**OPM 701 – Research Seminar Supply Chain Management**
FSS 2021

General Information:

1. The goal of this seminar is to introduce the participants to the conducting of scientific research. It thereby prepares the students for the writing of their MSc thesis. The seminar is geared towards students intending to write their thesis at the Chair of Logistics.

2. Each participant will explore one of the research papers listed below. The task is to review and critically assess the assigned research paper and to relate it to the corresponding stream of scientific literature. Each participant presents his/her findings in a written report (about 20 pages) as well as in a presentation (20 min + 20 min discussion).

3. A **kick-off meeting** for all participants will be held on **Friday, December 4, 10:15** in **BWL-ZOOM-02**. During this meeting, general guidelines for conducting a scientific literature review will be discussed and the deliverables of the seminar will be explained in detail.

   **BWL-ZOOM-02**

   https://uni-mannheim.zoom.us/j/8684542083?pwd=UGt5MFB1dko2cWtmL2c2Q2FYWkFldz09

   Room-ID: 868 454 2083
   Password: 798284

4. The written reports have to be **submitted** electronically and as a hard copy in two-fold by **Monday, May 10**.

5. The **presentations** will be held as a blocked session, most probably on **May 20 – 21** (exact times and room to be announced, might still be subject to change!).

6. The final grade for the seminar is composed of the following components: Written report (60%), presentation (30%), contribution to discussion (10%).

7. As the seminar is usually attended by a class of international students, the report and the presentations should be delivered in English.

8. There is a joint application process for all seminars offered by the chairs of the Area Operations Management. In the FSS 2021, this includes the following seminars:

    - OPM 701: Research Seminar Supply Chain Management (Chair of Logistics and Supply Chain Management), **topics labeled with 'L'**
    - OPM 761: Research Seminar Production Management (Chair of Production Management), **topics labeled with 'P'**
    - OPM 781: Research Seminar Service Operations (Chair of Service Operations), **topics labeled with 'S'**
    - OPM 792: Applied Seminar Procurement (Chair of Procurement), **topics labeled with 'B'**

    Detailed information on the seminar topics is available on the home pages of the respective chairs. In their application, students can indicate three to five preferred topics from all seminars.

9. Applications are open within the period **November 13 – 23**. Students have to join the ILIAS group **Seminar Application Area Operations** (link) and complete the **application form** there.

10. Additionally, students applying for a topic of OPM 701 must send an e-mail to logistics@bwl.uni-mannheim.de, titled "Seminar Application Documents", including a current **CV** and a **grades overview** (the one you can print yourself is enough). If you are applying for topics of the other chairs, please check if you have to send documents to them as well.

11. For any questions concerning the seminar, feel free to contact Katrin Waßmuth at katrin.wassmuth@bwl.uni-mannheim.de.

Seminar topics

Each participant will be assigned one of the topics listed below. The task then is to identify the main issues addressed by the paper, explain its methodology, including potential quantitative models, position it in the corresponding stream of scientific literature, and critically assess the paper's contribution to the literature as well as to practice.

**<u>Topic L01:</u> Mandl C., and Minner S. (2020). Data-driven optimization for commodity procurement under price uncertainty. Manufacturing & Service Operations Management.**

We study a practice-motivated multiperiod stochastic commodity procurement problem under price uncertainty with forward and spot purchase options. Existing approaches are based on parametric price models, which inevitably involve price model misspecification and generalization error. We propose a nonparametric, data-driven approach (DDA) that is consistent with the optimal procurement policy structure but without requiring the a priori specification and estimation of stochastic price processes. In addition to historical prices, DDA is able to leverage real-time feature data, such as economic indicators, in solving the problem. This paper provides a framework for prescriptive analytics in dynamic commodity procurement, with optimal purchase policies learned directly from data as functions of features, via mixed integer linear programming (MILP) under cost minimization objectives. Hence, DDA focuses on optimal decisions rather than optimal predictions. Furthermore, we combine optimization with regularization from machine learning (ML) to extract decision-relevant data from noise. Based on numerical experiments and empirical data, we show that there is a significant value of feature data for commodity procurement when procurement policy parameters are learned as functions of features. However, overfitting deteriorates the performance of data-driven solutions, which asks for ML extensions to improve out-of-sample generalization. Compared with an internal best-practice benchmark, DDA generates savings of on average 9.1 million euros per annum (4.33%) for 10 years of backtesting. A practical benefit of DDA is that it yields simple but optimally structured decision rules that are easy to interpret and easy to operationalize. Furthermore, DDA is generalizable and applicable to many other procurement settings.

**<u>Topic L02:</u> Zhen L., Huang L., and Wang W. (2019). Green and sustainable closed-loop supply chain network design under uncertainty. Journal of Cleaner Production 227(1), 1195–1209.**

The continuous influence of global warming has profoundly changed the operation mode of the traditional supply chain network. The balance between costs reduction and environmental protection has become an effective attempt to improve sustainable competitiveness for enterprises. This study presents an integration perspective for developing a green and sustainable closed-loop supply chain (CLSC) network under uncertain demand. A bi-objective optimization model is proposed with two objectives for CO2 emissions and total operating cost. Decisions regarding the environmental level and the factors affecting the facilities' capacity level have also been considered. The scenario-based method is adopted to represent the uncertain demand in the stochastic programming model. A Lagrangean relaxation method is developed to solve the model. The experimental results demonstrate the validity and efficiency of the proposed model and solution method. Several potentially useful managerial implications are also obtained for practitioners.

**<u>Topic L03:</u> Mackert J. (2019). Choice-based dynamic time slot management in attended home delivery. Computers & Industrial Engineering 129, 333–345.**

E-grocers with an attended home delivery service model operate in a highly competitive market characterized by thin profit margins. To ensure a profit-maximizing delivery schedule, the requirements for the joint management of demand and the vehicle routes are substantial.

Therefore, we study an e-grocer's operational problem of managing demand by means of dynamic time slot allocation. The purpose of dynamically allocating time slots is to influence customers' choices by offering a selection of time slots to a customer request, such that the overall expected profit of the resulting delivery schedule is maximized. The time slot offer decisions mainly depend on a request's opportunity cost. Hence, we first propose a mixed-integer linear program to approximate this opportunity cost, which scales linearly with the number of decision variables. In this approximation, we consider the consequences of expected time slot offer decisions for future customers on the final delivery schedule. We explicitly incorporate customer choice behavior using a generalized attraction model. Second, we propose a nonlinear binary program and its linearization based on the underlying choice model to make time slot offer decisions using the approximated opportunity cost. Due to the formulation's structural properties, it can be efficiently solved. In a computational study, we show the superiority of our approach in comparison to benchmarks applied in the academic literature and its applicability in an online environment.

**<u>Topic L04:</u> Strauss A., Gülpınar N., and Zheng Y. (2020). Dynamic pricing of flexible time slots for attended home delivery. European Journal of Operational Research.**

In e-commerce, customers are usually offered a menu of home delivery time windows of which they need to select exactly one, even though at least some customers may be more flexible. To exploit the flexibility of such customers, we propose to introduce flexible delivery time slots, defined as any combination of such regular time windows (not necessarily adjacent). In selecting a flexible time slot (out of a set of windows that form the flexible product), the customer agrees to be informed only shortly prior to the dispatching of the delivery vehicle in which regular time window the goods will arrive. In return for providing this flexibility, the company may offer the customer a reduced delivery charge and/or highlight the environmental benefits. Our framework also can accommodate customized flexible slots where customers can self-select a set of regular slots in which a delivery may take place. The vehicle routing problem (VRP) in the presence of flexible time slot bookings corresponds to a VRP with multiple time windows. We build on literature on demand management and vehicle routing for attended home delivery, as well as on flexible products. These two concepts have not yet been combined, and indeed the results from the flexible products literature do not carry over directly because future expected vehicle routing implications need to be taken into account. The main methodological contribution is the development of a tractable linear programming formulation that links demand management decisions and routing cost implications, whilst accounting for customer choice behavior. The output of this linear program provides information on the (approximate) opportunity cost associated with specific orders and informs a tractable dynamic pricing policy for regular and flexible slots. Numerical experiments, based on realistically-sized scenarios, indicate that expected profit may increase significantly depending on demand intensity when adding flexible slots rather than using only regular slots.

**Topic L05**: **Hernandez F., Gendreau M., and Potvin J.-Y. (2017). Heuristics for tactical time slot management: A periodic vehicle routing problem view. International Transactions in Operational Research 24(6), 1233–1252.**

In this study, we consider a tactical problem where a time slot schedule for delivery service over a given planning horizon must be selected in each zone of a geographical area. A heuristic search evaluates each schedule selection by constructing a corresponding tactical routing plan of minimum cost based on demand and service time estimates. At the end, the schedule selection leading to the best tactical routing plan is selected. The latter can then be used as a blueprint when addressing the operational problem (i.e., when real customer orders are received and operational routes are constructed). We propose two heuristics to address the tactical problem. The first heuristic is a three-phase approach: a periodic vehicle routing problem (PVRP) is first solved, followed by a repair phase and a final improvement phase where a vehicle routing problem (VRP) with time windows is solved for each period of the planning horizon. The second heuristic tackles the problem as a whole by directly solving a PVRP with time windows. Computational results compare the two heuristics under various settings, based on instances derived from benchmark instances for the VRP with time windows.

**Topic L06**: **Leyerer M., Sonneberg M.-O., Heumann M., and Breitner M.H. (2019). Decision support for sustainable and resilience-oriented urban parcel delivery. EURO Journal on Decision Processes 54(7), 267–300.**

The worldwide trend of urbanization, the rising needs of individuals, and the continuous growth of e-commerce lead to increasing urban delivery activities, which are a substantial driver of traffic and pollution in cities. Due to rising public pressure, emission-reducing measures are increasingly likely to be introduced. Such measures can cover diesel bans or even entire car-free zones, causing drastic effects on delivery networks in urban areas. As an option to reduce the risk of a regulation-induced shock, we present a resilience-oriented network and fleet optimization. We propose an innovative parcel delivery concept for last mile delivery (LMD) operations and develop an optimization model to support tactical planning decisions. Our model minimizes overall operating costs by determining optimal locations for micro depots and it allocates transport vehicles to them. An adjustable CO2-threshold and external costs are included to consider potential regulatory restrictions by city authorities. We implement our model into a decision support system (DSS) that allows analyzing and comparing different scenarios. We provide a computational study by evaluating and discussing our DSS with an example of a mid-sized German city. Our results and findings demonstrate the trade-off between cost and emission minimization by quantifying the impacts of various fleet compositions. The proposed logistics concept represents an option to achieve environmentally friendly, cost-efficient, and resilient LMD of parcels.

**Topic L07**: **Soysal M., Bloemhof-Ruwaard J.M., Haijema R., and van der Vorst J.G.A.J. (2015). Modeling an inventory routing problem for perishable products with environmental considerations and demand uncertainty. International Journal of Production Economics 164, 118–133.**

The transition to sustainable food supply chain management has brought new key logistical aims such as reducing food waste and environmental impacts of operations in the supply chain

besides the traditional cost minimization objective. Traditional assumptions of constant distribution costs between nodes, unlimited product shelf life and deterministic demand used in the Inventory Routing Problem (IRP) literature restrict the usage of the proposed models in current food logistics systems. From this point of view, our interest in this study is to enhance the traditional models for the IRP to make them more useful for the decision makers in food logistics management. Therefore, we present a multi-period IRP model that includes truck load dependent (and thus route dependent) distribution costs for a comprehensive evaluation of CO2 emission and fuel consumption, perishability, and a service level constraint for meeting uncertain demand. A case study on the fresh tomato distribution operations of a supermarket chain shows the applicability of the model to a real-life problem. Several variations of the model, each differing with respect to the considered aspects, are employed to present the benefits of including perishability and explicit fuel consumption concerns in the model. The results suggest that the proposed integrated model can achieve significant savings in total cost while satisfying the service level requirements and thus offers better support to decision makers.

**Topic L08**: **Tavaghof-Gigloo D., and Minner S. (2020). Planning approaches for stochastic capacitated lot-sizing with service level constraints. International Journal of Production Research.**

We investigate a stochastic capacitated lot-sizing problem whose optimal solution requires the integration of dynamic safety stock planning into lot-sizing. Then, we introduce an integrated mixed-integer linear program with service-level constraints. The integrated model endogenously sets dynamic safety stocks over replenishment cycles of different lengths determined by the model. Since there is limited capacity, soft service-level constraints are introduced to guarantee a feasible solution. In the experimental study, we compare the performance of the integrated model to the stochastic dynamic program and the widely-used sequential approach. If available capacity increases, the integrated model closes the gap to the lower bound approximated by using a stochastic dynamic program. If capacity is limited, the integrated model outperforms the sequential approach because it yields identical service levels with lower inventories. However, in the case of sufficient flexibility (capacity), we identify a major shortcoming of the integrated models: They can generate excessive safety stock if the re-planning opportunities under rolling horizon planning are ignored. To overcome this problem, we extend the integrated model to account for those re-planning opportunities.

*(The paper is currently unavailable, but we will provide it once the seminar starts. The contents of the paper are basically identical to those of chapter 4 of Tavaghof-Gigloo's PhD thesis, which can be found at https://mediatum.ub.tum.de/doc/1444212/1444212.pdf).*

**Topic L09**: **Özer Ö., Zheng Y., and Chen K.-Y. (2011). Trust in forecast information sharing. Management Science 57(6), 1111–1137.**

This paper investigates the capacity investment decision of a supplier who solicits private forecast information from a manufacturer. To ensure abundant supply, the manufacturer has an incentive to inflate her forecast in a costless, nonbinding, and nonverifiable type of communication known as “cheap talk.” According to standard game theory, parties do not cooperate and the only equilibrium is uninformative – the manufacturer’s report is independent

of her forecast and the supplier does not use the report to determine capacity. However, we observe in controlled laboratory experiments that parties cooperate even in the absence of reputation-building mechanisms and complex contracts. We argue that the underlying reason for cooperation is trust and trustworthiness. The extant literature on forecast sharing and supply chain coordination implicitly assumes that supply chain members either absolutely trust each other and cooperate when sharing forecast information, or do not trust each other at all. Contrary to this all-or-nothing view, we determine that a continuum exists between these two extremes. In addition, we determine (i) when trust is important in forecast information sharing, (ii) how trust is affected by changes in the supply chain environment, and (iii) how trust affects related operational decisions. To explain and better understand the observed behavioral regularities, we also develop an analytical model of trust to incorporate both pecuniary and nonpecuniary incentives in the game-theoretic analysis of cheap-talk forecast communication. The model identifies and quantifies how trust and trustworthiness induce effective cheap-talk forecast sharing under the wholesale price contract. We also determine the impact of repeated interactions and information feedback on trust and cooperation in forecast sharing. We conclude with a discussion on the implications of our results for developing effective forecast management policies.

**Topic L10**: **Yu H., Sun X., Solvang W.D., and Zhao X. (2020). Reverse logistics network design for effective management of medical waste in epidemic outbreaks: Insights from the coronavirus disease 2019 (COVID-19) outbreak in Wuhan (China). International Journal of Environmental Research and Public Health 17(5), 1770.**

The outbreak of an epidemic disease may pose significant treats to human beings and may further lead to a global crisis. In order to control the spread of an epidemic, the effective management of rapidly increased medical waste through establishing a temporary reverse logistics system is of vital importance. However, no research has been conducted with the focus on the design of an epidemic reverse logistics network for dealing with medical waste during epidemic outbreaks, which, if improperly treated, may accelerate disease spread and pose a significant risk for both medical staffs and patients. Therefore, this paper proposes a novel multi-objective multi-period mixed integer program for reverse logistics network design in epidemic outbreaks, which aims at determining the best locations of temporary facilities and the transportation strategies for effective management of the exponentially increased medical waste within a very short period. The application of the model is illustrated with a case study based on the outbreak of the coronavirus disease 2019 (COVID-19) in Wuhan, China. Even though the uncertainty of the future COVID-19 spread tendency is very high at the time of this research, several general policy recommendations can still be obtained based on computational experiments and quantitative analyses. Among other insights, the results suggest installing temporary incinerators may be an effective solution for managing the tremendous increase of medical waste during the COVID-19 outbreak in Wuhan, but the location selection of these temporary incinerators is of significant importance. Due to the limitation on available data and knowledge at present stage, more real-world information are needed to assess the effectiveness of the current solution.

**Topic L11**: **Klapp M.A., Erera A.L., and Toriello A. (2018). The dynamic dispatch waves problem for same-day delivery. European Journal of Operational Research 271(2), 519–534.**

We study same-day delivery systems by formulating the Dynamic Dispatch Waves Problem (DDWP), which models an order dispatching problem faced by a distribution center, where orders arise dynamically throughout a service day and must be delivered by day's end. At each decision epoch (wave), the system's operator chooses whether or not to dispatch a single vehicle loaded with orders ready for service, to minimize vehicle travel and penalties for unserved requests. We formulate an arc-based integer programming model and design local search heuristics to solve a deterministic DDWP where order arrival times are known in advance, use this variant to design an a priori solution approach, and provide two approaches to obtain dynamic policies using the a priori solution. We test and compare solution approaches on two sets of instances with different settings of geography, size, information dynamism, and order timing variability. The computational results suggest that our best dynamic policy can reduce the average cost of an a priori policy by 9.1% and substantially improves the fraction of orders delivered (order coverage), demonstrating the importance of reactive optimization for dynamic short-deadline delivery services. We also analyze the tradeoff between two common SDD objectives: total cost minimization versus order coverage maximization. We find structural differences in the dispatch frequency and route duration of solutions for the two different objectives, and demonstrate empirically that small increases in order coverage may require substantial increases in vehicle travel cost.

**Topic L12**: **Gui L. (2020). Recycling infrastructure development under extended producer responsibility in developing economies. Production and Operations Management 29(8), 1858–1877.**

To tackle the severe pollution caused by electronic waste (e-waste), several developing countries have introduced e-waste legislation based on Extended Producer Responsibility (EPR). A major challenge to implement EPR in developing countries is the lack of formal recycling infrastructure. In this paper, we study if a collective form of EPR implementation where producers may jointly invest in recycling facilities can promote their incentives to do so. We develop a Nash bargaining model that captures the decision dynamics underlying joint recycling facility investment. We show that despite its advantage in reducing producers' fixed investment costs, joint investment in the collective system may lead to a worse recycling infrastructure development outcome than independent investment in an individual system. This can particularly happen when the collective system involves products whose recycling costs are highly differentiated. We further show that cost sharing based on the principle of Individual Producer Responsibility (IPR) may undermine the recycling infrastructure development outcome in the collective system compared to simple proportional cost sharing rules. In practice, it is generally believed that IPR leads to better design incentives than proportional cost sharing rules. Accordingly, our result indicates that there exists a tradeoff between these two cost sharing rules, and promoting recycling infrastructure development via collective systems may come at the expense of design incentives and vice versa.