook. Since 1982 he had been Directeur de Recherche de classe exceptionnelle, CNRS and Ecole Polytechnique, Paris, and Director of the Laboratoire d'Econométrie (1989-1999). He was awarded the Lanchester Prize in 1965, the John von Neumann Theory Prize in 2013 and an honorary degree in mathematics from the University of Augsburg in 2004. He was the founding editor of Mathematical Programming and a past President of the Mathematical Programming Society. Dr. Balinski was the author of Fair Representation: Meeting the Ideal of One Man, One Vote (1982, reissued 2001, with H. P. Young) and Le suffrage universel inachevé (2004), and author or co-author of some one hundred scientific articles (OR, mathematics and other journals). Dr. Balinski made important contributions to linear and nonlinear programming, combinatorial optimization, and stable matching problems. His recent interest was the theory and applications of ranking and the design of electoral systems. One of his electoral systems is used in Zürich, Switzerland.

There is a historical oral history video listed here:
https://www.informs.org/Explore/History-of-O.R.-Excellence/Biographical-Profiles/Balinski-Michel

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