Business School
Chair of Logistics and Supply Chain Management
Prof. Dr. Moritz Fleischmann

UNIVERSITY OF MANNHEIM
Business School

OPM 701 – Research Seminar Supply Chain Management
HWS 2022

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 and SCM.

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 their 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 **Tuesday, 24 May, 13:45 CEST** in room **SO 318.** General guidelines for conducting a scientific literature review will be discussed and the deliverables of the seminar will be explained in detail.

4. The written reports have to be **submitted** electronically and as a hard copy in two-fold by **Monday 7 November**.

5. The **presentations** will be held as a blocked session, most probably on **17 and 18 November** (subject to change, exact times and room to be announced).

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 HWS 2022, 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 Management), **topics labeled with 'S'**
    - OPM 791: Research 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 from **29 April** to **13 May**. 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> Bakach, I., Campbell, A. M., & Ehmke, J. F. (2022). Robot-Based Last-Mile Deliveries with Pedestrian Zones. *Frontiers in Future Transportation 2*, 773240.

Since delivery robots share sidewalks with pedestrians, it may be beneficial to choose paths for them that avoid zones with high pedestrian density. In this paper, we investigate a robot-based last-mile delivery problem considering path flexibility given the presence of zones with varying pedestrian level of service (LOS). Pedestrian LOS is a measure of pedestrian flow density. We model this new problem with stochastic travel times and soft customer time windows. The model includes an objective that reflects customer service quality based on early and late arrivals. The heuristic solution approach uses the minimum travel time paths from different LOS zones (path flexibility). We demonstrate that the presence of pedestrian zones leads to alternative path choices in 30% of all cases. In addition, we find that extended time windows may help increase service quality in zones with high pedestrian density by up to 40%.

<u>Topic L02:</u> Ulmer, M. W., Thomas, B. W., Campbell, A. M., & Woyak, N. (2021). The Restaurant Meal Delivery Problem: Dynamic Pickup and Delivery with Deadlines and Random Ready Times. *Transportation Science 55*(1), 75-100.

We consider a stochastic dynamic pickup and delivery problem in which a fleet of drivers delivers food from a set of restaurants to ordering customers. The objective is to dynamically control a fleet of drivers in a way that avoids delays with respect to customers' deadlines. There are two sources of uncertainty in the problem. First, the customers are unknown until they place an order. Second, the time at which the food is ready at the restaurant is unknown. To address these challenges, we present an anticipatory customer assignment (ACA) policy. To account for the stochasticity in the problem, ACA postpones the assignment decisions for selected customers, allowing more flexibility in assignments. In addition, ACA introduces a time buffer to reduce making decisions that are likely to result in delays. We also consider bundling, which is the practice of assigning multiple orders at a time to a driver. Based on real-world data, we show how ACA is able to improve service significantly for all stakeholders compared with current practice.

<u>Topic L03:</u> Banerjee, D., Erera, A. L., & Toriello, A. (2022). Fleet Sizing and Service Region Partitioning for Same-Day Delivery Systems. *Transportation Science*.

We study the linked tactical design problems of fleet sizing and partitioning a service region into vehicle routing zones for same-day delivery (SDD) systems. Existing SDD studies focus primarily on operational dispatch problems and do not consider system design questions. Prior work on SDD system design has not considered the fleet sizing decision when a service region may be partitioned into zones dedicated to individual vehicles; such designs have been shown to improve system efficiency in related vehicle routing settings. Using continuous approximations to capture average-case operational behavior, we consider first the problem of independently maximizing the area of a single vehicle delivery zone. We characterize area-maximizing dispatching policies and leverage these results to develop a procedure for calculating optimal areas as a function of a zone's distance from the depot, given a maximum number of daily dispatches per vehicle. We then demonstrate how to derive fleet sizes from optimal area functions and propose an associated Voronoi approach to partition the service region into single-vehicle zones. We test the fleet sizing and partitioning approach in a computational study that considers two different service regions and demonstrate its pragmatism and effectiveness via an operational simulation.

Using minimal computation, the approach specifies fleet sizes and builds vehicle delivery zones that meet operational requirements, verified by simulation results.

Topic L04: Schubert, D., Kuhn, H., & Holzapfel, A. (2021). Same-day deliveries in omnichannel retail: Integrated order picking and vehicle routing with vehicle-site dependencies. *Naval Research Logistics 68*(6), 721-744.

Currently, the most common delivery mode offered in online retailing is next-day delivery. Retailers, however, are investigating whether same-day deliveries can be offered to online and store customers in order to meet increasing customer requirements. The present paper considers an integrated order picking and vehicle routing problem assuming same-day delivery in the field of omnichannel retailing. Within this context the paper focuses on the picking and delivery process for large durable consumer goods, for example, consumer electronics and home appliances with the option of associated installation services at the customer's home as well as store deliveries for click-and-collect customers and the short-term replenishment of store inventory. We develop a decision support model and a general variable neighborhood search-based algorithm that tackle the problem described by considering the tradeoff between picking and delivery costs while ensuring customers' delivery time windows. The results show the benefits of an integrated solution approach amounting to approx. 13% total cost savings on average, compared to a sequential approach typically applied in retail practice. A case study from an internationally operating omnichannel retailer demonstrates the advantages and applicability of the modeling and solution approach suggested.

Topic L05: Agi, M. A. N. & Yan, X. (2020). Greening Products in a Supply Chain under Market Segmentation and Different Channel Power Structures. *International Journal of Production Economics 223*, 107523.

This paper investigates product line expansion in which a green version of an existing conventional brown product is launched. We use a game-theoretic approach to study a supply chain consisting of one retailer and one manufacturer, either of which can be the leader of the supply chain. Our model assumes a market segmented based on the consumers' willingness to pay for the green feature of the product and incorporates a fixed cost related to launching the green product. Through our analysis, we define four pricing and positioning strategies for brown and green products. We explicitly express the conditions under which it is more profitable to expand the conventional product line with a green product and determine the region where each pricing strategy applies in the centralized system as well as in the two decentralized systems with each member as the leader of the supply chain. Our results also show that a manufacturer-led supply chain is better prepared than a retailer-led supply chain to overcome the fixed cost, launch the green product, and grasp benefits from the growth of the green consumer segment at an early stage of its development. We design two coordination mechanisms that allow the decentralized supply chain to achieve its first-best performance.

Topic L06: Gülserliler, E. G., Atasu, A., & Van Wassenhove, L. N. (2022). Business Model Choice under Right-to-Repair: Economic and Environmental Consequences. *INSEAD Working Paper No. 2022/05/TOM*.

Right-to-Repair (RTR) regulations require producers to design easy-to-repair products and supply necessary information and parts for consumers to independently undertake repairs. While these regulations aim to prolong product lifetimes through repairs, increase secondhand use, and reduce waste; the ease of access to proprietary information and spare parts can have unintended consequences. For example, they may facilitate cloning by third parties. The increased risk of cloning under RTR may, in turn, encourage producers to reconsider their business model choices between ownership and non-ownership models (e.g. leasing). In this paper, we analyze the effect of RTR on business model choice, and the implications for producers, consumers, and the environment. We identify the conditions under which RTR may motivate producers to retain ownership of products and bear responsibility for repairs to avoid competition from secondary markets and third-party clones. We find that RTR regulations may indeed lead to a lower environmental impact for some products. However, for a wide range of product types, these regulations may result in a "lose-lose" situation for producers and the environment, while also decreasing consumer surplus and potentially curtailing producers' incentives to innovate.

Topic L07: Huang, K., Kanaroglou, P., & Zhang, X. (2016). The design of electric vehicle charging network. *Transportation Research Part D: Transport and Environment 49*, 1–17.

The promotion of Electric Vehicles (EVs) has become a key measure of the governments in their attempt to reduce greenhouse gas emissions. However, range anxiety is a big barrier for drivers to choose EVs over traditional vehicles. Installing more charging stations in appropriate locations can relieve EV drivers' range anxiety. To determine the locations of public charging stations, we propose two optimization models for two different charging modes – fast and slow charging, which aim at minimizing the total cost while satisfying certain coverage goal. Instead of using discrete points, we use geometric objects to represent charging demands. Importantly, to resolve the partial coverage problem (PCP) for networks, we extend the polygon overlay method to split the demands on the road network. After applying the models to Greater Toronto and Hamilton Area (GTHA) and to Downtown Toronto, we show that the proposed models are practical and effective in determining the locations of charging stations. Moreover, they can eliminate PCP and provide much more accurate results than the complementary partial coverage method (CP).

Topic L08: Kourentzes, N., Svetunkov, I., & Trapero, J. R. (2021). Connecting forecasting and inventory performance: a complex task. *SSRN Electronic Journal*.

Problem definition. Operations and decision making, often rely on accurate forecasts. The business forecasting process requires choosing the appropriate forecasting method, evaluating forecasts, aiding expert interventions, among other activities. In such activities, the metric we select to assess the forecast performance becomes crucial. These metrics are often used as proxies for the economic impact of supported decisions that is much harder to quantify. However, this connection has not been adequately investigated. With forecasts, we are interested in the magnitude (accuracy) and the direction (bias) of their errors. Although the first has been extensively researched, there is very limited work on bias indicators. More importantly, growing evidence relates forecast bias with the quality of decisions, for example in inventory management. Yet, we lack metrics that are informative for single or multiple items, reliable

irrespective of data properties, and intuitive to the user. Lacking appropriate metrics can result in poor forecasts with adverse results on operations. *Methodology/results*. We propose a new metric that explicitly captures both accuracy and bias. We explore its connection with inventory management, using a real case study. We reaffirm the importance of forecast bias for inventory performance and demonstrate that the proposed "bias coefficient" exhibits the strongest connection from other existing alternatives. *Managerial implications.* The proposed metrics can help analysts evaluate forecasts directly while retaining a strong connection to operational decisions, driving improvements in the process. To support this, we provide novel visualisations based on the geometric properties of the new metric, which can aid all modellers, users, and decision-makers.

Topic L09: Amiri-Aref, M., Klibi, W., & Babai, M. Z. (2018). The multi-sourcing location inventory problem with stochastic demand. *European Journal of Operational Research 266*(1), 72-87.

This paper deals with a multi-period location-inventory optimization problem in a multi-echelon supply chain network characterized by an uncertain demand and a multi-sourcing feature. The aim of the paper is to propose a generic modeling approach to integrate key features of the inventory planning decisions, made under a reorder point order-up-to-level (s, S) policy, with the location-allocation design decisions to cope with demand uncertainty. Given the hierarchical structure of the problem, a two-stage stochastic mathematical model that maximizes the total expected supply chain network profit is proposed. This optimization model is intractable due to its non-linearity. Therefore, a linear approximation is proposed and a sample average approximation approach is used to produce near-optimal solutions. Numerical experiments are conducted to validate the proposed modeling and solution approaches. The results show the efficiency of the linear approximation of the (s, S) policy at the strategic level to produce robust design solutions under uncertainty. They underline the sensitivity of the design solution to the demand type and the impact of the inventory holding costs and backorder costs, especially under non-stationary processes.

Topic L10: Budiman, S. D. & Rau, H. (2021). A stochastic model for developing speculation-postponement strategies and modularization concepts in the global supply chain with demand uncertainty. *Computers & Industrial Engineering 158*, 107392.

Modern business traits have resorted companies to the global scale and complex supply chain operations to fulfill the customer demand around the world. In doing so, companies have to anticipate volatile and uncertain global demand, while adjusting their supply chain operations to various regional difference risks. Addressing these issues has motivated our study to propose a two-stage stochastic model of a supply chain network (SCN) design integrated to postponement and modularization concepts. The proposed research considers multi-period planning, involving procurement, processing, and sales of a multi-variant product with modular product architecture to model the operations in the supply chain network. The configuration of this comprehensive SCN is integrated to postponement strategy that is adjusted to speculation strategy, accommodating both forecast and demand-driven operations. The speculation-postponement strategy allows the optimization of the forecast-driven speculation strategy operations planning and service level of multiple items with varying value and variances, as well as the postponement strategy operations to be all adjusted to both global demand uncertainty and regional differences factors. The complexity of the model leads to the usage of the sample average approximation

method to yield a reliable solution efficiently. The results of configuring a global notebook computer SCN case study show that speculation-postponement (SP) strategies with early postponement can reduce excessive production processes, lost sales, deadstock, and increase the inventory turnover rate, allowing better uncertainty risks mitigation in optimizing the performance of the global SCN. Under various demand uncertainty levels, SP strategies can improve the supply chain operations efficiency while also being responsive in handling the unexpected changes to the uncertain demand. The results also highlight the importance to configure the SCN and SP strategy altogether with optimizing speculation strategy operations planning and production service level decisions to prevent sub-optimal solutions, such as the significant offset of the expected SP performance when the service level is not adjusted to demand uncertainty, showing how forecast-driven planning inaccuracy can be costly. Configuring SCN with the right SP strategy has consistent performance, potentially increasing SCN robustness and resiliency against global demand uncertainty risks.