



AT THE FOREFRONT OF ANALYTICS IN AFRICA



ORSSA Newsletter June 2019

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CONFERENCE TUTORIAL BY



Prof. M Grazia Speranza



Prof. Gerhard Geldenhuys



Prof. Erwin Pesch

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20 MAY 2019

31 JULY 2019

16 AUGUST 2019

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FROM THE EDITOR

By *BRIAN VAN VUUREN*

(*brianjohnvanvuuren@gmail.com*)



Brian van Vuuren

Dear ORSSA members,

Another quarter of the year has come and gone and I trust it's been a productive and enjoyable few months for you all.

This quarter's newsletter edition focuses on the Johannesburg chapter of the society. Unfortunately, we couldn't get together as many articles as we'd originally hoped. I think everyone has been very busy with their day-to-day and just didn't manage to get around to putting pen to paper (or, more appropriately, fingers to keys).

None-the-less, we've still managed to get together some great pieces, including an interview with our incoming ORSSA president, Gemma Dawson; insights into the history of the Joburg Chapter from ORSSA stalwart, Dave Evans; a fantastic trip down memory lane of how OR has been used in the Joburg Municipality over the years from Keith Sandrock, and more. I trust it will be an engaging read for all.

For me, the last few months has been all about observing and managing the 'un-sexy' side of change. I call it 'un-sexy' because, in today's vibrant and every-changing work climate, people seem to be changing jobs every year or two – forever moving on to the next challenge or pursuit. And, being so connected as a society, we are acutely aware of how exciting, progressive and challenging our colleagues and friends' careers look to be.

The other side of that fast-paced, ever-changing professional landscape is the people who are left behind. In this particular case – me. So, the un-sexy side of change is those people who are forced to fill the gaps left behind when talented, hard-working colleagues leave.

I've mentioned before that, despite studying for a long time, I didn't really do much preparation for a career in software development. It's been 18 months now, and I'm finally feeling like I'm getting to grips with the environment in which I work. That is, until my more experienced teammate (the one who taught me basically everything I know in the fronted space) made a career move and took up a job at Amazon Web Services.

This left me to take up the 'lead' on the frontend of the app on which my team works. Of course, I was rather unsettled at the thought. But those who work in the software space know that there's just not time for overthinking things or second-guessing your abilities. I just had to get on with it!

And, you know what? I did/am doing alright! I've taken charge of large-scale app changes and updates and nothing has fallen apart! (well – not yet anyway...)

But all of this taught me an important lesson – if we don't make an effort to push ourselves - professionally, intellectually, developmentally – we might miss the opportunity to grow. All of us are surrounded by excellent people with fantastic skills. Of course, they're an amazing resource to learn and develop our skills, but we should be wary of measuring our progress exclusively by the shadows of our mentors or teachers. Instead, we should absorb all we can from them, embrace collaboration wherever possible, but make ensure we still make space for ourselves to grow into our full potential, at our own pace and in our own time.

For those of you who wake up feeling like every day is geared to push you to your best – keep it up! For those of you who have maybe started to 'settle', perhaps it's time to make a change. It doesn't have to be a new career, job or even team - it could be as simple as a new mindset.

Hope you enjoy this quarter's edition!

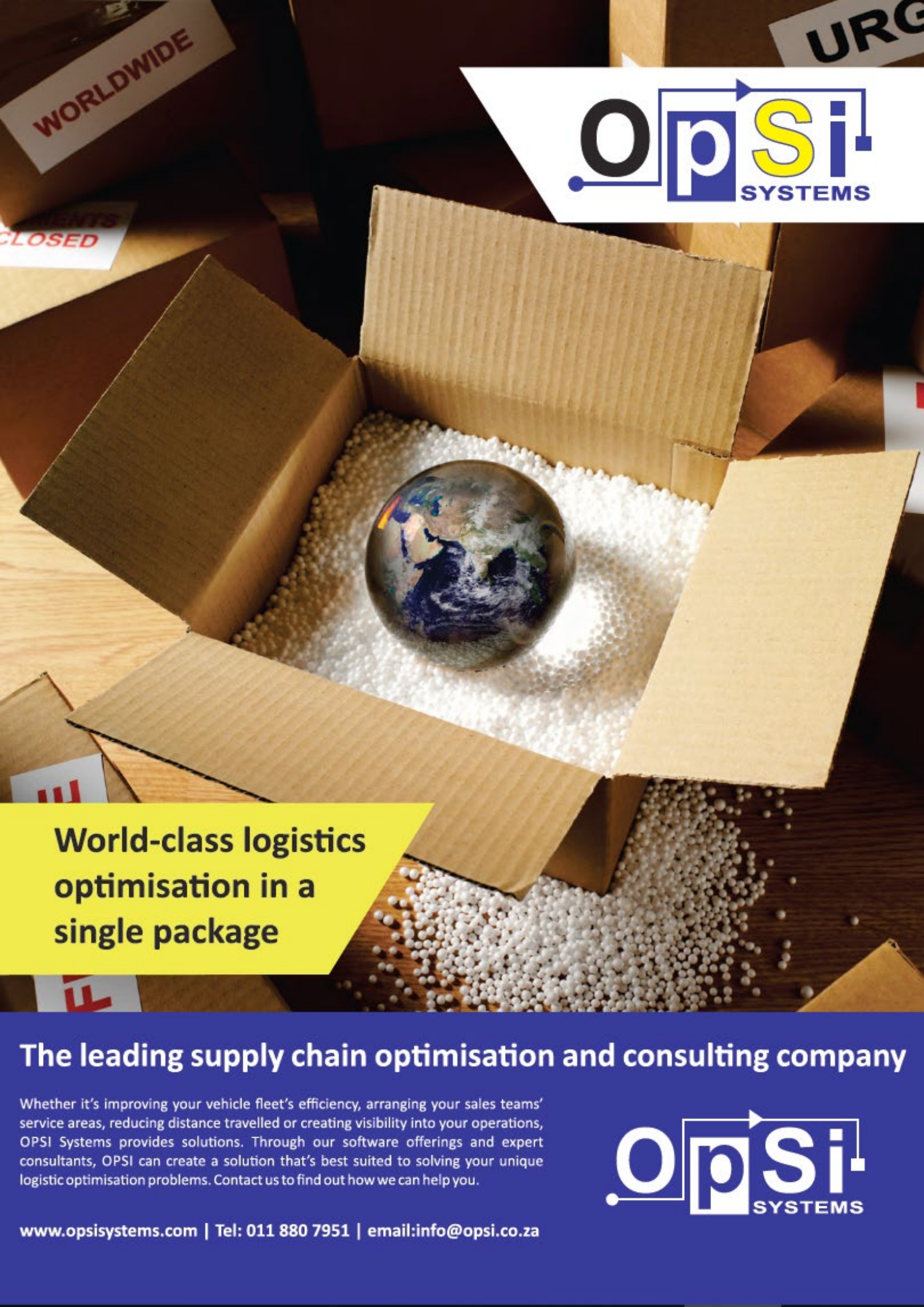
Until next time,
Brian

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FROM THE PRESIDENT'S DESK

By DANIE LÖTTER

(DANIEL@GLOBELOTTER.CO.ZA)

ORSSA PRESIDENT



Danie Lötter

Greetings to all ORSSA members. By the time you receive this quarter's edition of the Newsletter, we would have shockingly already passed the half-mark milestone of 2019! I trust that everyone has had a busy and productive 2019 thus far.

The June edition of the Newsletter is also the final one which you will receive before we meet for the annual conference in September. The annual conference is one of the highlights on the ORSSA calendar and this year's conference is scheduled to take place from 8-11 September at the The Vineyard Hotel in Cape Town. It is organized by the Western Cape chapter and is spearheaded by the local organizing committee chair Lieschen Venter. I would like to thank Lieschen and the rest of the local organizing committee for the sterling job they are doing in organizing this year's conference.

I would also like to extend a special word of thank you to the sponsors who made a contribution to help make the conference a success. They are, thus far:

- Pivot Sciences,
- the Department of Statistical Sciences at the University of Cape Town,
- the Centre for Business, Mathematics and Informatics at Northwest University,
- Bluestallion Technologies,
- the Department of Logistics at Stellenbosch University and
- the Department of Industrial Engineering at Stellenbosch University.

Registrations for the conference are well on their way and I would like to urge members to register for the conference

and to submit their abstracts for presenting their work. The closing date for abstract submissions is approaching fast and members have until 31 July to submit their abstracts. Prospective delegates who would like to make use of the discounted early-bird registration fee have until 1 July to register and pay for the conference.

This year, the local organizing committee were able to again invite two speakers to deliver keynote addresses. The first is Grazia Speranza (President of the International Federation of Operational Research Societies), and the second is Gerhard Geldenhuys (fellow and founding member of ORSSA). We look forward to their keynote addresses.

Finally, I would like to extend a friendly invitation to members of the Society to contact me should they have any suggestions as to how ORSSA can improve on the service it delivers to its members.

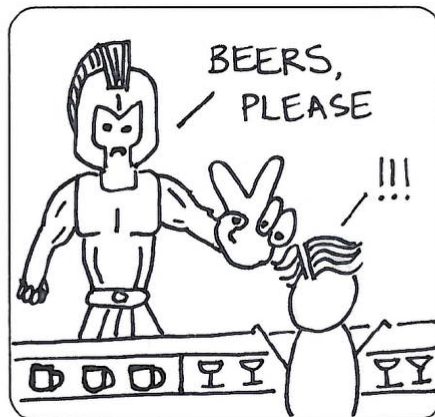
With my best wishes until we meet in Cape Town September

Daniel Lötter

HAVE YOUR SAY

The ORSSA Newsletter is an excellent medium for showcasing one's work or interests to the Operations Research community, not only in South Africa, but around the world.

Contributions of any nature are welcomed. If you would like to submit material to the Newsletter, please send your article or review, along with all associated media (e.g. images, charts, etc.) to the editor at brianjohnvanvuuren@gmail.com



GETTING TO KNOW THE JOBURG CHAPTER

compiled by Brian van Vuuren (brianjohnvanvuuren@gmail.com)



Gemma Dawson

When putting together idea of what kinds of articles could compose a nice introduction to and overview of the ORSSA Johannesburg Chapter, I (as always) wanted to include an interview with one of the chapter's members.

In the past, I've requested suggestions from Chapter Chairs as to who should be featured in these interviews. This request is also typically accompanied by an encouragement to think of a member who isn't necessarily 'part of the furniture' in the ORSSA community; thereby allowing readers the opportunity to become familiar with a wider variety of ORSSA members.

In this edition, however, we have the good fortune of featuring the chapter which our forthcoming ORSSA president calls home. And, although Gemma has been thoroughly involved in ORSSA events, conferences, exec committees and newsletter publications for quite some time, I thought it would be a good opportunity to ask a couple of questions in order to get to know her better as she gears up to lead the society in 2020.

When and how did you first become affiliated with ORSSA?

I moved to the Republic of Korea from Cape Town in early 2010 to teach English and during my time there I studied various undergraduate Operations Research courses through UNISA. My intention always was to return to South Africa and in researching career prospects within the OR-field, I came across the ORSSA website. At the beginning of 2016, I moved to Johannesburg to complete my honours degree in OR and once I had registered, I decided that it was time to join the society.

Not long afterwards, I was employed by Pivot Sciences which meant that I had basically jumped into the deep end of the ORSSA pool.

What sort of involvement have you had with the society?

Part of my initial job at Pivot Sciences was to help with the organisation of chapter events, so it was only natural that I agreed to take on the role as the Secretary for Johannesburg chapter at the end of 2016. I had also been nominated to take over the newly created position of Database Manager on the national executive committee and I started that position in January 2017. I held the position of Database Manager until the start of this year when I took over the Vice President role from Winnie Pelser and I remain the Johannesburg Chapter Secretary.

As the incoming president of ORSSA, what do you believe is the biggest challenge facing the society?

In the coming years, I would like to tackle the challenge of increasing the awareness of OR and ORSSA in South Africa. With the rapid rise in popularity of Data Science and Analytics, a lot of people are doing OR-related work without knowing the term Operations Research. By increasing the engagement from corporates, I believe that we can draw in their employees to our chapter events.

Outside of ORSSA what does your day-to-day job look like?

I am currently an Analytics Developer at [Chalcid](#), one of the newest ORSSA corporate members. Part of my job is helping to develop a client portal for [Icepack](#), a start-up based in Dublin that offers optimisation solvers. Through that project, I am learning new non-OR technical skills that have proven to be a fun challenge.

Chalcid also offers analytics consulting and it is under this banner that I get to exercise my OR skills. I thoroughly enjoy the process of consulting. I get to solve real-world problems for people and organisations that need help. The first puzzle is understanding what the problem truly is as clients tend to not fully understand this themselves. The back and forth between a myself and the client can be frustrating, but it is an important part of the process. Consulting also requires communicating complicated ideas and methods and this is also a challenge that I like to take on. And, of course, the actual technical work itself is the reason I am excited to get out of bed most mornings.

You've been involved in some interesting events in your local scientific community, such as Ada Lovelace Day, satRday and more – what are these all about and what is it about these events that attracts you?

[Ada Lovelace Day](#) is a worldwide celebration of women in science, technology, engineering and maths (STEM). The goal of Ada Lovelace Day is to increase the profile of women in STEM and celebrate their achievements. The event typically takes place on the second Tuesday in October and the Johannesburg Chapter has held an Ada Lovelace Day for the past two years. The first event was organised by myself and Esmarie Scholtz. Dr Sheetal Silal, who had just been awarded the [Tom Rozwadowski Award](#) for her incredible work in helping to curb the spread of Malaria.

The second year we invited [Ridhwana Khan](#), a software developer that had been named one of [#COCREATESA's Inspiring Fifty](#) women in the technology and innovation sectors.



Both events have been well attended by both ORSSA members and non-members and I am already making plans for the third Ada Lovelace Day!

An R-focused conference, [satR-days](#) are held across the globe with the intention of helping to grow local R communities

through offering a low-cost and accessible event. Andrew Collier of [Exegetic Analytics](#) has headed up the committee to organise the South African satRday since 2016. This year, the conference moved from Cape Town to Johannesburg and I was asked to join local organising committee. The conference was held in early April and seems to have been enjoyed by all those who attended. For those that missed out, the talks were recorded and are available on [YouTube](#).

As to what attracts me to these events, I believe in the importance of knowledge sharing and community building. Being part of these events benefits me, but it is nice to know that I am helping others too.



Discovery's headquarters in Sandton - the venue for the 2019 SatRDay conference

You're a passionate ambassador of women in the sciences – what would you like to see more/less of in this regard?

Operations Research as a field is a testament to the power of bring together people from diverse backgrounds. Most of us know the OR origin story but for those who are in the dark, modern operations research came to fruition during the period around the two World Wars. During this economically difficult time, governments and militaries were searching for new ways of making quantitative-based decisions. To aid the war effort, scientists from different disciplines were brought together, each with their own unique set of diverse skills and knowledge.

The moral of the story is that diversity drives innovation and creativity. Encouraging people who do not fit the stereotype to join the field is essential in both academia and industry. Of course, a policy of diversity is harmful if there isn't importance placed on inclusivity. These are strategies that are not easy but need to be actively pursued and prioritised within in organisations. This stands not only for women in STEM but any under-represented group.

From anecdotal evidence gathered at our annual conference and events, it does appear that ORSSA has a better gender-balance than other STEM fields but other groups are missing which is very concerning. I would like to see this change in the coming years.

Do you have a 'dream job'? If so, what is it?

For me a dream job is one that challenges me to grow and learn. I think I have been very fortunate and every position I've held since graduating in 2005 has in some manner been my dream job for different reasons. From teaching to consulting each has brought unique sets of lessons that have help me grow.

What is the most exciting opportunity for people working in the field of OR

Operations Research gives people the power to make informed decisions. With the continued progress of the Fourth Industrial Revolution, the way that we seek out his help is rapidly changing. OR is already playing a crucial role in helping to bring systems that give people and organisations to power to act.

What would you like to convey to students considering a career in OR?

If you are a person who loves the thrill and challenge of solving a problem and, since this is a career where you never stop learning, you need to have an inherent drive to always be advancing. If you recognise yourself in these statements, then you must consider a career in OR.

LET US KNOW WHAT YOU'RE UP TO

The ORSSA community would love to hear your news. If you've taken on a new job, an interesting research topic, completed your studies or finished a noteworthy certification or course, please let us know and it may be featured in one of our upcoming newsletters. Your insights, experiences and information aren't only interesting to the community, but they also help and inspire others who are looking to do something similar. Please send all relevant information and media to brianjohnvanvuuren@gmail.com

THE HISTORY OF THE JOBURG CHAPTER

A PERSONAL HISTORY BY THE CURRENT CHAPTER SECRETARY

Written by Dave Evans (daveevans@gmail.com)



Dave Evans

In the early seventies, the Johannesburg Chapter of ORSSA was primarily business and mining focused. Anglo American had strong OR staff in both Johannesburg and Welkom and AECI had a team numbered in the teens. Other mining houses also had OR activities – Derek Saunderson was at JCI, and the Joburg Municipality had a team which included Keith Sandrock. Keith's summary of the work done in the municipality is included as a separate article.

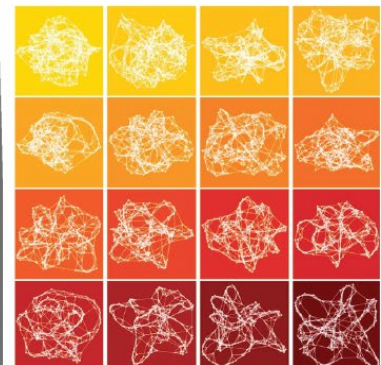
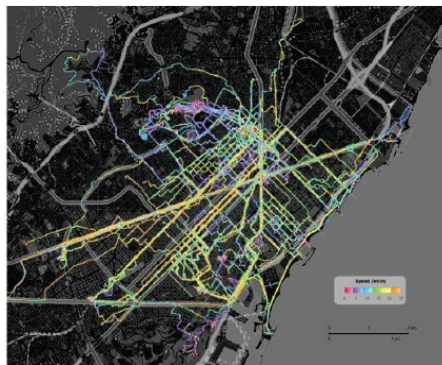
At that time, AECI contributed several of the committee members – people like Jim Buttery, Rob Eales, Alan Hawcroft and Daves Bromley and Evans were involved. The Newsletter was hard copy, of course – an A5 booklet printed as four sides per A4 sheet, so involving all kinds of fun, formatting, sequencing sheets, folding, etc. That activity involved most of AECI's OR Group once a quarter, with a team of people trotting round a large table, picking up the relevant sheets and then depositing them onto gradually growing newsletters, with someone else removing and stapling the completed ones to make room for the next cycle.

AECI also (probably unknowingly) sponsored the printing costs. Posting was a painful activity as well, of course, printing labels, stuffing envelopes (Yes, that is the official phrase) and then trotting off to the post office with several hundred of them.

The Joburg Chapter typically held around 6 events a year through the eighties. They took place all over the city. One popular venue was the old Chamber of Mines Club – later demolished to make room for the new south end to Barry Hertzog Avenue in Milpark. Gene Woolsey, of the Colorado School of Mines, was a frequent visitor to South Africa in those days, and ran a travelling salesman problem workshop which my recollection tells me lasted more than one day, for which the Chapter charged a significant fee.

People like Tom Saaty and Pat Rivett also visited and were in-spanned for similar events. I remember a rather odd moment at a dinner part – I think for Tom Saaty, hosted by Paul Fatti, where Tom got onto the topic of the amazing power of synchronization, and that four of us would be able to lift him up, sitting on his chair, with one hand each. I can't remember exactly how he got us synchronized

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that precisely, and hyped up to the degree necessary to risk breaking something, but he did, and we did, too, and he was not a small man!

Another venue we used in those days was the Wits Business School – I remember a simulation language ‘shoot out’ we held there – probably back in the days of punched cards, where three different vendors presented to us – and their competitors - about why theirs was the best. Another one held there was on the statistics of marketing in the context of toothpaste. The speaker was stressing the true inherent benefits of one toothpaste over another. I asked him a question along the lines of never ever having used a toothpaste which had done a less than adequate job of cleaning my teeth, and therefore what inherent benefits any one toothpaste could have over any other (and I don’t think the situation has changed in the slightest, whatever current adverts tell us.) I didn’t get a convincing answer...

One of the other initiatives which occurs from time to time is educational – I have a clear recollection of speaking to students at Wits on more than one occasion, with Paul Fatti and/or Hans Ittmann, and various people have done the same thing over the years at schools – my last one of those was only a year or two ago.

The idea of ‘social’ events probably came in some time around the turn of the century. We held several of those in Midrand, so that they were also more convenient for Pretoria Chapter members.

While I worked at the Development Bank, in Midrand, we had several seminars there, as that was obviously also convenient for Pretoria members, and also next door at Vodaworld when Louis Dannhauser, who worked there, was chapter chair. In recent years, Opsi, in Rosebank, and Discovery, in Sandton, have also been venues we have used several times.

While ad hoc seminars still occur, we have started to also celebrate ‘regular’ ones, the two which are currently quite well established being ‘pi’ day (14th March – 3.14, in American formatting) and Ada Lovelace day, the latter commemorating the (hopelessly under acknowledged) role of women in ‘STEM’ – science, technology, engineering and maths.

The other new activity is the *Analytics Meetups* which are currently held before work every second Wednesday. These have proved enormously popular and rotate around various venues in the northern suburbs – typically coffee shops, one of which is also in the Discovery head office in Sandton. A normal gathering is from 5 to 10 people, and topics are wide ranging, to put it mildly, but obviously this is acceptable to the participants – members and non-members, as they keep coming back.

The chapter is in exceptionally good health, and we look forward to that continuing well into the future.

OR IN THE JOHANNESBURG MUNICIPALITY

Written by Keith Sandrock (sandrock.keith@gmail.com)



Keith Sandrock

When I worked in the Johannesburg Municipality City Engineer’s Department (CED) from 1961 to 1984, there was a pervasive culture of continuous improvement – doing things better. I don’t know how it started, I was simply swept into it from day one.

The Statistical Services Division (later *Branch*) was formed at this time and provided a supporting role throughout CED but mainly to the Forward Planning Branch in which it started as a division. I stress the supportive role – we did not make far reaching decisions – those were made by engineers and planners.

The tools we used were basic statistical methods, ANOVA, Curve fitting (linear but mostly non-linear, using regression, etc.), forecasting, time series analysis, simulation, stochastic models, and heuristic models amongst others. There was of course highly specialised transportation modelling.

In the 1960’s and 1970’s our computing power was an ICL 1900 mainframe belonging to the City Treasurer’s Dept. We were allowed to run programs on this behemoth after hours - that is from 5 p.m. onward. There was very little suitable software, and so the first requirement was an ability to write good Fortran and Assembler (ICL’s PLAN) programs. They had to be good, because memory was tiny. After a while we had a decent library of homebuilt software, and analyses became easier and faster. The first spreadsheet software only became available many years later so in our day we wrote our own spreadsheet programs to do simulation and answer “what if”. Today that would be easy using something like Excel.

The main project handled by the Forward Planning Branch was the Greater Johannesburg Area Transportation Study. The leaders were Anthony Marsh (branch head) Bernard Carlson and Ivor Carlyle (both transportation engineers with USA MS degrees). Johan Venter initially headed the statistical services division.

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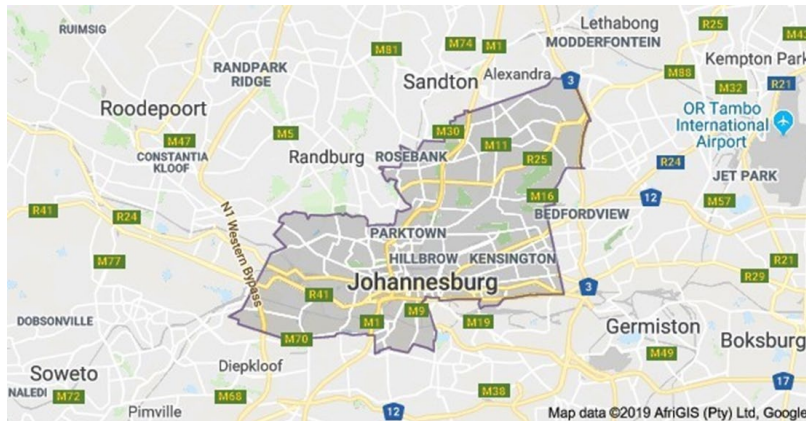
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To facilitate the transportation study a computerised Land Use Inventory (LUI) was developed. For every parcel of land in the Johannesburg municipal area (see map above) the land use by category was painstakingly obtained from building plans. The main categories were: Residential, Business, Office, Recreational, Medical, Industrial (by category) etc. and these were further broken down. This was a massive undertaking using untold manhours (a team of pensioners was employed¹). The LUI started to become useful after about 6 years of work, and it was ongoing – land use was constantly changing and the LUI had to be kept up to date. We (Stats Division) were responsible for getting all this hard copy information into the mainframe and developing Fortran software for extracting parameter driven summaries as well as special once off reports.



The image above demarcates the grey area referred to as 'Johannesburg' in this article.

What was this used for?

Inter alia for trip generation and attraction modelling using known trip generation and attraction factors for each 10 sq m of floorspace by category. Also for estimating working population density in the CBD (Central Business District). Other departments also made use of the LUI for their planning operations.

In parallel with the LUI and with the help of the Land Survey Branch and Siemens SA, a fledgling digital terrain model for the city was developed. Familiar as we are with today's GPS, it is almost impossible to visualise the difficulties we had in extracting land use information by category for a demarcated area of the city. The digital terrain model helped ease this problem.

Car Ownership: Cars per 1000 population.

A really good model was developed for estimating future car ownership. It was asymptotic of course, and calibrated using existing data.

What was the ultimate aim of all this activity?

The location of motorways, bus routing, location of Park-and-Ride Facilities, location of parking garages etc. and the big one – the design of the Johannesburg Underground.

¹ These pensioners were chosen for their numerate ability and ability to read and interpret building plans. Amongst them were professionals, clerks, a school principal, a WW2 British Army colonel, - a delightful mix, and I thoroughly enjoyed working with them.

The underground was to be multi-storey parking garages on the periphery of the CBD feeding an underground rail system. Outside the CBD was a surface rail rapid network extending towards the suburbs but not very far. Tunnelling was cut to a minimum, the idea being to dig up roads, construct the underground rail system, and then replace the roadway on top.

The detailed design of the underground was checked by invited experts from London Underground and Paris Metro. Once satisfied that they had a viable system Johannesburg City approached higher tiers of Government for financial help to build it. It never occurred to the planners that this request would be refused. But it was. That was the

end: Johannesburg could not go it alone: project shelved – forever. However, the positive was years of phenomenally interesting work. We all felt these were amongst our most rewarding years. Time has borne this out – none of us, ever again, was privileged to work on a project of this complexity.

Origin-Destination Survey analysis. (O-D)

The Forward Planning Branch conducted O-D surveys from time to time along major routes into the CBD. The modus operandi was simple. Little road blocks were set up and drivers asked where they started from and where the trip would end. Passengers were counted. The analysis was more complex and involved Fortran programming and programming a big Calcomp flat bed plotter. The result was a detailed picture of traffic flow into and out of the CBD and this information was also passed to Major Roads Branch, whose engineers ensured the routes were upgraded to keep pace with requirements. O-D results were used mainly for transportation engineering. The simulation modelling was quite complex because what we had to load a road network to capacity, and then determine how traffic would best sort itself out using alternative routes.

Pedestrians

The comfort of pedestrians was not forgotten. We developed a heuristic model for estimating peak pedestrian volumes and density, using easily obtained data during off-peak periods. Planners introduced pedestrian malls to alleviate discomfort, and Johannesburg CBD became a nice place to walk around in.



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Beef Production Optimisation.

This project was very interesting and managed by Dr Wally Ehret who later headed the veterinary division at Johannesburg Zoo.

Johannesburg has two sewerage farms, one north and one south of Johannesburg. Raw sewage is processed there and according to environmental laws, the water from the treatment plant must be allowed to flow over land before being allowed to enter a river. Contact with soil has a detoxifying effect. Pastures were developed for this and a beef herd established on Northern Farm. The beef produced provided an income for Johannesburg. Artificial Insemination (AI) was used for breeding and accurate records kept of Sire/Dam progeny from birth to market. Where we came in was computerisation and analysis of these records. Using basic statistical techniques the best sire/dam combinations were identified. That is: best in terms of beef production (the rate at which calves put on weight and final weight), and beef quality (the final grading of the carcass). Optimising AI breeding using these parameters resulted in Northern Farm's beef herd becoming one of SA's very best. A champion sire's sperm, stored in liquid nitrogen, can be used for up to 20 years after his death.

Would a New Shopping Centre be feasible?

The Town Planning Department often received applications for rezoning of properties by developers who wished to construct a shopping centre, for example. Using the LUI

and the digital terrain model it was possible to conduct a feasibility study. A new shopping centre attracts clients in the vicinity according to the floor space size and usage (e.g. groceries, clothing, etc.) and inversely according to travel distance, location and floor area (by use category) of nearby shops. For each category of floor space usage, town planners have an attraction factor per 10 sq m. And for travelling distance and presence of nearby shops, inverse factors. There were also factors for revenue generation per 10 sq m by category. The cost of building the proposed centre was estimated. Using Fortran, a program was created to model this situation. The result was a tool giving planners a basis on which to make a rezoning decision. Incidentally if a proposed new centre was marginally feasible, adding a bottle store clinched it. Presence of a bottle store inflates attraction parameters.

Valuation Roll.

The City Valuer was John McCullough and he took great pains to get a correct valuation for each property. This involved plenty of field work, together with statistical techniques such as multiple regression analysis, and factor analysis. His problem was that property rates were based on land value. If there are vacant land sales in a suburb, then there isn't a problem, but Johannesburg is largely built up and for most suburbs there have not been vacant land sales for many years. But there are property sales. John's problem was to get an accurate estimate of the value of the improvements and subtract this from the sales value of the

property, to get the residual land value. To do this he used a pro forma which listed all the factors that added value such as total sq m of buildings, type of construction, number of rooms by type, carpets and other finishes, garden, pool, etc. – everything to do with adding value. It was a lengthy list. His valuers would then visit a recently sold property and fill in this sheet. We came in at this point, getting the data into the mainframe and running regression analyses to obtain each variable's contribution to total cost. Relationships were not always linear over the data range and compensation had to be made for this. Over time, John obtained coefficients so refined that the value of improvements on a property could be accurately assessed, and by subtraction, the residual value: the stand value. Factor analysis was also used to determine an importance hierarchy. Using all this information, realistic land values and hence realistic rates were calculated. The main advantage of this approach was that for any suburb, the rates per sq m were the same for every stand, and had nothing to do with the value of the improvements. Hence the man who built an expensive house was not penalised for his endeavour as is the case when basing rates on market value.

Solid Waste Collection – Cleansing Branch

The collection and disposal of solid waste using compactor and other vehicles was managed by Stan Verrier at that time. John Bicheno did the OR work and this I obtained from him. The OR work in CED Cleansing Branch was three main areas:

Refuse Collection Team size optimisation: This was simulation: essentially a trade-off between declining unit productivity per worker with increasing team size and costs of vehicle and manpower. Other variables were bin spacing, distance to landfill and vehicle capacity. This was also used to help justify the introduction of plastic bags and later 'Sulo' type bins.

Fleet size optimisation: Collection vehicles are very expensive and have high breakdown rates due mainly to things that people throw away, plus their hydraulics. When a vehicle breaks down penalties are incurred like overtime working, and vehicle recovery, and the vehicle may be out of service for a number of days. The issue is how many spare, or standby, vehicles there should be. The approach was a simulation model, assuming that all refuse must be collected every week.

Number of landfill sites: This is essentially a trade-off between economies of scale of a landfill vs travel distances, with no collection costs of the collection vehicle and team. LP as tried on this, but many non-linear variables made it unsuitable. Calculations were then done for every possible combination of up to 5 landfill sites, each with unique trav-

el distances and collection times for every area.

Other studies included newspaper recycling feasibility, garden waste sites, and street sweeping. These latter were essentially 'systems' type studies.

I recall doing refuse generation and composition modelling by socio economic groupings. Using census data on average household income we had already divided Johannesburg into socioeconomic regions for other studies. For each region the amount of waste generated (volume and weight) was estimated, and from field sampling by Cleansing Branch personnel, the composition of this waste. In affluent areas there was a lot of putrescibles such as food waste, paper, clothing material, etc., and as income drops one found ash, wood, metal, building material, etc., increasing and valuable refuse decreasing. Sometimes they found a crankcase!

Whenever I see a house with two bins filled to overflowing I think back to those days. In order to generate this much waste, one must have spent a mighty lot of money.

Mechanical Branch.

Johannesburg operated a massive fleet of vehicles, from buses to compactor vehicles to bakkies and small cars and the fleet was monitored using a commercial Fleetmaster system. We ran the system for them on the mainframe. It provided excellent management information and enabled the Department to run a very efficient fleet. One of the outputs was fuel consumption per vehicle. The manager was able to spot a fuel thief using this info. But oil theft was more problematic, because oil was kept in drums, and pumped out with the hand pump as required. He solved this by having graduated dipsticks made in the workshops and an employee record the readings every morning and brought to him. This was a meaningless activity of course but he was something of a psychologist. As soon as people saw that oil usage was being checked the consumption dropped.

Miscellaneous

There were always miscellaneous routine daily activities going on as well as requests from other branches some of which involved LP, ANOVA, etc. Stanley Hurwitz was the ANOVA expert. He successfully analysed data that were not normally distributed, had unequal subclasses, missing values etc.

A final thought: Council Bursaries to study B.Sc. with Statistics as the major, full time at Wits, were awarded to 7 applicants during my time. They enjoyed working off their commitment in the Branch.

WHY EVERYONE SHOULD ATTEND A WINTER SCHOOL

Written by Robert Bennetto (robert.bennetto.za@gmail.com)



Robert Bennetto

In December 2018 I received a ORSSA mailer that had the details of a Winter School in Network Optimisation, to be held in Portugal in January 2019.

I had never considered attending a winter school before and wasn't going to give it a second thought until I saw that Bill Cook (who *literally* wrote the book on the Travelling Salesman Problem) would be giving a full day of lectures at the school. That sealed the deal for me. I thought it would be a great opportunity to get my TSP book signed, and perhaps have an interesting conversation with someone who is among the top applied mathematicians in the world.

Little did I know, but Bill Cook would be one of several fabled practitioners I would have the opportunity to meet. This is really the crux of the problem; had I not taken the plunge by attending the winter school, I would have seriously missed on the remarkable people that were there. I would go so far as to say, that while Bill Cook delivered a great day of lectures, that there are facets from every single day that I enjoyed. Each day was enthralling and topical in its own way. A few of the lectures were deeply technical, some had far reaching implications, some with fantastic modelling insight and others that would have helped fast-track anyone attempting to get to the core of a topic quickly.

Each of the lectures were well prepared, flawlessly delivered, and were followed by an afternoon of "homework" - worked examples based on the content delivered that day, to be completed and assessed by the lecturer in person at the end of the day. This really helped reinforce concepts that were presented and actually helped lubricate conversation with the lecturers and other students (most exercises were completed as a group of 3-4 students).

The students who attended the school were predominantly European with an emphasis on German, French and Italian students. There were several students from interesting places, such as Lebanon, Turkey, Iceland, Norway, Belgium and Hungary. I engaged a lot with the French and German students (a probabilistic inevitability) who were a hoot - although that would be a fair assessment of almost all the students who attended (with the exception of one Italian that wasn't spanked as a child and was unapologetically rude).

I soon realised through our daily interactions that there were big cultural differences between us. At one of the pub evenings, I discovered that a particular German student

didn't know who Nelson Mandela was. When I pressed him to take a guess - he thought that perhaps Nelson Mandela is a famous footballer, but couldn't quite put his finger on it. Needless to say, the other German students mocked him relentlessly, so I doubt he'll forget any time soon.

It also turns out that the French are very cagey when talking about politics or their own political views (especially around other French students). The middle-eastern students were incredibly open and friendly - A stereotype I had formed in my own mind was overthrown by the Lebanese.

Something that stood out for me was that this was a group of around 50 people who all identify as Operations Researchers - a very unusual situation in South Africa. One of the reasons for this is that I think many of them took a rather direct path into mathematical optimisation, as opposed to an indirect path through some other discipline that facilitated an introduction to Operations Research. Most students were completely funded in their chosen research and were able to attend the winter school as a result.

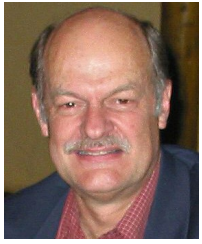
There are so many pro's to attending this kind of event. The opportunity to chat to students that have been taught differently yields significant insight. Seeing where research emphasis is being placed is always valuable. Receiving canonical information from the source (the lecturers) for concepts in your field is vital, especially if you're doing post graduate research. The people you meet and the conversations you'll have over coffee are an experience in itself - because you're around people who are genuinely interested in the same core topic as you. It makes striking up conversation, or finding a way to connect with people quite effortless.

I find random cocktail parties or "mingling" quite a painful process - these kinds of events are nothing like that. I ended up having a long one-on-one lunch with Bill Cook on his first day at the school which was fascinating - and managed to get my book signed after all :-)

I'm definitely going to be more active about seeking out these kinds of events in the future, as it was an excellent experience. I hope you learn from my mistakes and also seek them out while you still can!

BOOK REVIEW: COMMUNITY-BASED OPERATIONS RESEARCH

Written by Hans W. Ittmann (hittmann01@gmail.com)



Hans Ittmann

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.

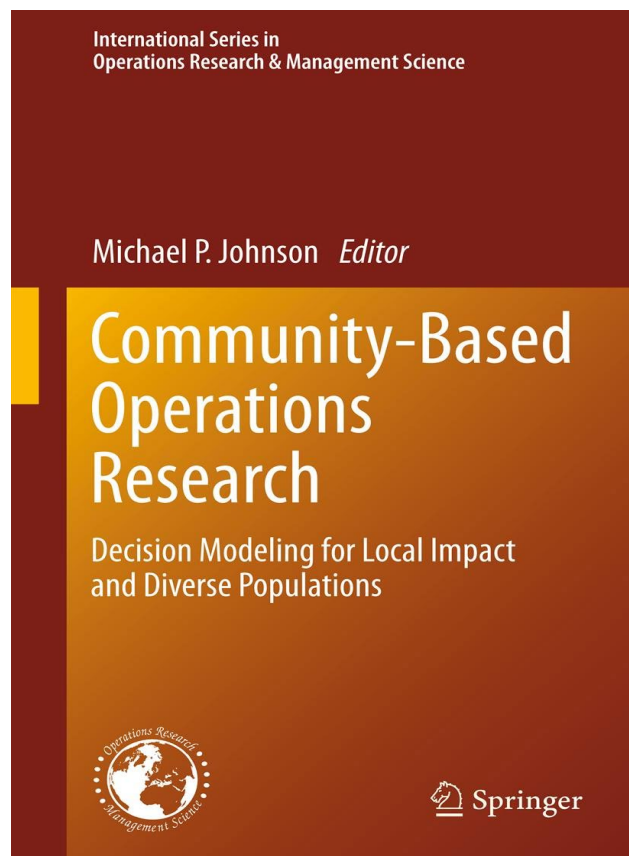
The book is divided into four Parts, with each Part consisting of several chapters. There are 13 chapters with a total of 31 contributors.

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.

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).