

# IFORS

International Federation of Operational Research Societies

NEWS

## From the President

### Can Operations Research Contribute to Sustainability?


**Grazia Speranza** <grazia.speranza@unibs.it>

Sustainability is one of the words that nowadays often appears, with different degrees or shades of relevance, in speeches of politicians, scientists, private citizens. Newspapers speak of sustainability, companies make their products and their production and distribution processes sustainable. Sustainability usually refers to the capacity for the biosphere and human civilization to coexist. The exploitation of resources, the direction of investments, the orientation of technological development, the decisions taken by institutions and politics should all be in harmony and enhance both current and future potential to meet human needs and aspirations. Sustainability has three interconnected domains: environment, economic and social.

Greta Thunberg, born in 2003, has attracted the attention to the challenges our planet is facing, contributing to an increase of the sensitivity of many towards these challenges and hopefully enhancing the definition of action plans capable of changing the business-as-usual that may lead to dramatic changes that would take place in few decades. Obviously, the young generations will be more impacted by the climate change than the older ones but the political and economic powers are not in their hands. The climate change, and especially the temperature increase, is reducing the size of glaciers, increasing the level of the oceans. It is changing the planet, not only its surface, the agriculture and the economy, but also the whole society, with huge migrations forecasted from regions where lakes will dry. The time frame in which such changes are expected in the business-as-usual

scenario is too small to allow the human kind to slowly adapt.

Sustainability involves, in its three domains, several other dimensions, besides the environmental one. Hunger should be fought with over one third of the world food wasted. Transportation is a major source of pollution, especially with cities growing everywhere. Energy should become affordable and clean. Production and consumption should become responsible, with an increased rate of recycled materials. Public health should be improved. Green companies that are equal opportunity employers should be supported.

Achieving sustainability requires a huge global effort where each and every one should give a contribution, small or big. Then, the question that is the title of this editorial is: Can Operations Research contribute to sustainability? Can we contribute to sustainability? I think we can. Operations Research is a discipline that, by vocation, looks at systems and improves their efficiency. Energy, transportation, production, distribution, health are all areas where we have worked, improving decision making. We can give a contribution to sustainability in educating our students towards the choice of new, and not only economic, objectives. We can contribute in having sustainability in mind whatever problem we work on. 



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### Editorial Box

Luciana Buriol <buriol@inf.ufrgs.br>

I am glad to release the September Issue of IFORS News Letter! This issue starts with a message from our President, Dr. Grazia Speranza, encouraging all of us to think about how operations research can contribute to sustainability. In the OR Impact Section, you will find the article "The new Frontier of Capacity & Revenue Optimization: the Europcar Mobility Group experience", while in the Tutorial Section you will find "Predicting the likelihood of being upper level in Nepalese organizations". Both articles summarize results from innovative research. Next, we added a call to the IFORS Prize for OR in Development 2020. We invite all who have a project that fits into the scope of the Prize to submit it! In the OR for Development Section, you will find the article "Home Health Care Logistics in a Developing Country", one of the first works in this subject written by a group from South America. In the Book Review Section, Hans Ittman summarizes "Operations Research in South Africa – the first 50 years". Ending this issue, we have reports of many important OR events hosted in several cities around the world. Before you start Reading, please reflect upon this issue: how can each one of us contribute to a sustainable world, in particular considering your OR expertise. 🌍

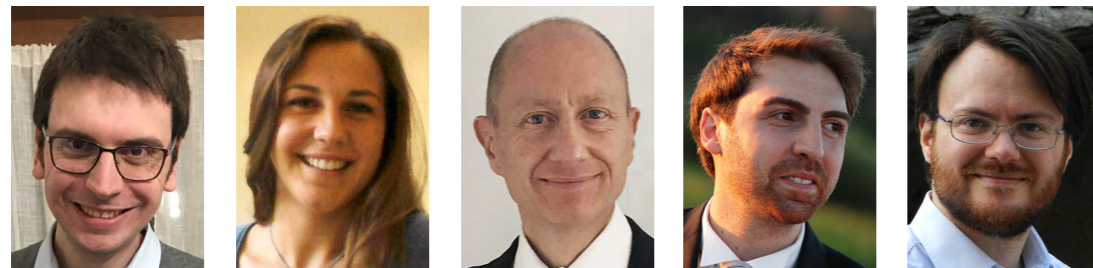


Articles demonstrating direct benefits from implementing OR studies

Sue Merchant <suemerchant@hotmail.com>; John Ranyard <jranyard@cix.co.uk>

## The New Frontier of Capacity & Revenue Optimization: The Europcar Mobility Group Experience

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### Introduction

The car rental industry was estimated to be worth \$60bn globally in 2016 and is expected to double by 2022. It is highly competitive. The aim of providers is to have the right car, at the right location, at the right time and sold at the right price. However, many uncertainties have to be managed by providers, including demand variability, seasonality, weather and above all, actions of competitors.



Europcar Mobility Group (EMobG) is a major player in mobility markets, operating a portfolio of 9 mobility

brands (from car rental to car sharing and chauffeur services), including the Europcar brand, which is number one in Europe. In 2014 EMobG engaged ACT Operations Research (ACT OR) to design and implement a new system to improve fleet planning and rental price optimisation.

### Overview of the car rental business

Management decisions by providers can be grouped into two:

- a) **Fleet capacity**, which involves having the right car in the right location to meet the expected demand. This can be subdivided into **long term** (12 months ahead): contracts with vehicle vendors, defining the number of cars to buy and the policy for returns. The contracts include economic conditions and penalties; **mid-term** (a few months ahead): fleet planning, i.e. where to place the purchased cars; and **short-term**: planning car transfers between stations to cover demand peaks or to limit low usage in specific areas.
- b) **Revenue Management**, i.e. maximizing income from car rentals.>>

>> This involves setting prices for each type of car, based on the duration of the rental and market conditions and managing promotions so as to ensure, as far as possible, that demand matches the available number of vehicles. An important aspect is to minimize the number of free upgrades, which are provided when the category of car booked by the client is not available.

### The need for improved processes

The mission of EMobG is to be the preferred "Mobility Service Company" by offering alternative attractive solutions to vehicle ownership, with a wide range of mobility-related services: vehicle-rental, chauffeur services, car-sharing, scooter-sharing and peer-to-peer car-rental. EMobG has four major brands: Europcar® - the European leader in vehicle rental services; Goldcar® - the most important low-cost car-rental company in Europe; InterRent® - 'mid-tier' brand focused on leisure; and Ubeeqo® - one of the European leaders in car-sharing.

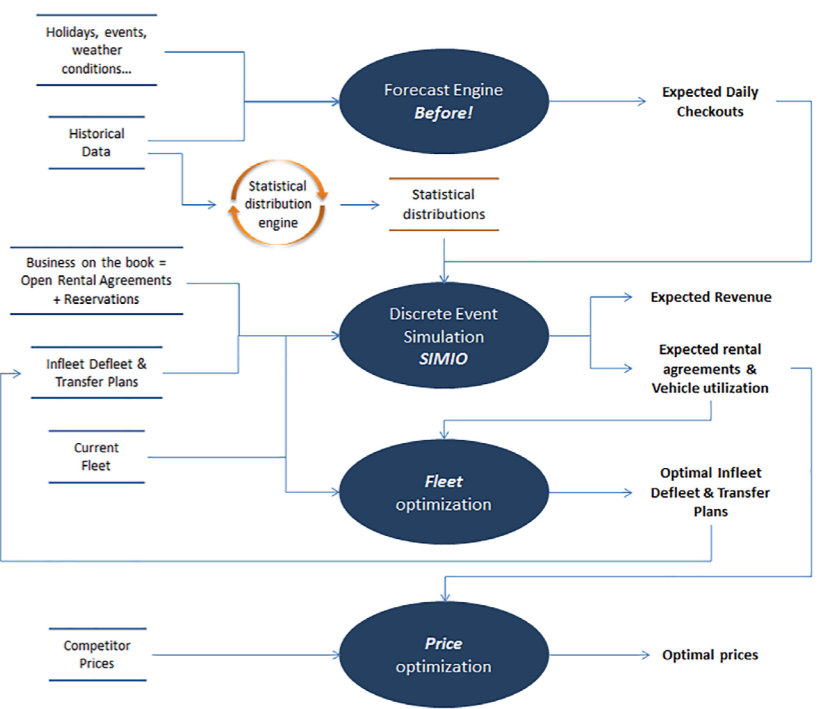


Figure 1: Data Flow of the Opticar Solution

EMobG delivers its mobility solutions via an extensive network in 140 countries (including 20 wholly owned subsidiaries in Europe, 2 in Australia and New Zealand, franchises and partners). In 2018, the Group had a revenue of around €2.9bn and 12,000 employees.

Competition is intense in the car rental industry and the availability of increasing amounts of data, increasing computing power and improvements in relevant software stimulated the company to seek an improved system to support its operations. ACT Operations Research (ACT OR), a software company which specializes in providing corporate decision-making software using OR approaches and has been established for 20 years was chosen for this task. It's involvement resulted in the development of a system called **Opticar**.

### Opticar – Europcar's fleet capacity and revenue optimization system

The four components are as follows:

**Forecasting Module (unconstrained):** this is ACT OR's forecasting platform *Before!*, which selects the best result from several forecasting algorithms, including autoregressive integrating moving average, exponential smoothing and neural networks. Forecasts are provided each day for 24 weeks with the aim of estimating new rental agreements. Several user-defined criteria, including bank holidays, special events, and weather conditions are incorporated and the output is the forecast demand which is not constrained by vehicle availability.

**Fleet Demand Simulation** – The forecasting module estimates the number of new rentals each day but not their duration nor which location the car will be returned to. This module, implemented in a discrete simulation package SIMIO, provides estimates of

anticipated rental agreements over the next 24 weeks, the state of Europcar's business over this time and daily fleet utilisation. Many uncertainties are incorporated such as late returns (requested and not requested), paid and free upgrades and cancellations.

**Fleet Optimisation** – In this module fleet capacity is formulated as a linear programming model but solved using a meta-heuristic algorithm, which simultaneously optimises fleet composition and utilisation. Some user constraints can be included, such as not transferring cars between locations that are far apart or allocating certain vehicle types to locations subject to high theft. The output gives *Infleet Optimisation* (the acquisition and assignment of vehicles to specific zones based on the expected revenue, costs, demand, and other constraints; *Transfer optimization* (movement of vehicles in the available fleet from one zone to another. The system considers the transfer times and costs, and forecast demand for each zone; and *Decommission Optimization*: the removal of operating vehicles from the fleet.

**Dynamic Price Optimisation** – this module considers rental prices as decision levers to enable management to match forecast demand from the simulation in constrained and unconstrained scenarios. It incorporates rules-based pricing (input by users from their business knowledge) and conventional pricing optimisation, with simulation being used to find the best balance between the two.

### Implementation of Opticar

An initial pilot version was introduced in Italy in late 2014, replacing the previous manual system and eventually leading to an increase in fleet utilization of 4.8%. This success persuaded senior management, in conjunction with ACT OR, to roll out the system to nine further countries as a major well-funded project, coordinated by EMobG International. >>

>> It involved a week of online training for local staff, with early results being monitored so as to fine tune the system. Comprehensive user guides and follow up online training were also provided and each year a users' conference has been run to enable employees from different countries to share knowledge, best practices and prospects.


### The impact of Opticar

Since the beginning of the project, thanks to more efficient capacity and revenue management, the benefit is estimated to be around about \$14m per year in terms of cost savings, largely through improved fleet utilization. Examples include a 3% increase in revenue per day in Spain and a saving of £1.3m on upgrades in the UK. In the last 5 years Europcar rental revenue

has increased by almost \$584m in a very competitive market, where the growth of low-cost competitors has exploded and driven down prices in the wider market, resulting in lower revenue per day.

### Reference

Guillen J, Ruiz P, Dellepiane U, Maccarrone L, Maccioni R, Pinzuti A, Procacci E (2019) Europcar Integrates Forecasting, Simulation, and Optimization Techniques in a Capacity and Revenue Management System, J Applied Analytics, vol. 49 (1)

**Editors' note:** This article is published by kind permission of Michael Gorman, the editor of the INFORMS' Journal of Applied Analytics. The project was a runner-up in the INFORMS' Edelman Prize Competition in 2018. 

## Tutorial

# Predicting the Likelihood of Being Upper Level in Nepalese Organizations

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**Abstract:** Career success is measured with subjective and objective indicators. This paper focuses on objective indicator as occupational hierarchy as upper and lower level with the application of binomial logistic regression with backward entry method. Out of seven variables studied five variables were found significant.

### Introduction

"How do people move up the career ladder?" is one of the major career development questions concerned in organizations (Conger, 2002). Moving up the career ladder is one of the tangible indications of career success. In this circumstance, understanding the factors that contribute on moving up the career ladder is essential for employees. Moreover, being in upper level of organization is a destination of employees in their career ladder, which is also considered as objective element of career success. Career success varies from person to person. However, it is defined as positive psychological or work-related outcomes or achievements that the individual accumulates because of work experiences (London & Stumpf, 1982, Judge & Bretz, 1994, Judge et.al., 1995, Seibert et.al., 1999, Seibert & Kraimer, 2001). Psychological outcomes are largely related to subjective measures and non-psychological outcomes are objective. Objective career success refers to outcomes, which are visible (Jaskolka, Beyer, & Trice, 1985), more observable, more tangible, (Ballout, 2009) and publicly assessable (Arthur, Khapova, & Wilderom, 2005). Subjective measures of career success refers to one's feelings of accomplishment and satisfaction with his or her career, across any dimensions that are important to that individual (Van Maanen, 1977) and they are partially based on objective indicators (Judge T. A., Cable, Boudreau, & Bretz Jr., 1995).

The current paper has considered "being in upper level" (i.e. hierarchical status) as a single indicator of career success and is based upon the career success measured through objective career success only.

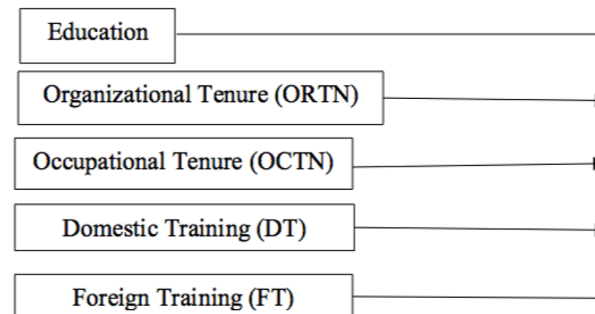
**Human Capital** is knowledge-based assets of any organization that leads to competitive in market. Becker defined human capital as capabilities of individuals that gained through investments of time, effort, and money on Education, tenure and training (Becker G. S., 1993). The study therefore considered them as elements of human capital.

**Networking Behaviour** refers to individuals' behavior relating to involvement in network, where they maintain contacts with people relating to work, participating in social gathering, involving in socializing program, taking part in visible task in organization and professional circle.

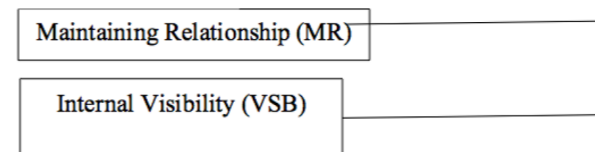
The relationship has been portrayed in the schematic diagram. So, the current study is triggered by a research question "Do human capital and networking variables influence on explaining the likelihood of being upper level of organization?" In order to address the research question, the following hypothesis has been formulated based on literature.



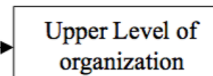
### Human Capital



### Networking



### Objective Career Outcome



H: At least one of variable influence on explaining the likelihood of being upper level of organization.

### Objective and Methodology

The aim of this paper is to assess the model explaining the likelihood of objective career outcome measured by being in upper level of organization specially with its human capital and networking determinants.

The paper has adopted objectivist philosophy of research (Saunders, Lewis, & Thronhill, 2012). The paper is based on self-administrative survey conducted targeting to collect the data from officers of Nepal government organizations (GO) and officer level bankers from commercial banks. Total of 479 respondents from 31 GO's, and 29 commercial banks within Kathmandu valley were selected for study.

The dependent variable "being in upper level" was measured by asking their designation. Later, they have been classified as upper level and lower level (dichotomous variable). The independent variable human capital indicators (Education, organizational and occupational tenure, and training) were measured by asking them to mention.

*Education* indicates the highest academic degree earned by participants, which has been classified into "graduate and post graduate", and "M. Phil and above". Tenure is the numbers of years employees spend in their service, which make them more experienced in their work. Tenure has also been measured as occupational

tenure and organizational tenure. Occupational tenure refers to numbers of years civil servants and bankers spend in their civil service and banking profession. Organizational tenure is numbers of years they spend in their current working organization, and bank respectively. *Training* is operationalized as numbers of training and development program they attended in their service period either in Nepal or foreign country. Attending training and development program in foreign country enhances international exposure to some extent.

The networking behaviors have been operationalized for the study by two variables: i) maintaining relationship within work and professional circle, ii) being visible in official activities based on items developed by Forret and Dougherty, (2001). The 7-point likert scale was used to measure networking, and all the items were translated into Nepali language.

A binomial logistic regression was performed to ascertain the effects of human capital, and networking variables on the likelihood of being in upper level of organization. Binomial regression was performed with backward entry aiming to removing insignificant determinants from model.

Table 1: Test for linearity

		B	S.E.	Wald	df	p	Odds ratio
Step 1	EDU	2.227	1.385	2.585	1	.108	9.275
	OCTN	1.049	.337	9.691	1	.002	2.854
	ORTN	-.532	.272	3.835	1	.050	.588
	DT	-.712	.332	4.604	1	.032	.491
	FT	1.342	.638	4.428	1	.035	3.827
	MR	-.220	.972	.051	1	.821	.802
	VSB	-.422	.725	.339	1	.561	.656
	OCTN by ln_OCTN*	-.248	.088	8.041	1	.005	.780
	ORTN by ln_ORTN*	.190	.084	5.077	1	.024	1.209
	DT by ln_DT*	.229	.101	5.102	1	.024	1.257
	FT by ln_FT*	-.398	.261	2.326	1	.127	.672
	MR by ln_MR*	.063	.248	.065	1	.799	1.065
	VSB by ln_VSB*	.192	.211	.829	1	.362	1.211
	Constant	-6.063	4.797	1.597	1	.206	.002

\*p value of the interaction term of independent continuous variable < 0.00357

### Assumptions:

All the assumptions of the model has been satisfied including the dependent variable measured on a dichotomous scale (occupational status: upper level and lower level) and the linearity assumption.

Table 2: Logistic Regression Predicting Likelihood of Upper Level of Organization Based on human capital and networking variables

No of Steps	Variables	B	S.E.	Wald	df	p.	Odds ratio	95% C.I. for odds ratio	
								Lower	Upper
Step 1	Education	3.076	1.296	5.632	1	.018	21.668	1.708	274.837
	OCTN	.200	.038	27.751	1	.000	1.221	1.134	1.316
	Organizational Tenure	.146	.045	10.720	1	.001	1.157	1.060	1.262
	Foreign Training	.833	.200	17.299	1	.000	2.300	1.553	3.405
	Maintaining Relationship	.012	.062	.039	1	.844	1.012	.897	1.143
	Internal Visibility	.183	.071	6.640	1	.010	1.201	1.045	1.380
	Constant	-9.043	1.831	24.379	1	.000	.000		
Step 2	Education	3.043	1.281	5.643	1	.018	20.962	1.703	258.090
	OCTN	.200	.038	27.821	1	.000	1.221	1.134	1.315
	Organizational tenure	.145	.044	10.730	1	.001	1.156	1.060	1.261
	Domestic training	-.018	.050	.130	1	.719	.982	.891	1.083
	Foreign training	.834	.200	17.329	1	.000	2.303	1.555	3.410
	Internal visibility	.187	.068	7.708	1	.005	1.206	1.057	1.377
	Constant	-8.842	1.505	34.498	1	.000	.000		
Step 3	Education	3.049	1.272	5.743	1	.017	21.089	1.742	255.244
	OCTN	.200	.038	27.902	1	.000	1.222	1.134	1.316
	Organizational tenure	.144	.044	10.761	1	.001	1.155	1.060	1.259
	Foreign training	.813	.191	18.023	1	.000	2.254	1.549	3.281
	Internal visibility	.193	.066	8.456	1	.004	1.213	1.065	1.381
	Constant	-8.998	1.461	37.932	1	.000	.000		

Note: Education is for "M.Phil and above" compared to "Bachelor and Master's"

#### Testing for linearity

Linearity of the continuous variables with respect to the logit of the dependent variable (upper level of organization) was assessed (Box & Tidwell, 1962). A Bonferroni correction was applied using all fourteen terms in the model resulting in statistical significance being accepted when  $p < 0.00357$  (Tabachnick & Fidell, 2014). Table 1 shows that all the interaction terms of independent continuous variables are insignificant at the new adjusted significant level. Based on this assessment, all continuous independent variables were found to be linearly related to the logit of the dependent variable.

#### Testing for outliers using case diagnostic

There were fifteen residuals with value greater than  $\pm 2.0$ , identified in seven runs, which were removed from analysis.

#### Finding

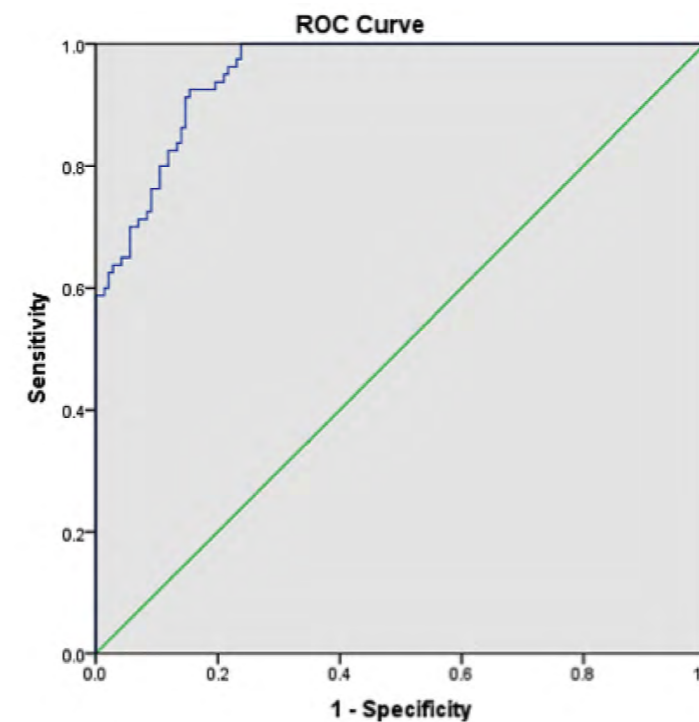
The logistic regression model was statistically significant,  $\chi^2(5) = 162.938$ ,  $p < 0.0005$ . The model explained 74.6 percent (Nagelkerke R<sup>2</sup>) of the variance in upper level and correctly classified 86.5 percent of cases. Sensitivity, the percentage of case that had the observed characteristics (i.e. upper level) which were correctly predicted by the model (i.e. true positive) was 81.1 percent. Specificity, the percentage of cases that did not have observed characteristics (i.e. officer level) which were correctly predicted by the model (i.e. true negative) was 89.6 percent.

Positive predictive value, the percentage of correctly predicted cases with the observed characteristics compared to total number of cases predicted as having the characteristic, was 81.08 percent. Negative predictive value, the percentage of correctly predicted cases without the observed characteristics compared to total number of cases as not having the characteristic, was 89.55 percent. Of the seven variables entered in first run, five variables: four human capital variables – EDU, OCTN, ORTN, and FT; and networking variable – VSB plus constant were remained in 3rd step. The results for this logistic regression model are summarized in table 2. According to the result found, following binomial logistic regression model is fitted:

$$\text{logit (upper level)} = -8.998 + 3.049\text{EDUCATION} + 0.200\text{OCTN} + 0.144\text{ORGANIZATIONAL TENURE} + 0.813\text{FOREIGN TRAINING} + 0.193\text{INTERNAL VISIBILITY} + \epsilon$$

Overall, human capital variables (besides, Domestic Training) and networking variable – Internal Visibility were positively associated with likelihood of exhibiting upper level. This shows investing in human capital and being more visible lead to hold upper level of organization.

The area under the curve below is observed to be 0.952 (95% CI, 0.929 to 0.929), which is an excellent level of discrimination (Hosmer Jr, Lemeshow, & Sturdivant, 2013) that excellently discriminate the two levels under study.



#### Discussion and Conclusion

Results of the current investigating the likelihood of being upper level indicated a strong support for both human capital variables and networking variables. Individuals who developed their human capital, and who involved in networking behavior, were substantially more likely to be in upper level of organization. However, human capital component – domestic training and networking behavior – maintaining relationship are not in the final model, but education was appeared as significant predictor for likelihood of being in upper level of organization

Occupational tenure was found as significant predictor of objective career success. The result was found consistent with theoretical justification. The human capital perspective (Becker, 1975) argued that work experience produces an individual specific knowledge and skills that are valuable to the organization in return individual receives reward in the form of higher compensation and/or hierarchical status.

In consistent with several previous studies (Nkomo & Cox, 1990; Cox & Harquail, 1991; Stroh, Brett, & Reilly, 1992; Hurley & Sonnenfeld, 1998; Boudreau, Boswell, & Judge, 2001; Forret & Dougherty, 2004), the study found positive impact of organizational tenure on objective career outcome. In this connection, Johnson & Eby (2011) argued those with longer organizational tenure are more entrenched in the power structure of organization. Training has been examined from two indicators: training and development program attended in Nepal and in foreign country. The significant positive beta weight indicated that foreign training was one of the major predictors of likelihood of being in upper level of organization

On examining the impact of networking variables, maintaining relationship within work and professional activities was found as excluded variable in final model. The study found, however, visibility predicted positively to upper level of organization, indicating more visible were

likely to hold upper position of organization. The result is consistent with theoretical argument of signal theory (Spence, 1973).

To conclude, understanding the determinants of being in upper level of organization is most essential for individuals in career ladder in order to help in their career plan. The study found Education, tenure and foreign training from human capital and increasing internal visibility from networking behavior influence the likelihood of being in upper level of organization. However, domestic training and maintaining relationship were found insignificant in order to predict the likelihood.

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## Call for submissions to the IFORS Prize for OR in Development 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

The Prize will be awarded during the 22nd Triennial conference to be held in Seoul, Korea, June 21-26, 2020. The winner will receive a grand prize of US\$4,000 and the runner-up a prize of US\$2,000. One person from each finalist team will be given free registration to the conference.

Entries must describe an OR application implemented in practice in a developing country, to assist one or more specific organizations in its decision-making process, and should demonstrate original features in methodology or implementation. The entries must include some description of the application's social context and its impact on the decision-making process or on the organization(s) for which it was conducted. Where appropriate, the relevance of the country's state of development to the study should be addressed. A stress on developmental issues will be an important factor in the judging. Works of a purely technical nature, or those which have no relevance in the developmental context, will not be considered.

The submission process has been simplified with respect to previous years. It will consist of two stages, where the first requires a short summary describing the application (maximum five pages) including context/

problem description, methodology/solution approach, results/impact, timeline, and involvement of local researchers. In the second stage, a selection of entries will be invited to submit a full-length manuscript (maximum 25 pages). This may be based upon other reports or articles previously submitted or published. If selected to be among the finalists, the entry should be presented by at least one of the authors during the 2020 IFORS Triennial Conference.

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

For judging criteria and other submission details, please visit the IFORS website. Other inquiries should be sent directly to the Prize Chair:

**Mario Guajardo** (e-mail: mario.guajardo@nhh.no), Associate Professor, Department of Business and Management Science, NHH Norwegian School of Economics, Bergen, Norway.

### 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



## OR Applications for Sustainable Development: Home Health Care Logistics in a Developing Country

Elena Valentina Gutiérrez <elena.gutierrez@udea.edu.co>

The project described here was developed by Gutiérrez, E.V., Cortés, S., Palacio, J.D., Villegas, J. Part of this article is adapted from Gutiérrez et al. (2019) and Cortés et al. (2018).

The use and application of OR techniques have motivated several researches in Colombia to study relevant problems in the local context, and to develop decision support tools. Thanks to the support that IFORS, ALIO and ASOCIO have given to OR for Development, and to the institutional frameworks presented in conferences such as ICORD (Calvillo, 2017), Colombian researchers have a more clear path to focus their efforts and contribute to Sustainable Development Goals (SDGs). This is the case of researches at Ingeniería y Sociedad (I&S) Research Group, from the Department of Industrial Engineering at Universidad de Antioquia, Colombia. Within their research lines, their team study and apply OR methods to support decisions in areas such as

healthcare, education, and sustainable development. In line with Goal 3 from SDGs (*Good health and well-being*), they have worked to contribute to Target 3.8, in order to improve "access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines...". Thereby, a project developed applying OR for improving healthcare services is described here, as well as the evidences that OR can actually contribute to solve real problems in developing countries.

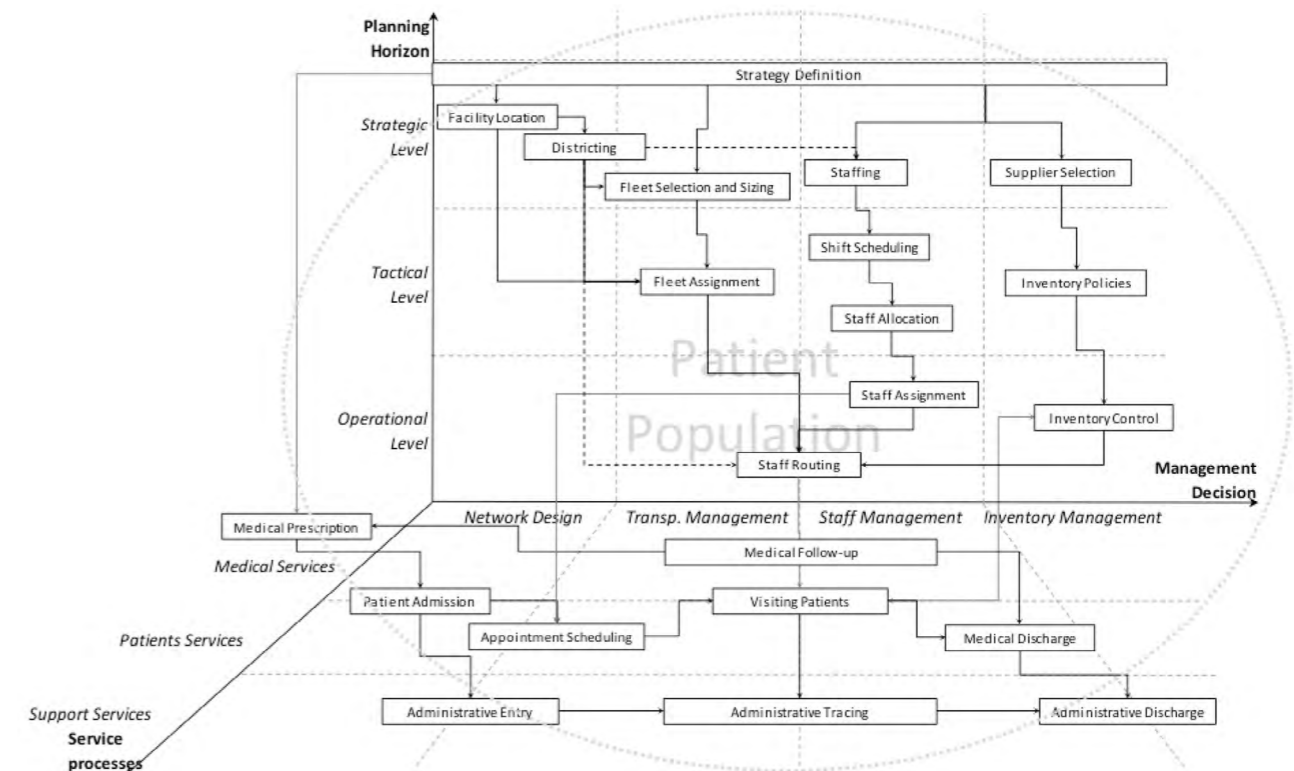
Increase on life expectancy and the aging of the population, among other socio-economic factors, have generated an increase in demand for health services, worldwide (World Bank, 2016). >>

>> Home Health Care (HHC) services appeared around 1950 as an alternative to improve the performance of health care providers and the utilization of scarce resources. The increase of demand for HHC services has been evidenced worldwide, and in Colombia HHC providers have increased from 482 as of December 2013, to 1,829 as of August 2019 (Colombia, 2019). A HHC system works as a health service network which usually operates in urban settings, and includes the patients, their families, the health institution, people involved in logistics and financial aspects of home care, and the home care team. Coordination of this health service delivery network implies a set of logistics decisions in different planning horizons (see Fig.1). These decisions are particularly complex in Latin America (LA), among other reasons, given the rapid-growing phenomenon, which refers to the increment of the population in urban areas, mainly due to the decrement of the population in rural areas. In LA, 79% of the population lives in cities, which usually results in common problems of urban areas: proliferation of marginal neighborhoods, increment of epidemic diseases, absence of governmental control and security, and lack of basic services such as health services (PNUMA, 2010; UNFPA, 2011). Furthermore, recent researches evidence that, despite advances on OR applications for HHC logistics decisions, HHC providers in Colombia make most logistics decisions empirically, and decisions related to Network Design (see Fig.1) present the lowest maturity levels for logistics capabilities (Gutiérrez et al., 2019).

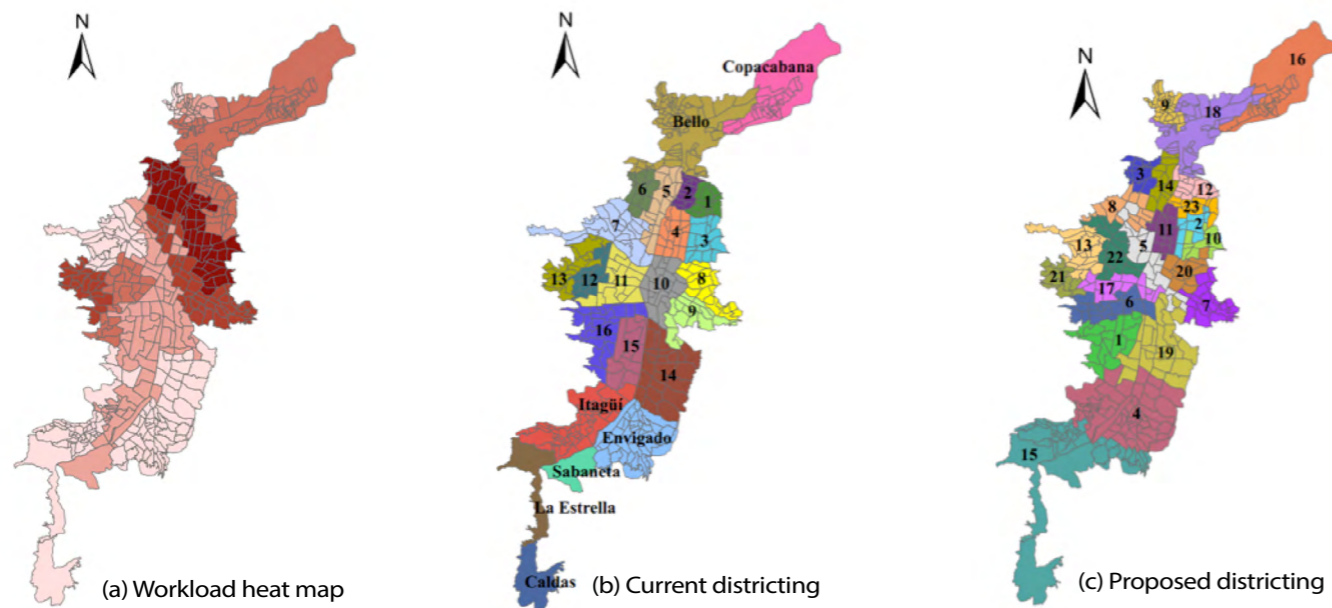
Consequently, I&S Research Group Coordinator developed a project in which a multidisciplinary team composed by industrial engineers and operations researchers worked together with the HHC Program from the health institution from Universidad de Antioquia

(IPS-UdeA), to improve districting decisions within the Network Design management dimension. By 2016, the Program annually received 1,350 chronic patients, on average, all subscribed to the subsidized public health program in Colombia, which offers health services to the most vulnerable population in the country. The districting problem (DP) consists of defining districts made up of several territorial basic units-BUs (i.e., city quarters), allocating to each district the available resources, so that the workload of the staff and the quality of services provided to patients are equitable. The DP is critical in HHC and it impacts the capacity and productivity of each medical staff by defining the size of the area in which the assigned patients are located. Thus, based on previous formulations to include rapid-growing city features into the DP in HHC (Gutiérrez and Vidal, 2015), the team developed two approaches to support districting decisions: a model based on a mixed integer linear programming (MILP) formulation, and a greedy randomized adaptive search procedure (GRASP).

The implementation of the proposed approaches required an understanding of logistics processes of the HHC Program at IPS-UdeA (Gutiérrez et al., 2018), and a detailed study of patients' population in terms of their epidemiological profile (Jaén et al., 2019). Furthermore, an integration of geographical information systems (GIS) with registers of HHC services was key to model patient demand requirements within the urban area. These data included registers from the metropolitan area of Valle de Aburrá, composed by ten municipalities including Medellín, capital of Antioquia, and the second largest city in Colombia. In January 2018, the HHC Program implemented the GRASP approach to find a districting configuration for 484 BUs, with the aim to minimize workload imbalance.



▲ Figure 1. Home Health Care Logistics Management Framework, Source: Gutiérrez and Vidal (2013)



▲ Figure 2. Districting Decisions for HHC Program of IPS-UdeA at Valle de Aburrá, Colombia  
Source: Cortés et al. (2018)

For doing so several computational experiments were completed, first to tune key parameters for the GRASP, and second to equitably compare the current districting configuration with the one proposed by the approach (see Fig.2). The proposed districting configuration (Fig.2(c)) improved the work imbalance in a 57%: this generated a fairer districting configuration in terms of workloads assigned to each district, and consequently to each medical staff. Despite minimizing distance was not explicitly modelled, IPS-UdeA managers' report that the proposed configuration has contributed to reduce travel times, because medical staff is more concentrated into a specific service area.

Additionally to the benefits achieved by a more balanced districting configuration, HHC Program Managers report that the proposed configuration is also used as an input for routing and sequencing daily visits to patients' homes. The approach developed by the team is currently a key tool to review districting decisions: the HHC Program increased from 1,350 annual acute patients from 2016, to 2,000 chronic, plus 1,500 acute patients, annually prescribed to the program. The number of patients in the HHC Program is now larger than the beds capacity in the hospitalization service of the IPS-UdeA, and HHC services are contributing to improve access to quality essential health care services. OR methods can help to improve health service in developing countries, and thus contribute to SDGs.

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## Book Review

### Book Launch

Hans W. Ittmann <hittmann01@gmail.com>

**Operations Research in South Africa – the first 50 years** by Hennie A Kruger and Jan H van Vuuren (Editors), 2019, African SunMedia, Stellenbosch, pp. 1028, ISBN 978-0-620-84721-6 (Print), R750 South African Rand (Hardcover) (around 50 US dollar plus postage)

The Operations Research Society of South Africa (ORSSA) celebrated its 50th anniversary at its most recent annual conference held from 8 to 11 September 2019 in Cape Town. As part of these celebrations the society launch a book titled: **Operations Research in South Africa – the first 50 years**. The book records the history and activities of the society over five decades. In addition, it chronicles the history of operations research while several chapters are devoted to new and recent methodological developments of the discipline. (As the author of this contribution to the IFORS News is also a contributor to the book discussed here, this cannot be a book review but is just an outline of the book.).

OR involvement by South Africans goes back many years. South African scientists were involved, as operations researchers, during World War II. After the war the first known operations research related work in South Africa, during the early fifties, was in the mining environment. There was one South African, RR Tusenius, amongst the delegates that attended the first international OR conference held in Oxford, the United Kingdom (UK), in 1957. However, it was only during the late sixties that a group of young enthusiasts started meeting informally to discuss interesting operations research topics. At a meeting held in April 1968, with guest speaker, the well-known UK operations researcher, Prof BHP (Pat) Rivett, a National Steering Committee was constituted with the aim of establishing an operations research society in South Africa. This happened on 21 November 1969 in Johannesburg during the first conference of the Operations Research Society of South Africa. The society, the first to be established on the African continent, has a proud history that is captured, comprehensively, in this new publication.

The book is structure in six main parts, each with several chapters or sections. A significant number of authors, all members or past members of ORSSA, contributed to various parts or sections of this voluminous book. Each chapter is independent of the rest of the chapters which allows a reader to read single chapters, or parts, without loss of contextual understanding. Over and above having a preface and a list of all the authors, with short biographies on each one at the beginning of the book, there is also a chapter 0 which gives an outline and description of what operations research is!

Part One is devoted to the birth and emergence of the multi-discipline of OR. Many developments, over centuries, can be attributed towards contributing to what became known as operations research. These are outlined and discussed in detail in chapter 1. Mathematical developments, in the chronological order that these occurred over time and how these contributed to OR, are presented, culminating in the period 1936 to 1945, the real birth of OR. The Post-War period is addressed in chapter 2 covering aspects such as the diffusion of OR into industries, academic research that was initiated to contribute to the development of this new discipline, the establishment of learned societies, the first OR conferences as well as the first OR related publications. The last chapter in Part One focusses on the early years of OR in South Africa before the founding of ORSSA.

The entire Part Two is devoted to activities of ORSSA. The establishment of the society is covered in chapter 4. Soon after the creation of ORSSA, several regional chapters, the real lifeblood of the society, were formed. There are currently six chapters, the last one being Zimbabwe, the neighbouring country, and this forms part of the outreach into Africa by ORSSA, one of its objectives. There is a chapter covering all the annual ORSSA conferences, currently 47 that were held over the 50-year period, as well as other related conferences. ORSSA was involved in organizing several international conferences including the 13th Multi-Criteria Decision Making (MCDM) conference in 1997, the 4th International Conference on Operations Research in Development (ICORD) in 2001 and the

18th International Federation of Operational Research Societies (IFORS) triennial conference which was held in Sandton in 2008. In 1985 ORSSA started publishing its own bi-annual journal with the name ORION. Chapter 7 lists all the papers published in this journal while detail is provided on volumetric statistics, paper topics, the citation of papers together with a comprehensive analysis of the authorship of papers.

Four chapters in Part Two is dedicated to awards and recognitions bestowed by ORSSA. Annually a member of ORSSA receives the Tom Rozwadowski medal for the best journal article published in the preceding calendar year. >>



>>The background to this prestigious medal, named after a founding member of the society, the winning papers and some interesting statistics concerning these papers are discussed in chapter 8. What is also mentioned in this chapter is international recognition the work ORSSA members received. Included in this is the work done by a team for the military that won the Franz Edelman award in 1996, the work of a team from the chemical company, Sasol, that were finalists in 2010 for the Franz Edelman award and a paper that won the Goodeve medal of the Operational Research Society of the UK in 1983. Chapters 9 to 11 contain detail, respectively, on all the Fellows of ORSSA, other Recognition awards winners (there are 4 different recognition categories) as well as the annual national student competition winners. In the latter case there are two different student competitions namely one for fourth year students and one for Masters' students. The last two chapters in this Part covers OR for Development and the effort of ORSSA to reach out to the rest of Africa.

In Part Three the OR landscape in South Africa is presented in four different chapters. There is a chapter on OR in the private and public sectors in South Africa, and one on OR in the military. Stellenbosch University was the first university to offer OR courses in South Africa. This happened in the early sixties. A separate chapter outlines what OR courses were offered by this university, how the courses offered changed over time, etc. and detail on OR students that graduated from this university. A further chapter in Part Three is devoted to OR teaching and research conducted at eight other universities in South Africa.

What makes this book a bit different is that it also includes trends in OR methodology. Topical areas in OR are presented giving an account of an areas' origin, the development thereof while significant aspects of each are highlighted. Part Four, with its seven chapters, thus focus on traditional and recent developments in OR.

Chapters 18 and 19 describe Hard OR techniques and the emergence of Soft OR approaches respectively. In each of these two chapters the techniques are briefly outlined and described. The five subsequent chapters each cover one of the following topics: multi-criteria decision analysis and multi-objective optimisation; the rise of metaheuristics; computer simulation modelling; the coming of age of machine learning, and the age of big data and distributed computing.

In conclusion the last two chapters, that constitute Part Five, gives, respectively, a perspective of the current state of OR in South Africa while the last chapter is an attempted to indicate what the future holds for OR in South Africa.

Finally, Part Six contains several appendices with lists of all the ORSSA Presidents, Fellows and Honorary members, all the Executive Committees over the entire 50-year period, annual conference venues, recipients of the TR medal, recipients of recognition awards as well as the names of all the national student competition winners. There is also a timeline of Operations Research related events including OR events from elsewhere in the world.

Various books have been published on topics related to the history of OR. Operations Research in South Africa – the first 50 years is the first, or one of the first books, dedicated solely to the history of a national society. During the gala dinner at the 48th ORSSA conference this book was ceremoniously handed to the current ORSSA President by the two editors of the book. The South African OR society has a proud history. It is a vibrant and active society with many achievements. As a relatively small society, located on the most southern part of Africa, it has played a significant role in operations research in the country, the region and internationally. 🌍

Nationality	Attendees	Applicants	Institutions
Brazil	12	17	13
Colombia	12	15	7
Chile	10	16	11
Argentina	8	10	7
Spain	4	4	7
Peru	3	3	3
Mexico	3	3	3
Cuba	2	3	2
Uruguay	1	2	1
Portugal	1	1	1
Iran	1	1	1
Philippines	1	1	1
Germany	1	1	1
Pakistan	1	0	0
Canada	0	1	1
Australia	0	1	1
France	0	1	1
Italy	0	1	1
Belgium	0	1	1
France	0	1	1
Puerto Rico	1	0	1

Changes about the venue occurred since the initial residence considered to host all the attendees was unavailable in July. The venue was moved to the *Agronomic School* campus (ETSEA). The accommodation of all attendees was not guaranteed by the second students' residence and a nearby hotel covered lacking rooms. Social activities took shape also. Visits scheduled at the first days were considered convenient to as soon as possible introduce the attendees into the social reality of a medium-size Spanish city, experiencing the genuine Catalan culture and history.

Many nationalities attended ELAVIO as shown in the table. Most of them came from Brasil, Colombia and Chile. Others came from Europe or Australia where citizens from Latin America were doing research.

The arrival of participants was mostly on Sunday, June 30, some from Dublin after attending the *EURO* Conference. A shock of hot weather was waiting for the participants with more than 40°C at several days. There was no problem inside the classrooms. The academic programme was built with mini-courses of 4 hours, and of regular presentations for a couple of hours. The opening *Mini-Course* was given by **Willi Duran** about "Successful Operations Research applications from the academy in Chile and Argentina in the last 15 years". Among the OR applications those addressed to sports problems were most interesting to the audience. **Rafael De Oliveira Silva** presented his experience in "Modelling sustainable livestock systems with examples from Brazil". The day ended up with a visit to Gardeny, the castle of the Temple order located in a hill; later a walk was offered through the main street of Lleida, stopping in historical places of the city.

On Tuesday, **Victor Albornoz** presented "Modelling and solving problems in agriculture by column generation". Afternoon-evening was reserved to visit the city Museum and the Old Cathedral (Seu Vella), the main attraction of the city. On Wednesday, **José F. Oliveira** presented the mini-

course "Cutting and Packing: what you see is what you model" with an active participation of attendees. In the afternoon, **Ana Póvoa** presented "Design and Planning Sustainable Supply Chains" giving a surprise to participants with a quiz made with Kahoot. In the evening, a first *Poster Session* was conducted and everybody took part actively.

On Thursday, **Gerardo Blanco** started a short communication about "Technological options of IT and OR in the pig industry at the 21st century" sponsored by an institutional EU-project supporting ELAVIO. Afterwards, **Antonio Alonso** presented his talk about "Risk management in planning of natural resource operations: an approach based on stochastic programming". Antonio ended his presentation inviting all participants for the *CLAIO 2020* to be held in Madrid. Covering an unforeseen gap, **Mario Guajardo** moved his presentation about "Benefits sharing in collaborative logistics by cooperative game theory". In the afternoon, **Jordi Castro** illustrated the participants about "Optimization and Support Vector Machines". Next, the second *Poster Session* had a few less presenters, but not lesser interest by the attendees. The posters sessions were complemented with coffee breaks, stimulating the participants to interact. In the evening, the *Nastasi Hotel* hosted the banquet of ELAVIO - a dinner starting with many typical dishes, including snails, ham and cheese served with good wine. Two main dishes of fish and meat followed before finishing with an excellent dessert. Coffee and liquor was offered before starting the dancing session. All participants benefitted from the good ambiance, as remarked even by waiters of the hotel restaurant. No doubt, it was the most impacting social activity of ELAVIO 2019.

On Friday, **Emilio Carrizosa** talked about "Mathematical Optimization in Data Science". Finally, a nice competition promoted by **Mario Guajardo** and a questionnaire to evaluate organisational aspects and activities lead ELAVIO 2019 to the end. After lunch, people said "goodbye" to each other and expressed their best wishes for the future while sharing echoes of the last talks, merged with memories of the last night.

As a result of the questionnaire evaluating ELAVIO, the judgement expressed by participants was very positive and encouraging for the organizers. 🌍

## OR Schools

### ELAVIO 2019 in Lleida

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The ELAVIO 2019 (Latin America Summer School in OR), held in Lleida (Spain) from July 1-5, 2019, has been a real success under different dimensions: the organisation, support, assistance and contribution of participants, the keynote speakers, committee members and even the clerk people at University of Lleida.

Thanks to **Emilio Carrizosa** as SEIO president and **Guillermo Duran** as ALIO president for their support to our proposal. Thanks also to the previous local committee organizing ELAVIO who transferred valuable information and details to start preparing present edition. It was challenging to hold the XXIII ELAVIO in Lleida, Spain. The institutional support of IFORS, EURO, CYTED (Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo), ORAFM and UdL assured with 24 travel scholarships and 4 EURO sponsored participants a minimum number of attendees.

A big surprise was the nearly ninety applications (cf. the table).



▲ Participants in the classroom.

Most of them came from Brazil and Chile. The number of grants (travel scholarships of 1000€ covered by CYTED) were assigned proportionally among countries. In parallel, IFORS applications were received and ranked, and EURO participants selected among the nominees by each national OR society. Latin American applicants without a travel scholarship were offered an accommodation scholarship. All in all, near 70 participants were accepted to take part at the ELAVIO.



▲ Participants at the banquet; tasting snails. From left to right: Cristiane Defalque and her husband, Mariana Serván, Mariana Guardiola, Jenny Paola Ríos (tasting snails) and Camila Pereira dos Santos.

## ALIO and INFORMS meet at Cancun for an Operational Research Beach Party

**Roger Z. Ríos-Mercado** <roger.rios@uanl.edu.mx>  
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**Andrés Medaglia** <amedagli@uniandes.edu.co>

The *ALIO-INFORMS Joint International Conference* took place in beautiful Cancun, Mexico from June 9 to 12, 2019 (<http://meetings2.informs.org/wordpress/2019international/>). The conference brought together the research communities from the *Association of Latin-Iberian American Operations Research Societies (ALIO)* and the *Institute for Operations Research and Management Science (INFORMS)*. The *Mexican Society of Operations Research (SMIO)* served as host for this conference.

Since the opening ceremony on Sunday, it was clear that this would be a memorable conference. The *SMIO Distinguished Lecturer, Enrique Covarrubias* from ACTINVER, gave a delightful plenary talk entitled “*Will Artificial Intelligence Kill Markowitz?*”, where he discussed how to combine machine learning algorithms and modern portfolio theory to make investment decisions. The evening welcoming cocktail was held at the JW Marriot, the host venue, where beer, wine, and delicious *hors d'œuvres* consisting of delicacies of the fine Mexican seafood and regional cuisine from this Caribbean beach were served.



▲ After Cole's plenary: enjoying conference highlights and friendship. From left to right: Prof. Roger Ríos (PC Co-Chair), Prof. Cole Smith, Prof. Erick Moreno-Centeno (Emerging Sessions Chair) and Prof. José Luis González (General Chair).

Plenary speakers included *Natashia Boland* from Georgia Tech, USA, who spoke very charmingly on frontiers of integer programming, and *Cole Smith* from Clemson University, who gave a fantastic talk on the applications, mathematics, and algorithms of two-player optimization problems. There were also three *Keynote Lectures* delivered by *Elena Fernández* from Universidad de Cádiz, Spain, *Alice Smith* from Auburn University, USA, and *Eduardo Uchoa* from Universidade Federal Fluminense, Brazil. *Elena* gave a fascinating lecture on location/routing problems, *Alice* presented an enlightening talk on decision science inspired by nature, and *Eduardo* delivered a thoughtful talk on advances in exact algorithm for vehicle routing problems.

*Tutorials*, organized by *Dave Morton* from Northwestern

University, USA, were given by academic leaders in a wide range OR fields such as *Alexandra Newman* from Colorado School of Mines, USA, *Javiera Barrera* from Universidad Adolfo Ibáñez, Chile, *Mariel Lavieri* from University of Michigan, USA, *Andre Diniz* from Electrobras Cepel, Brazil, *Emilio Carrizosa* from Universidad de Sevilla, Spain, *Iván Contreras* from Concordia University, Canada, *Martin Savelsbergh* from Georgia Tech, USA, and *Meisam Razaviyayn* from University of Southern California, USA. All the tutorials were wonderful and highly regarded by the participants.



▲ Keynote lecturer: Prof. Elena Fernández.

Many talks were presented as part of the technical program who was led and beautifully organized by *Angélica Salazar* from Universidad Autónoma de Nuevo León (UANL) as *Contributed Sessions Chair*, *Erick Moreno-Centeno* from Texas A&M University as *Emerging Sessions Chair*, and *Allen Butler* from Wagner Associates, USA, as *Practice Curated Chair*. *Luciana Buriol* from Universidade Federal do Rio Grande do Sul, Brazil, acted as *Plenary and Keynote Chair*.

During the conference, we had 294 registered participants from 25 countries including attendees from USA (125), Mexico (34), Chile (21), Canada (14), Brazil (12), Colombia (10), United Kingdom (10), Spain (8), Germany (7), France (7), Japan (7), China (6), Israel (5), Netherlands (5), South Korea (4), Taiwan (3), Hong Kong (2), Italy (2), Uruguay (2), Australia (1), Czech Republic (1), Iceland (1), India (1), Peru (1), Saudi Arabia (1), and Switzerland (1). Among these participants, 67 were graduate students.

The *Conference Gala Banquet* was held on Monday evening at the beach of the JW Marriot under a breathtaking view of the ocean and sunset. The dinner buffet included delicious seafood and regional dishes under a very warm atmosphere that was enjoyed very much by all participants.

The conference ended Wednesday afternoon, but many remain in Cancun for a few more days to keep enjoying the beautiful surroundings. Cancun is located in a region rich in historical heritage. Some participants visited astonishing archeological sites such as Chichen-Itza, crib of the ancient Mayan culture. 🌍

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**Cathal MacSwiney Brugha** <cathal.brugha@ucd.ie>

The 30th *European Conference on Operational Research, EURO XXX*, was held in University College Dublin, Ireland from 23rd to 26th June, 2019.

Many helped to make it a success, including the International Programme Committee, chaired by *Luís Gouveia*, the Organising Committee, headed by *Seán McGarraghy*, Abbey Conference Partners, University College Dublin, the Association of European Operational Research Societies (EURO), and the Analytics Society of Ireland

The following are a few highlights. Detailed information about the conference can be got from <https://www.euro-online.org/> and the conference website <https://www.euro2019dublin.com/>.

It was held in six buildings fairly close to each other on the *Belfield campus of University College Dublin*, south of Dublin's city centre. This ensured a good conference atmosphere amongst the 50+ streams and ~2,400 participants from ~70 countries.

Amongst the welcome addresses to the delegates was a lively speech by *Mary Mitchell O'Connor TD*, Minister of State at the Department of Education with special responsibility for Higher Education, on behalf of the people of Ireland. She did more than welcome the delegates. She emphasised the importance to her and to the Irish Government of the discussions that delegates would be having, and about how operational research could help deal with the challenges of climate change, and the extent to which OR could assist by making the uses of information technology better regulated and more transparent, so exposing and revealing the ways information can be distorted.



▲ EURO 2019: this is Dublin, Ireland – at the Opening Session: Four Dancing.

In accordance with tradition, most of the awards were presented at the end of the conference. The two most prestigious were presented at the welcome ceremony. Delegates were challenged to guess the winner of the 2019 *EURO Distinguished Service Medal Award (EDSM)*, as his fascinating early history was revealed. It turned out to be Italy's *Paolo Toth*, who had

received the *EURO Gold Medal* back in 1998.

*Martine Labbé* was then presented with the 2019 *EURO Gold Medal (EGM)*, the highest distinction within OR in Europe. As this was the first time a woman won, it was welcomed with enthusiasm. And then the audience was enthralled by her informative presentation [https://www.euro-online.org/media\\_site/reports/EGM2019.pdf](https://www.euro-online.org/media_site/reports/EGM2019.pdf).

The opening ceremony concluded with some very lively Irish music and dancing, to give people a feeling for the culture of the country they were visiting.

Highlights of the three days of the programme included three cutting edge plenary lectures.

*Ulrike Reisach* challenged the delegates to think about “*Artificial Intelligence – How Ethics and Governance Could Contain the Manipulation of Societies*”. She gave examples of how organizations and their designers, architects and developers, can ensure compliance with ethical and social norms, and create trust in their systems.

*William Cook* gave the *IFORS Distinguished Lecture*, on “*The Traveling Salesman Problem: Postcards from the edge of impossibility*”. His use of circles and diagrams to illustrate the structures of solutions set a challenge to every delegate to better represent their work in the future.

*Dick Den Hertog* addressed the question of how to apply theory to the world of practice, with a talk on “*What every OR practitioner should know about Robust Optimization*”. He showed how to formulate an uncertainty region for the uncertain parameters within which one might be able to safeguard a solution.

The conference continued the practice of recent years of having specialised sessions on emerging themes.

UCD's *Paula Carroll* chaired a “*Women in OR Panel Session*” to discuss “*The Equality, Diversity and Inclusion agenda*”, with panellists: *Sally Brailsford*, *Martine Labbé*, *Anna Nagurney*, *Ulrike Reisach*, and *Daniele Vigo*.

The EURO Working Group on “*Practice of OR*” had several “*Making an Impact*” sessions: Peer Networking, Lightning Talks, and a *Roundtable Discussion* on “*Can OR save the world?*” chaired by *Cathal MacSwiney Brugha* with panel: *Ulrike Reisach*, *Dick den Hertog*, *Dennis Huisman*, and *Anna Nagurney*.



▲ Professor Cathal MacSwiney Brugha, President, Analytics Society of Ireland, Corresponding author of this report





▲ IFORS Distinguished Lecture celebrated by Professor William Cook.

The conference provided an opportunity to consider the history of EURO in Europe and in Ireland. Early European 'greats' who were unable to travel were missed: *Hans-Jürgen Zimmermann*, *Jean-Pierre Brans*, *Jakob Krarup*. Early Irish 'greats' were welcomed: *David Kennedy*, founder of the Irish OR Society; former President *Roy Johnston*; and *Fred Ridgway*, Organising Chair of the 1972 IFORS Conference in Dublin. It was this conference that decided to set up EURO. Unfortunately 1978 Edelman Prize Winner Harry Harrison, and former President Frank Bannister, couldn't make it.

And Guinness, Ireland's famous drink figured. Delegates were treated to some Guinness Fudge. *Graham Rand* gave the history of how the statistical t-test was developed by an

employee of Guinness in Dublin: "The life and contribution of *William Sealy Gosset: Student's t-test brewed at Guinness*". *Eibhlin Colgan*, Archive Manager at Guinness Storehouse, Diageo, gave a talk on "Moving grain and beer at the Guinness St. James's Gate Brewery", the history of how O.R. and logistics have changed at Guinness from its foundation in 1759 up to now, illustrated with photos from the archives.

The *Gala Dinner* took place in Dublin's Aviva Stadium, the home of Irish Rugby Football, also with Irish music entertainment. On their arrival a piper welcomed the delegates.

The conference was not without its moment of sadness. The wonderful, warm, intelligent and talented *Antoinette Muntjewerff* was losing her battle with cancer, when she should have been bringing her special expertise combining law and complexity to the Ethics in OR stream and competition. We dedicated the session to her.

On the last day of the conference there were several awards: *EURO Excellence in Practice*, *best EJOR Paper*, *ROADEF/EURO Challenge*, and *EURO Doctoral Dissertation Award*. This last was won by *Martina Fischetti* for "Mathematical Programming Models and Algorithms for Offshore Wind Park Design", appropriately, given the concern many at the conference felt about climate change and the need to explore renewable energy. There was a positive sense of confidence at the conference. So, who knows, sometime in the future wind off the Atlantic coast of Ireland might become converted into electricity and gridded across Europe. 🌍

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▲ Jacek Gondzio (centre), EUROPT Fellow 2019, between Giancarlo Bigi (EUROPT Chair, left) and Miguel Anjos (EUROPT Fellow 2017, right).

#### Geographical Distribution of the participants

The workshop was attended by a total of 94 participants (including 29 post graduate students) with the following geographical distribution: United Kingdom, 26; Italy, 15; Germany, 7; France, 7; Spain, 5; Portugal, 4; Belgium, 3; Czech Republic, 3; Mexico, 3; Austria, 2; Chile, 2; Greece, 2; HK, 2; Japan, 2; Turkey, 2; Brazil, 1; Canada, 1; China, 1; Israel, 1; Lithuania, 1; Poland, 1; Romania, 1; Switzerland, 1; USA, 1.

## EUROPT Workshop 2019

The 17th EUROPT 2019 Workshop on Advances in Continuous Optimization was hosted by the University of Strathclyde, Glasgow, United Kingdom.

This workshop continued the line of previous EUROPT workshops: first held in 2000 in Budapest, followed by the workshops in Rotterdam 2001, Istanbul 2003, Rhodes 2004, Reykjavik 2006, Prague 2007, Remagen 2009, Aveiro 2010, Ballarat 2011, Siauliai 2012, Florence 2013, Perpignan 2014, Edinburgh 2015, Warsaw 2016, Montreal 2017, and Almeria 2018.

The 17th EUROPT 2019 Workshop was a satellite meeting following the 30th European Conference on Operational Research (EURO 2019, Dublin, Ireland, 23rd -26th June) (<https://www.euro2019dublin.com/>). The preparations of the 17th EUROPT 2019 Workshop were distributed between a Programme Committee, composed by 40 EUROPT members, including the EUROPT Managing Board members, as well as 9 EUROPT Fellows and 7 EUROPT Past and Honorary Chairs, and the Organizing Committee, composed by 8 members of the Intelligent Computational Engineering Laboratory (ICELab), including 4 PhD and post-doc researchers, as well as 3 staff of the University of Strathclyde. Their compositions are available at <http://icelab.uk/europt-2019/programme-committee/> and <http://icelab.uk/europt-2019/organising-committee/>. The organisation was also supported by the Glasgow Convention Bureau.



▲ EUROPT 2019 Plenary Speakers (from left): Claire Adjiman, Daniel Kuhn, Margaret Wright.

#### The 2019 EUROPT Fellow Lecture

As every year, the EUROPT Managing Board, on the basis of the nominations received from the EUROPT's members, assigns the EUROPT Fellowship to an outstanding researcher in the field.

The recipient of the 2019 EUROPT Fellowship is **Jacek Gondzio**, Professor of Optimization at the University of Edinburgh, who delivered the EUROPT Fellow Lecture on *Interior Point Methods and Beyond*. Prof. Gondzio received the award from *Giancarlo Bigi* (EUROPT Chair) and *Miguel Anjos* (EUROPT Fellow 2017).

#### Scientific Programme

The scientific programme of the event consisted of 68 talks (20 minutes for each presentation), organised on four parallel streams, and three plenary lectures (four, including the EUROPT Fellow Lecture) delivered by **Claire Adjiman**, Professor of Chemical Engineering, at the Imperial College, London, on *Deterministic global optimisation of mixed integer nonlinear bilevel programs*; **Daniel Kuhn**, Professor of Operations Research at the College of Management of Technology at EPFL, on *Wasserstein Distributionally Robust Optimization: Theory and Applications in Machine Learning*; and **Margaret Wright**, Silver Professor of Computer Science at Courant Institute of Mathematical Sciences, New York University, on *Teaching Numerical Optimization: How to Move from Theory to Code?*

This latter talk was delivered in a way that stimulated a broad discussion on many different didactical aspects of teaching numerical optimization and programming for undergraduate and postgraduate students.

#### Social Programme

The 17th EUROPT 2019 Workshop incorporated also a series of social events, including lunches in the foyer area of the Strathclyde Business School, the *Welcome Drink Reception* hosted by the Glasgow City Council at the Glasgow City Chambers, and the *Conference Gala Dinner* at The Trades Hall of Glasgow.

During the *Welcome Drink Reception*, *Bailie James Scanlon*, on behalf of the Lord Provost of Glasgow, welcomed the event and the participants, stressing the commitment of the city toward research and the hosting of events to promote open minded knowledge exchange. **Edmondo Minisci**, Chair of the EUROPT 2019 Programme Committee, replied thanking the city of Glasgow and, overall, all the colleagues that supported the organisation of the event. In particular, the inclusive nature of the EUROPT working group and the clear commitment of all the members to educate through research many young researchers, as also highlighted by the attendance of many students, became recognised.

During the closing session of the workshop, among other announcements and acknowledgements, *Gerhard-Wilhelm Weber* informed about the IFORS 2020 conference (Seoul, South Korea, June 21-26, 2020), and *Sonia Cafieri* announced that the 18th EUROPT Workshop will be organised in Toulouse, France, on July 2020.

#### Support and Sponsors

The scientific and social programmes of the EUROPT 2019 Workshop would not have been possible without the support of the Intelligent Computational Engineering Laboratory (ICELab), the entire EUROPT Working Group, and EURO. 🌍



▲ EUROPT 2020 Announcement – See you in Toulouse!

## EWG-ORD 2019 Dublin: a Move towards Sustainability – Preparing for 20th Years Anniversary of UN’s Launch of Millennium Goals

Milagros Baldemor <milagros\_baldemor@yahoo.com.ph>



▲ Group photo at EWG-ORD 2019 (from left to right): Mr. Jaime del Rosario, Prof. Adewoye Olabode, Prof. Dr. Zilla Sinuany-Stern, Prof. Dr. Gerhard-Wilhelm Weber, Prof. Dr. Lorena Pradenas, Dr. Aparajita Bannerjee, Prof. Dr. Carla Henriques, Prof. Dr. Nina Kajiji, Dr. Elise del Rosario, Prof. Dr. Gordon Dash, Prof. Dr. Milagros Baldemor, Prof. Dr. M. Teresa Ortuño, Dr. Hua Jin, Prof. Dr. Begoña Vitoriano, Prof. Dr. Bo Li, Prof. Dr. Phillips Obasohan.

“Renewable: Energy, Health and Sustainability” was the theme of the recently concluded European Working Group - Operations Research for Development Workshop (EWG-ORD) 2019 held at the University College Dublin (UCD) last June 20, 2019 (<https://www.nkd-group.com/EWG/home.html>). The workshop was a Satellite Event of the EURO 2019 International Conference which took place last June 23-26, 2019, at the same venue (<https://www.euro2019dublin.com/>).

The EWG-ORD was established in 2006 and aimed at providing and facilitating communication links among European and other researchers working on areas of Operational Research for Development (<https://www.euro-online.org/web/ewg/29/ewg-ord-euro-working-group-on-operations-research-for-development>, <https://www.euro-online.org/websites/ord/>). It has organized annual workshops to promote the importance of Operational Research in improving the lives of people in developing and developed countries.

The EWG-ORD 2019 Workshop aimed to continue the 2018 workshop’s Madrid forum for debate and exchange of knowledge and experiences towards the achievement of the Sustainable Development Goals through the application of OR and an in-depth discussion into renewable energy, health, and well-being, and other topics on sustainability. Herewith, we as EWG-ORD prepared us further towards the 20th Years Anniversary of the United Nations Millennium Goals Launch in 2020. In fact, by her Keynote Speech, Prof. Maria Teresa Ortuño of Complutense University of Madrid, highlighted and discussed with us “Protecting Life, Health and Well-being of Populations Along the Disaster Cycle, Some OR Models in Humanitarian Logistics”.

Four scientific Sessions were organized: (a) Session *Logistic Models for Sustainability* chaired by Prof. Milagros R. Baldemor, which included the following papers: *Multistage Stochastic Programming Model for Strategic Facility Location and Tactical Resources Allocation for Humanitarian Logistics* and *Reverse Logistics for Medical Equipment Use of MCDM Methods* (b) Session *Public Policy Decisions for Sustainability*, chaired by Prof. Begoña Vitoriano with the papers: “Supporting Public Decision-Makers in the Design of Energy Efficiency Program: A Portfolio-Based Approach” and “Policies of Government Subsidies in a Green Dual-Channel Supply Chain” and “Dynamic Lot Sizing and Promotion Decision with

the Impact of UK Tax Legislation”; (c) Session *Development, Sustainable Communities and Innovation*, chaired by Prof. Dr. Carla Henriquez with the papers: “Operational Research: A Tool for Economic Development, Advancing Water-Resource Management: Application of Novel OR Analytics Snow Classification on Sentinel-2 Imagery by MARS” and “Analysis of Workplace Characteristics and Blood Pressure Status Among Civil Servants in Rural and Urban Communities of Niger State, Nigeria”; and lastly, (d) Session *Quality Education*, chaired by Prof. Gerhard-Wilhelm Weber with the papers: “The 7Es Instructional Model and Its Longitudinal Impact on the Mathematics Achievement of Tertiary Students” and “Higher Education for Sustainable Development: Its Importance and Risks”. For closer details about papers and authors, please visit <https://www.nkd-group.com/EWG/Programme/programme.html> and <http://www.nkd-group.com/EWGORD-2019/EWG-ORD2019Abstracts.html>.

Each presentation was enriched by the **Reactions** of the assigned participants and questions from the other researchers. There was also an active atmosphere of sharing the best practices among the institutions and methodologies/strategies in the teaching-learning process. After the closing session, a Dinner took place as a bonding session among the participants and paper presenters which served as an avenue to discuss among themselves future collaborations.

On June 21, the Organizing Committee co-chaired by Prof. Nina Kajiji and Prof. Gordon Dash of the University of Rhode Island, USA, brought the participants to a Full-Day Tour to Glendalough, Wicklow Mountains, Kilkenny, and sheep dog trials for them to see the beauty of historical Ireland which they enjoyed most.

The friendly support and guidance of Honorary Chairs of EWG-ORD, Dr. Elise del Rosario along with Prof. Dr. Gerhard-Wilhelm Weber, and of our host from UCD, Prof. Cathal MacSwiney Brugh (University College Dublin), contributed much to the success of the workshop. The organizers’ encouragements opened the doors for future collaborations. Moreover, EWG-ORD offered a limited number of grants to partially support the expenses of participants from weak currency countries. The support of the workshop sponsors – EURO, University College Dublin, and the University of Rhode Island – was very much appreciated. 🌍

## ECCO XXXII – The European Combinatorialists meet in Malta

Silvano Martello <silvano.martello@unibo.it>

Almost 90 participants from Australia, Austria, Belgium, Brazil, Canada, France, Germany, Greece, Hong Kong, Hungary, Ireland, Israel, Italy, Kosovo, Malta, Poland, Portugal, Russia, Spain, Switzerland, Turkey, United Kingdom, and USA got together for ECCO XXXII (<https://ecco2019.euro-online.org>) from May 30 to June 1, 2019 at the Cavalieri Art Hotel in St. Julian’s, Malta. This was the annual conference of the European Chapter on Combinatorial Optimization (ECCO). The scientific program included about 70 talks on several aspects of combinatorial optimization, covering its main theoretical and application aspects.

Four plenary lectures were delivered by

- Fred Glover (University of Colorado at Boulder, United States) with Gary A. Kochenberger (University of Colorado Denver, United States) on *QUBO Models in Optimization, Machine Learning, and Quantum Computing*;
- Martin Charles Golombic (University of Haifa, Israel) on *The Wonderful World of Chordal Graphs*;
- Alexander S. Kulikov (St. Petersburg Department of Steklov Institute of Mathematics, Russia) on *Boolean Circuit Size: Overview of Known Results and Open Problems*;
- Maria Grazia Speranza (Università degli Studi di Brescia, Italy) on *Integrated and Collaborative Routing Problems*.

ECCO is particularly proud of the speakers it invites at its conferences. In the last five years, plenary lectures at ECCO conferences were delivered, among others, by David S. Johnson, Jack Edmonds, Bill Bixby, Christos H. Papadimitriou.

The Program Committee and the Organizing Committee, both chaired by John Baptist Gauci, crafted a wonderful social and academic programme. The social program included a welcome reception held on Thursday 30th May in the Babylon Terrace of the Cavalieri Art Hotel. The conference excursion took place on Friday 31st May and included a guided tour of the Marsaxlokk fishing village in the south of Malta, the megalithic temple complex of Ħaġar Qim in Qrendi, dating back to approximately 3600 BC, the complex of St. Paul’s Catacombs in Rabat, that represent the earliest archaeological evidence of Christianity in Malta, and the old capital city Mdina. The conference dinner was a barbecue that took place on Friday 31st May in the Private Lido of the Cavalieri Art Hotel by the main pool and surrounded by the Mediterranean Sea. Two optional excursions were also organized on Saturday 1st June, visiting the capital city of Malta, Valletta, and the traditional village feast of Tarxien.

The Sunday Times of Malta dedicated a full page to the event. See the articles at <https://timesofmalta.com/articles/view/photo-of-the-week-june-16-2019.714040> and at



▲ Plenary lecture of Fred W. Glover (with Gary A. Kochenberger) (Photo by Van Dat Cung)

<https://timesofmalta.com/articles/view/combinatorial-optimisation-and-a-conference-in-malta.714028>

The EURO Working Group on Combinatorial Optimization, ECCO (<http://ecco.grenoble-inp.fr>) was created in 1987 by C. Roucairol, D. de Werra and A. Rinnooy Kan. For the first ten years it was chaired by Catherine Roucairol. Since 1987 it is chaired by Silvano Martello with an Advisory Board that includes Jacek Błażewicz, Van Dat Cung, Alain Hertz, and Paolo Toth. ECCO has since then gathered researchers working in different fields of operations management, logistics, production scheduling, location and distribution problems, resource allocation, flexible manufacturing, metaheuristics, to name a few. Since 1988, the group has been bringing researchers together each year to discuss the latest advances in combinatorial optimization. With over 1600 members, ECCO it is currently one of the largest EURO working groups.

- **ECCO has a tradition of conferences held in charming locations: The latest conferences (2000 –) were held in Capri, Bonn, Lugano, Molde, Beirut, Minsk, Porto, Limassol, Dubrovnik, Jerusalem, Malaga, Amsterdam, Antalya, Paris, Munich, Catania, Budapest, Koper, Fribourg, and Malta.**
- **A special issue of the *Journal of Combinatorial Optimization* on “Theory and applications in combinatorial optimization” (open to all ECCO and CO members) was launched, with submission deadline of December 1, 2019.**
- **The next ECCO conference, organized by Alexander Kulikov, will take place in Saint Petersburg (Russia), from June 4 to June 6, 2020. Saint Petersburg, Russia’s cultural capital, is home to the Hermitage, one of the largest art museums in the world. Its historic centre is a UNESCO World Heritage site.** 🌍

# Manufacturing Meets Operational Research at Anniversary "100 Years of Technical Education in Poznan"

International Scientific and Technological Conference,  
Poznan University of Technology, May 19-22, 2019

Maciej Szafranski <maciej.szafranski@put.poznan.pl>, Magdalena Graczyk-Kucharska  
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The aim of **Manufacturing 2019** was to review the state-of-the-art of knowledge, present the results of scientific research, innovations and implementations, and provide an international forum for spread and exchange of experience in the area of Design and machines building, Manufacturing technologies, Metrology, Rapid prototyping and Virtual reality, and Management and Production management. In fact, through the latter field, but all the other areas as well, **Operational Research** enters and has become so much appreciated by the *Manufacturing 2019* community. Additional goals of *Manufacturing 2019* were: integration of the scientific community with the economic environment; establishment of cooperation with partners from industry, business and domestic and foreign research and development centers (<http://manufacturing.put.poznan.pl/en/>).

The immense success of *Manufacturing 2019* is owed to the hard work and enthusiasm of the *organizing team* headed by the hosts and Conference Chairs Prof. Dr. Adam Hamrol, Prof. Dr. Olaf Cizak and Prof. Dr. Stanislaw Legutko. **Conference Topics** included: Machine design and testing Manufacturing process planning; Manufacturing techniques; Metrology and measurement systems; Material engineering; Management and production engineering; and Solutions for Industry 4.0. *Manufacturing 2019* proceedings were published as a book by Springer as Lecture Notes in Mechanical Engineering series. The conference strongly succeeded in broadening the



▲ At the Stream "Staff for the industry of the future" (from left): Dr. Eng. Maciej Szafranski, Dr. Olena Hrybiuk, M.Sc. Roman Psiuk, Assoc. Prof. Dr. Lesya Verbovska, Prof. Dr. Alla Polyanska, Dr. Eng. Marek Goliński, Dr. Eng. Magdalena Graczyk-Kucharska, Prof. Dr. Scott Erickson, Prof. Dr. Eng. Waldemar Jędrzejczyk, Prof. Dr. Gerhard-Wilhelm Weber - from Poland, Ukraine and the USA, respectively.

issues of manufacturing discussed in previous years. Conference venue was *Poznan University of Technology (PUT) Lecture and Conference Center* (that also hosted *EURO 2016*). The conference was attended by overall nearly 200 participants.

There were 5 **Keynote Speakers** in plenary sessions: Cezary Tadej (Volkswagen Company Volkswagen Poznań): "Our way to Industry 4.0"; José Machado (University of Minho, Portugal): "Production systems on the context of I4.0"; Sandra Heffernan (Textile Design Massey University, New Zealand): "Design and manufacturing systems: New Zealand's novel perspectives"; Josu Takala (University of Vaasa, Finland): "Validating a Decision Making Method basing on Technology and Knowledge Priorities for Sustainable Strategies for Innovative Start-ups". The social events included a Gala Dinner – where also *Best Paper Awards* and *Best Session Awards* were handed out, a Boat Float, and a Company Tour to Volkswagen Września. We were speakers and chairs of a stream and session named **Staff for the industry of the future**, and presented our work by the speech "Cooperation of education and enterprises in improving professional competences - analysis of needs". One of the other participants in this session was Gerhard-Wilhelm Weber (PUT, Poznan, Poland) who presented "Multi-Objective Aggregate Production Planning Model Considering Overtime and Outsourcing Options under Fuzzy Seasonal Demand", coauthored with a young Iranian research team. In fact, we all took part actively in lively discussions that resulted from many oral talks and poster presentations, gave feedback and advice on the basis of our knowledge about research in our community of worldwide OR. >>



▲ Visiting the Lab on "Knowledge Acceleration" at Poznan University of Technology. Laboratory in Time for Professionals BIS – professional Wielkopolska project (from the left): Prof. Dr. Scott Erickson, Prof. Dr. José Machado, M.Sc. Anna Tatarska, Prof. Dr. Gerhard-Wilhelm Weber, and Dr. Eng. Maciej Szafranski.

>> Together with *Willi*, we introduced *EURO* and *IFORS* to the participants and invited old and new friends to actively take part at our *OR* conferences, such as *EURO 2019* in Dublin, Ireland (<https://www.euro2019dublin.com/>) and *IFORS 2020* in Seoul, Korea (<http://www.ifors2020.kr/>), where we welcome friends to attend and help building up Streams and Sessions. Already our invitation became positively responded by organizers and participants of *Manufacturing 2019*. The whole congress was framed by a "100 years" celebration of Poznan University of Technology. During the year 2019 there has been a lot of events with participation from

all over the world, with national and local authorities from universities, government institutions, business organizations and other entities, including Andrzej Duda, President of the Republic, and Jarosław Gowin, Minister for Higher Education and Research. International conference *Manufacturing 2019* was a major event in the yearly calendar of this big celebration at PUT.

We are happy that modern *Operational Research* is in the heart of our university's and country's characteristics and future development! 🌍



## XIII Metaheuristics International Conference

Andres Medaglia Gonzalez <andres.medaglia@uniandes.edu.co>



The 13th edition of the Metaheuristics International Conference (MIC2019) was held in Cartagena (Colombia) from July 28 to 31, 2019. The Caribbean campus of the Universidad de los Andes in Cartagena was the perfect setting for attendees to disseminate and keep up to date with the progress in the area of metaheuristics, its techniques, empirical and theoretical research, industrial applications, and interface with other domains. A long-standing tradition of the conference is its commitment to disseminating the field throughout the world. The conference, held for the first time in Breckenridge (Colorado, US) in 1995, has traveled to Singapore and Tokyo in Asia; Hamburg, Barcelona, and Porto in Europe; Agadir (Morocco) in Africa; Montréal and Angra dos Reis (Brazil) in the Americas, among many other cities. Bringing this community to the Caribbean, and in particular, to Cartagena (Colombia), was a special and magical experience.

The conference brought 100 participants (37 students) from 17 countries: Colombia (35), France (14), Brazil (11), United States (9), Spain (7), Japan (5), Portugal (4), Mexico (2), Cuba (2), Chile (2), Canada (2), United Kingdom (2), Lebanon (2), Switzerland (1), Austria (1), and Germany (1).

This year's MIC had three plenaries delivered by leaders of the optimization community. In the first plenary, Michel Gendreau (École Polytechnique Montréal, Canada) shared a historical perspective of the field, illustrating it with stories behind the three editions of the Handbook of Metaheuristics. In the second plenary, Celso Ribeiro (Federal Fluminense University, Brazil) provoked attendees by showing how metaheuristics relate to the most relevant problems of our society, such as the current polarization that we are experiencing globally. Finally, the third plenary by Andrea Lodi (École Polytechnique Montréal, Canada), invited the audience to discover challenges and opportunities that arise at the frontier of machine learning.

In this edition of MIC, three tutorials focused on the

state-of-the-art (and practice) of the field. Luciana Buriol (Universidade Federal do Rio Grande do Sul, Brazil) shared some lessons learned from her practical experience applying routing and scheduling in urban contexts. Ramón Álvarez (Universitat de València, Spain) delivered a comprehensive tutorial on packing problems, focusing on the challenges that lie at the intersection with routing, where these problems naturally arise in industrial applications. José Fernando Oliveira (Universidade do Porto, Portugal), presented a novel methodology based on metaheuristics to generate realistic scenarios of combinatorial problems that push the limits of optimization methodologies.

The social program featured a welcome cocktail on Sunday, July 28, offered at the Holiday Inn Hotel. On Tuesday, the stone walls of Cartagena, an old fortress built to defend the city of Cartagena from pirate attacks, was the perfect setting to have dinner surrounded by a spectacular view of the sea and the historic center. During the meal, folk dancers shared rhythms from the city and the Caribbean region.

This edition of MIC was supported by Universidad de los Andes (Colombia), Universidad de Antioquia (Colombia), Fundación Universidad de Antioquia (Colombia), EU/ME - EURO Working Group on Metaheuristics (special thanks to Marc Sevaux, Université de Bretagne-Sud, France), with the endorsement of the Colombian Association of Operational Research (ASOCIO). The MIC organizing committee was formed by professors Rubén Ruiz (Universitat Politècnica de València, Spain), Jorge E. Mendoza (HEC Montréal, Canada), Juan G. Villegas (Universidad de Antioquia, Colombia) and Andrés L. Medaglia (Universidad de los Andes, Colombia). The committee relied on the flawless work of the personnel of the Caribbean campus, led by Myriam Pérez (Universidad de los Andes); Vanina Jacob from Public Relations (Universidad de los Andes); and Alfaima Solano, graduate assistant of Industrial Engineering and the Center for Optimization and Applied Probability (COPA – Universidad de los Andes). 🌍

## Let's all meet in Korea!

The 22<sup>nd</sup> Conference of  
the International Federation of Operational Research Societies

# IFORS 2020

Coex, Seoul, Korea

June 21 (Sun) - 26 (Fri), 2020

<http://www.ifors2020.kr>



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