OPM 761 – Research Seminar Production Management

Spring Term 2025

The goal of this seminar is to introduce the participants to conduct scientific research. Thereby, it prepares the students for the writing of their Master's thesis. The seminar is geared towards students intending to write their thesis at the Chair of Production Management.

Participants will explore one of the topics listed below. They will review and critically assess the corresponding scientific literature and present their findings in a written report (18 to 22 pages) as well as in an in-class presentation (15 - 20 min + 20 min discussion). Each participant is also expected to critically assess the presentations of the other students in the ensuing discussion.

Applications will be accepted from **November 8th, 2024** until **November 22th, 2024**. Admission to the seminar will be confirmed by e-mail at latest on November 29th, 2024 and must be reconfirmed by the participant at the kick-off meeting.

The **Kick-off meeting** will be held on **December 2nd, 2024** between 12:00 and 13:30 (CET). During this meeting, an introduction to scientific writing and presentations for term papers will be given.

A brief session on introduction to Overleaf and LaTeXwill also be offered. The time and date of this session will be decided in the Kick-off meeting among the interested students.

The **written reports** have to be submitted by Monday, **March 19th, 2025** in the following formats:

- Two-fold hard copy version.
- Electronic version including a copy of the references cited in the report and auxiliary information (tables, data, programming code, etc.).

The **presentations** will be held as a blocked session during between **1st and 4th April 2025**. Attendance at all presentations is mandatory.

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

There is a joint application process for all seminars offered by the chairs of the Area Operations Management. In the spring term 2025, this includes the following seminars:

- **OPM 741:** Applied Seminar Supply Chain Management
  Chair of Logistics and Supply Chain Management, Prof. Dr. Moritz Fleischmann
  (Topics labeled with “L”),
- **OPM 760:** Project Seminar Operations Analytics,
  Chair of Production Management, Prof. Dr. Raik Stolletz
  (Topics labeled with “P”),
- **OPM 761:** Research Seminar Production Management,
  Chair of Production Management, Prof. Dr. Raik Stolletz
  (Topics labeled with “P”),

- **OPM 781:** Research Seminar Service Operations Management
  Chair of Service Operations Management, Prof. Dr. Cornelia Schön
  (Topics labeled with "S"),
- **OPM 792:** Applied Seminar Procurement
  Endowed Chair of Procurement, Prof. Dr. Christoph Bode
  (Topics labeled with "B").

Detailed information on the seminar topics and the link to the online registration tool are available on the home pages of the respective chairs. In their applications, students can indicate up to five preferred topics from all seminars.

In addition, applicants for OPM 761 must send an email with (1) CV, (2) official B.Sc. and M.Sc. grades overviews, and (3) the list of courses in the Area Operations that you are currently enrolled in to opm761@uni-mannheim.de. For any further question concerning the seminar please also contact the chair via opm761@uni-mannheim.de.

P8 – Overview of optimization models in call center staffing

Objectives: In many service systems, staffing drives both costs and service quality by ensuring that the right number of employees are available for various processes. A call center for example, might aim to minimize personnel cost while ensuring a certain service level. One example could be to consider the negative impacts on waiting time or customer abandonments.

The goal of this research seminar is to provide a comprehensive overview of utilized optimization models for time-dependent staffing in call centers. Existing literature should be critically assessed and compared by describing the utilized optimization models (objective, constraints, ...). Relevant trade-offs (e.g. balancing cost savings and lost sales) and managerial findings presented in literature should be presented and discussed.

Prerequisites: Knowledge in variability and optimization models (e.g. OPM 561)

Basic Paper: Defraeye and Van Nieuwenhuyse (2016); Stolletz and Tan (2024)

> **Abstract**: Many service systems display nonstationary demand: the number of customers fluctuates over time according to a stochastic—though to some extent predictable—pattern. To safeguard the performance of such systems, adequate personnel capacity planning (i.e., determining appropriate staffing levels and/or shift schedules) is often crucial. This paper provides a state-of-the-art literature review on staffing and scheduling approaches that account for nonstationary demand. Among references published during 1991–2013, it is possible to categorize relevant contributions according to system assumptions, performance evaluation characteristics, optimization approaches and real-life application contexts. Based on their findings, the authors develop recommendations for further research.

P9 – Ramp-up phase: how to realize when it's over?

Objectives: In production management, ramp-up refers to the process of gradually increasing the production capacity of a system until the planned long-term production capacity is exploited. Ramp-up phase, i.e. the period in which this gradual increase in production occurs, takes place when a new product is introduced or when a new production technology starts up. The time-dependent production capacity (variability; dynamics) during a ramp-up phase makes planning tasks difficult from an operations perspective. For example, decreased system output can cause violation of contracts with clients and harm the reputation of the firm. In order to avoid such problems and perform a good resource allocation, the period in which a stationary production capacity is reached has to be identified correctly. Predictive analytics approaches can be used to identify the end of ramp-up phase. One of the possible predictive analytics approaches is the usage of truncation heuristics. This approach utilizes system output to identify the end of the ramp-up phase by trying measuring standard deviation of system output and analyzing patterns.

The goal of the research seminar is to give an overview on predictive analytics approaches to identify the end of ramp-up phase. The importance and causes of ramp-up phase should be explained and managerial implications should be critically assessed. The student is expected to describe and compare the predictive analytics approaches: 1) truncation heuristics, 2) machine learning, 3) graphical methods based on their methodology and limitations.

Prerequisites: Knowledge in stochastic manufacturing systems (e.g. OPM 561)

Basic Paper: White Jr (1997); Surbier et al. (2014); Stolletz and Tan (2024)

Abstract: The start-up or warm-up problem arises in steady-state, discrete-event simulation, where the arbitrary selection of initial conditions introduces bias in simulated output sequences. In this paper, we develop and test a new truncation heuristic or resolving the start-up problem. Given a finite sequence, the truncation rule deletes initial observations until the width of the marginal confidence interval about the truncated sample mean is minimized. This rule is easy to implement, has strong intuitive appeal, and is remarkably effective in mitigating initialization bias. We illustrate the performance of the heuristic by comparison with enhanced implementations of alternative truncation rules proposed in the literature. All rules are applied to output sequences generated by ten runs each of four representative queuing simulations. Results confirm the significance of the start-up problem and demonstrate that simple truncation heuristics can solve this problem. All of the rules tested are shown to provide improved accuracy without undue loss of precision. We conclude that all four of the rules tested represent attractive solutions to the start-up problem.

P10 – Creating Robust Workforce Schedules under Uncertainty

Objectives: In service systems, the number of customers arriving often depends on the time of day. When creating shift schedules, managers have to consider this time-dependency in order to match supply and demand. In addition, customer demand is in most cases stochastic, i.e., the exact number of customers arriving to the system is not exactly known ex ante. If more workers are assigned than were actually (ex-post) needed, significant costs are incurred from this overstaffing. On the other hand, assigning less workers than actually needed leads to understaffing, and with it the revenues and the quality of service suffers. Some service systems are defined as flexible, e.g., such as in the base paper of Mattia et al. (2017), where two classes of employees exist, where the first class is serving customers and the second class is usually working on customer-unrelated tasks in the back office. However, they can also be used to serve customers by moving them to the front of the office where customer contact takes place. This flexibility is used in case that understaffing occurs, i.e., when the number of scheduled first class employees does not suffice to serve the actual customer demand. Robust optimization can be utilized to solve this shift scheduling problem when incorporating stochastic customer demand. Mattia et al. (2017) minimize the maximum expected costs for reallocating employees from the back office to the front office over all possible realizations of customer demand.

The goal of this seminar thesis is to provide a comprehensive overview of the recent publications on robust optimization models for personnel scheduling under uncertainty. The reviewed articles should be classified and compared according to their assumptions, objectives, and the methods used to ensure robust results. A critical assessment of the literature and suggestions for future research concludes this thesis.

Prerequisites: Knowledge in optimization models (e.g., OPM 561, 662)

Basic Papers: Mattia et al. (2017)

> **Abstract**: We study the shift scheduling problem in a multi-shift, flexible call center. Differently from previous approaches, the staffing levels ensuring the desired quality of service are considered uncertain, leading to a two-stage robust integer program with right-hand-side uncertainty. We show that, in our setting, modeling the correlation of the demands in consecutive time slots is easier than in other staffing approaches. The complexity issues of a Benders type reformulation are investigated and a branch-and-cut algorithm is devised. The approach can efficiently solve real-world problems from an Italian call center and effectively support managers decisions. In fact, we show that robust shifts have very similar costs to those evaluated by the traditional (deterministic) method while ensuring a higher level of protection against uncertainty.

P11 – Balancing Speed and Costs in Service Systems

Objectives: Queueing systems are analyzed in a multitude of context: Call centers, traffic, airports, healthcare, restaurants, and customer services in general. One lever for the performance of such a system is the service rate, i.e., how many customers per time unit can be served. The service rate can be increased by, e.g., speeding up services, simplifying processes, and on the other hand reduced by additional up- and cross-selling, or by putting more diligence into the service. A higher service rate decreases congestion, and thus waiting. However, a higher service rate can come with other costs. E.g., in the so-called quality-speed trade-off literature it can also lower the value of the service provided to the customer. Depending on the business application, literature assumes different components in the objective function, such as waiting costs, revenues depending on the service rate, costs in the service rate, etc.

The goal of this seminar thesis is to provide a detailed overview, classification, and comparison of different objective functions in the queueing literature with decisions on the service rate. The underlying motivation of the objective functions should be explained. Moreover, the optimization problems should be classified with respect to the dimensions of the variability cube (Stolletz and Tan, 2024). Relevant applications and managerial insights, as well as structural similarities and differences between the considered objective functions should be identified. A critical assessment of the literature concludes this thesis.

Prerequisites: Basic knowledge in stochastic modelling (e.g., OPM 561)

Basic Papers: Anand et al. (2011), Stolletz and Tan (2024)

> **Abstract**: In many services, the quality or value provided by the service increases with the time the service provider spends with the customer. However, longer service times also result in longer waits for customers. We term such services, in which the interaction between quality and speed is critical, as customer-intensive services. In a queueing framework, we parameterize the degree of customer intensity of the service. The service speed chosen by the service provider affects the quality of the service through its customer intensity. Customers queue for the service based on service quality, delay costs, and price. We study how a service provider facing such customers makes the optimal "quality–speed trade-off." Our results demonstrate that the customer intensity of the service is a critical driver of equilibrium price, service speed, demand, congestion in queues, and service provider revenues. Customer intensity leads to outcomes very different from those of traditional models of service rate competition. For instance, as the number of competing servers increases, the price increases, and the servers become slower.

P12 – Managing Elective Care with Two Classes of Customers

Objectives: In many service systems customers are heterogeneous. For elective care, i.e., for healthcare treatments that are neither urgent nor required, different customers could exhibit different attributes. This could be the willingness to pay, customer's patience or the desired quality. The former is directly related to the price, while the latter might be affected by the speed at which the service is conducted. In the mentioned system, managers can decide on both the price and the speed. The quality-speed literature assumes that the quality of service is increasing in the service time, i.e., the more diligence is put into serving a customer, the higher the provided value. Price and speed thus influence how many customers will join a system and seek service. The arrivals to such systems as well as the actual service times are often stochastic. Queueing models are used to describe these systems. To reflect heterogeneous customers, it can be assumed that a share q of customers is of type A, while the remaining $(1 - q)$ are of type B, or that customer's preferences are uniformly distributed over some range.

In this seminar thesis, a detailed overview, classification and comparison of the quality-speed tradeoff literature assuming heterogeneous demand in healthcare systems should be provided. Structural differences to models in which heterogeneous servers are assumed should be highlighted. Moreover, the optimization problems should be classified with respect to the dimensions of the variability cube (Stolletz and Tan, 2024).

Prerequisites: Basic knowledge in stochastic variability (e.g., OPM 561)

Basic Papers: Ni et al. (2013), Stolletz and Tan (2024)

> **Abstract**: In many customer-intensive services, the perceived quality of service decreases in the speed of service. Usually, an increase in service speed induces different marginal reductions in quality for heterogeneous customers. To bring insight into the managerial implications of this difference, we classify customers in terms of intensity parameters, and investigate the behavior of each class of customers in a queueing framework. The optimal service speed and price are derived to maximize service provider's revenue. Our results demonstrate that no class is always attractive to the provider, and thus there are usually several combinations of service price and speed reaching the same maximal revenue. Moreover, under some mild conditions, the provider could gain more revenue by treating different classes with discrimination than by adopting uniform treatment.

References

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Ni, G., Xu, Y., and Dong, Y. (2013). Price and speed decisions in customer-intensive services with two classes of customers. *European Journal of Operational Research*, 228:427–436.

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