# Report on the 30*th* Graduate Program in Operations Management (GPOM)

# July 12, 2019, Augsburg, Germany

This report captures the 30th Graduate Program in Operations Management (GPOM) presentations, panel negotiations and interactive discussion at the workshop on advanced analytical methods in Manufacturing, Logistics, and Services domains, which took place on July 12, 2019, in Augsburg, Germany. This GPOM workshop was organized and conducted by Dr. Jan Schoenfelder and Ms. Antje Hilbrig at the Chair of Health Care Operations/Health Information Management, University Center for Health Sciences at the Klinikum Augsburg (UNIKA-T) and Faculty of Business and Economics, University of Augsburg.

The workshop began with sincere welcome and opening remarks by Prof. Dr. Jens O. Brunner. The approximately 40 participants contributed to the workshop from University of Augsburg (UA), Technical University of Munich (TUM), and Catholic University of Eichstaett-Ingolstadt (KU). For the rest of the workshop, the presenter became a facilitator, eye-catching comments, insights, and questions from Prof. Dr. Brunner (UA), Prof. Dr. Fontaine (KU), Prof. Dr. Grunow (TUM), Prof. Dr. Klein (UA), Prof. Dr. Kuhn (KU), and Prof. Dr. Tuma (UA) as well as those around the room. The breaks allowed attendees to be amused by some pieces of delicious cakes and warm coffee in a spacious environment. Participants were then divided into groups of 4-5, each person took it in turns to present their issues, and had it brainstormed to drive their own learning and share understandings with others, which also assisted with networking.

In the following, the pertinent concepts and activities covered in the workshop have been briefly explained in a detached tone to clarify the ideas behind each project.

- "***Production planning under seasonal and uncertain demand: an application in the agrochemical industry***" by **Alexandre Forel** from **Technische Universität München**
  In the agrochemical industry, tactical production planning is done using uncertain sales forecasts as demand can depend on unpredictable parameters such as meteorological conditions during the next growing season. In order to deal with uncertainty in the forecasts, it is common in practice to implement a production plan in a rolling-horizon fashion. However, frequent updates of demand forecasts may lead to high nervousness: important variations in the quantities planned at successive production plans. Because of the important impact of demand forecast evolution on the planning quality, we integrate the forecast evolution in a cost-minimizing dynamic programming problem using the Martingale Model of Forecast Evolution (MMFE). The customer satisfaction and the capacity limits are included using chance-constraints on the service level and feasibility respectively. We investigate approximation techniques to solve the multi-product case, which is known to have large computational requirements. The benefits of considering forecast evolutions are assessed in a numerical study comparing the MMFE to a myopic model that ignores forecast evolution.
- "***Crowdsourced logistics: the pickup and delivery problem with transshipments and occasional drivers***" by **Stefan Voigt** from **Katholische Universität Eichstätt-Ingolstadt**
  An application of the Sharing Economy is crowd shipping, where occasional drivers (ODs) share their time and excess capacity of their vehicle to ship parcels. We consider a setting, in which a carrier operates a fleet of vehicles with regular drivers (RDs) to ship parcels from pickup to delivery points. Additionally, the carrier uses a platform where ODs offer their willingness to fulfil pickup/delivery tasks. To better integrate the ODs the carrier operates transshipment points. At these transshipment points, ODs or RDs can hand over or take on, respectively, their freight. The carrier has to decide which tasks are assigned to RDs, which to ODs, in which sequence the drivers attain to the customers and whether transshipment points are used. The carrier aims to minimize the overall costs, which arise from the distance traveled by RDs and the compensation paid to ODs. The problem at hand is modeled as MIP and called Pickup and Delivery Problem with Transshipments and Occasional Drivers (PDPTOD). We develop a solution approach based on an Adaptive Large Neighbourhood Search in a Simulated Annealing framework, which solves practical-size problem instances within a reasonable time. We

conduct numerical experiments on well-known instances extended by ODs and transshipment points. We conclude that introducing transshipment points is an opportunity to reduce costs. However, the potential depends on the instance at hand and is sensitive to the assumed compensation scheme.

- "***Strategic planning of a 2G bioethanol production network in the EU, considering economic and ecological criteria***" by **Lars Wietschel** from **Universität Augsburg**
  We propose a bi-objective model for strategic planning of a 2G bioethanol production network in the European Union. The decisions of the model are the location and the size of a biorefinery, the collection mode and collection flow for the feedstock and the distribution mode and flow for the product. Furthermore, the model decides whether to substitute first-generation bioethanol or to substitute fossil gasoline. We optimize two conflicting objects containing economic and ecological concepts using ε-constraint approach. The goal functions of the model are the economic results, the three ReCiPe Endpoints (damage categories) human health, ecosystem quality, and resource scarcity. Furthermore, we consider the midpoints (impact categories); especially the global warming potential, as this indicator is widely accepted and can be communicated. The calculation of the midpoints also gives an idea about the composition of the endpoints and the environmental hotspots.
- "***Optimizing the patient logistics in a hospital regarding fairness aspects and planning of breaks***" by **Alexander Horn** from **Universität Augsburg**
  In hospitals, patients often have to wait a very long time before being transported from one ward to another. This can be for many reasons, such as not enough staff, bad planning of the staff for the transport routes, etc. The resulting waiting times of patients lead to bad patient care. This problem can be considered as a Vehicle Routing Problem with Time Windows (VRPTW). We propose a MIP model minimizing the waiting times for patients, idle times for staff and balancing the workload of the staff including the planning of breaks. In further research, we have the goal to solve this problem with real data from a large German hospital. In that case, there are 700 to 900 patients that have to be transported from one ward to another each day. Our goal is to develop a Column Generation approach to speed up the solution process.
- "***Minimizing failed-delivery costs with customer-related data***" by **Markus Frank** from **Katholische Universität Eichstätt-Ingolstadt**
  The absence of the customer during the delivery in attended-home delivery applications leads to high failed-delivery costs. Specific external customer-related data allows for an estimation of whether the customer is at home within certain time windows or not. The so derived probability that the delivery will be successful is used to minimize overall costs by assigning the optimal time window, considering the trade-off between vehicle routing costs and failed-delivery costs.
- "***Multi-project scheduling for engineer-to-order production***" by **Robert Brachmann** from **Technische Universität München**
  High-value capital goods such as special-purpose machinery are designed and manufactured in multi-project engineer-to-order (ETO) environments. We model the problem as an extension of the re-source-constrained project-scheduling problem with flexible resource profiles (FRCPSP), which con-siders flexible demand and flexible availability of resources. For each activity, the duration and the allocation of a given resource demand over time have to be determined to take into account precedence constraints between activities. For each resource, the capacity made available above or below a nominal level has to be decided, subject to working time accounts. The objective is to minimize the sum of weighted tardiness. Using a step-variable formulation, we propose a deterministic MIP of the problem. In our computational study, we solve real-world instances and investigate the impact of activity and resource flexibility on solution quality and computation time.
- "***Capacity allocation auctions for truthful information sharing in sales and operations planning***" by **Frank Hage** from **Technische Universität München**
  We study an intra-organizational sales and operations planning (S&OP) problem. Sales persons responsible for separate regions have private information on demand quantity and selling price. They compete for internal production capacity since they aim to maximize their bonus based on units sold. That is why sales persons inflate their demand forecast, leading to reduced profitability of the company. To address this problem, we develop a capacity allocation auction, which considers sales persons' reluctance to share their private information. Our proposed S&OP auction induces truthful information

sharing and achieves an efficient outcome in theory. The analytical approach is consistent with the methodology of prevalent literature on coordination mechanism for S&OP. Besides this traditional approach, we verify our S&OP Auction in lab experiments and demonstrate that it outperforms proportional allocation, a commonly used mechanism in practice, in terms of incentive compatibility and efficiency when demand is certain. We determine how demand uncertainty affects the performance of the S&OP Auction and how its performance develops over time. Our findings contribute to revealing how sophisticated coordination mechanisms perform in laboratory experiments compared with simple allocation rules and have implications for S&OP processes employed in practice.

- "***Recourse decisions with stochastic patient demand using column generation***" by **Markus Seizinger** from **Universität Augsburg**
  Nurse schedules typically contain assignments over a month and are created multiple months in advance. These schedules are usually designed to cover demand forecasts based on historical observations. Workforce-related inputs include information about nurse availability, shift preferences, and nurse qualifications. Such schedules do not incorporate possibilities of flexible reassignments of qualified nurses that allow daily readjustments in response to unexpected patient demand fluctuations. To overcome this issue, a pool of float nurses could be implemented. This pool consists of experienced nurses who can be assigned to one of several medical departments on short notice. The scheduling task for these float nurses is to decide on their working shifts in advance. The research questions are: (i) How and when should the hospital take advantage of flexible nurse scheduling to reduce the negative effects of hospital overcrowding and demand fluctuations while providing high-quality patient care and consideration of nurse satisfaction? (ii) How large must the float nurse pool be to be able to take advantage of additional flexibility?