

Bachelorarbeitsthemen - BWL

FSS 2024

1. Applications of queueing systems with impatient clients in service operations

Queueing systems are used in various service systems, such as call centres, health care, emergency services, and repair facilities. In many of these service systems, customers leave the queue before being served (e.g. abandonment or balking) due to a lack of patience. However, different applications result in different queueing models, since some applications have specific characteristics that should be modeled (e.g. limited waiting room due to COVID-19 regulations).

The goal of the thesis is to conduct a literature review and compare different real world applications for queueing systems. Existing literature should be critically assessed and compared with respect to characteristics of considered application areas. Moreover, the impact of impatience and the resulting managerial insights should be discussed extensively.

Literature: Koole and Mandelbaum (2002)

2. Design and control of healthcare operations

Healthcare systems throughout the world are under pressure to widen access, improve efficiency and quality of care. They strive to balance utilization with timely and high-quality care. As an example, emergency departments offer care to patients who present without prior appointment. However, nearly half of emergency departments operate at or above capacity, leading to long patient waiting times. The stochastic and time-dependent nature of arrival and handling of patients make such systems hard to analyze and optimize. Queueing theory can be used to analyze such systems under basic assumptions.

The goal of the thesis is to conduct a literature review about stochastic healthcare operations with retrials (before or after service). Existing literature should be critically assessed and compared by describing different applications, the specific assumptions on the considered optimization problems (objective, constraints, ...). Moreover, the resulting managerial insights should be discussed extensively.

Literature: Yom-Tov and Mandelbaum (2014); Keskinocak and Savva (2020)

3. Rational retrial queues: models, applications, insights

Queueing systems are used in various service systems, such as call centres, health care, emergency services, and repair facilities. In many of these service systems, customers may not be able to enter the system due to insufficient system capacity (blocking). Moreover, these blocked users may re-enter the system at a later time point. Queueing literature usually assume that customer behaviour is exogenous (following a predetermined behaviour) and focus on performance evaluation of the system. Rational queueing theory on the other hand studies the strategic behaviour of customers and operators in queueing systems. By analyzing a queueing system from a game-theoretic perspective, one can gain interesting and applicable operational insights.

The goal of the thesis is to give an overview about rational retrial queues, i.e. rational queues that incorporate retrials. Existing literature should be critically assessed and compared by describing different models, applications, specific characteristics, and resulting optimization models (objective, constraints, ...). Moreover, the impact of different strategic behaviour and the resulting managerial insights should be discussed extensively.

Literature: Kerner and Shmuel-Bittner (2020); Cui et al. (2019)

4. Virtual waiting in service operations

The concept of virtual waiting is used in amusement parks, call centers, and airports. After the registration at arrival, the customer can leave the queue and does not have to wait in line. The customer returns to the queue at a specified point in time. The advantage for the customers is that they can use their time more effectively.

The objective of the thesis is to give an overview over such virtual waiting options in service operations based on literature or business applications. Possible applications of this concept have to be described in detail. The specific assumptions and rules of the virtual waiting system should be described, compared with each other, and critically assessed.

Literature: De Lange et al. (2013)

5. Dynamic and stochastic service systems in airport terminals

Various service industries face time-dependent arrivals. In addition, the total number of available servers and hence the total processing capacity can be also be time-dependent.

The goal of this thesis is to provide a comprehensive overview of the recent publications on the application of time-dependent queueing systems in service systems in airport terminals, such as check-in counters, security checks, departure lounges, and baggage claim facilities. The reviewed articles must be classified based on their assumptions, application area, performance evaluation measures, and assumptions on the optimization problem (if applicable), i.e., input data, decisions, objective functions, etc. The thesis must also provide an overview of the managerial insights mentioned in the reviewed research papers. A critical assessment of the literature and suggestions for future research concludes this thesis.

Literature: Schwarz et al. (2016); Rodríguez-Sanz et al. (2021)

6. **Application of time-dependent queueing in health care facilities and emergency departments**

Various service industries face time-dependent arrivals. In addition, the total number of available servers and hence the total processing capacity can be also be time-dependent.

The goal of this thesis is to provide a comprehensive overview of the recent publications on the application of time-dependent queueing systems in service systems in health-care facilities and emergency departments. The reviewed articles must be classified based on their assumptions, application area, performance evaluation measures, and assumptions on the optimization problem (if applicable), i.e., input data, decisions, objective functions, etc. The thesis must also provide an overview of the managerial insights mentioned in the reviewed research papers. A critical assessment of the literature and suggestions for future research concludes this thesis.

Literature: Schwarz et al. (2016); Andersen et al. (2019)

7. **An Overview on the Games Used for Teaching Operations Management**

Using simulated games has been proven to be one of the most effective ways when it comes to teaching operations management. In most of these games, practice decision making in practical but simulated situations.

The goal of this bachelor thesis is to provide an overview of the research papers proposing manufacturing related games for teaching operations management. The student must classify the games based on the decision problem behind them and explain them in detail providing insights into how much effort it takes for them to be implemented in a real class. A critical assessment of the games and their practical relevance concludes this thesis.

Literature: Lewis and Maylor (2007)

8. **Optimization Models for Pumped Storage Hydropower Operations**

The use of Pumped Storage Hydropower (PSH) has emerged as a pivotal solution in enhancing the stability and efficiency of renewable energy systems. A significant benefit of PSH lies in its flexibility, allowing it to function as a pump or turbine at different times of the day according to needs. One of the most important aspects of managing such systems is the optimization of the energy storage and release to ensure a harmonious balance between energy demand and supply.

This bachelor thesis aims to systematically review research papers that introduce optimization models for managing PSH operations. It will organize these studies according to their major assumptions on demand and supply/capacity. This includes characterization of input parameters, key decisions to be made, objectives, and constraints. Moreover, the optimization problem must be classified with respect to the dimensions of the variability cube (Stolletz and Tan, 2024). Additionally, the thesis will critically assess the advantages and possible drawbacks of PSH, specifically focusing on the discussed and overlooked aspects of the optimization problem, thereby identifying research gaps. This analysis, grounded in evidence from the literature review, will provide valuable insights into the potential role of PSH in evolving energy systems.

Literature: Jia (2013); Bozorg Haddad et al. (2014)

9. **Prescriptive Analysis for Efficient Operations of Pumped Storage Hydropower Systems**

The use of Pumped Storage Hydropower (PSH) has emerged as a pivotal solution in enhancing the stability and efficiency of renewable energy systems. A significant benefit of PSH lies in its flexibility, allowing it to function as a pump or turbine at different times of the day according to needs. One of the most important aspects of managing such systems is the optimization of the energy storage and release to ensure a harmonious balance between energy demand and supply.

This thesis analyzes an optimization model to identify the optimal daily operation schedule for PSH systems, focusing on energy storage and release decisions to efficiently balance energy demand and supply. The model proposed by Jia (2013) will be analyzed in detail. The detailed analysis involves describing the mixed-integer linear programming model and briefly positioning it within the existing body of literature. A refinement of the model will be implemented using an optimization tool (student's choice) such as Python's DoCPLEX, GAMS, or AMPL. Sensitivity analysis will be conducted, focusing on parameters like energy prices to assess their impact on the system's operational strategy. This numerical analysis seeks to provide managerial insights into the factors affecting PSH efficiency and effectiveness.

Literature: Jia (2013)

Prerequisite: Familiarity with mixed integer programming model implementation on platforms such as Python-docplex, GAMS, AMPL, etc.

10. **Emergency Department Staffing**

In staffing problems, decision makers try to determine the optimal number of staff to employ during a certain time period. In deterministic scenarios, optimal staffing levels can often be determined accurately. However, if the underlying system exhibits stochastic behavior, e.g., uncertainty in customer arrivals or service times, the task of staffing becomes more complex. This is especially relevant in emergency departments. In case of unexpected high demand, low staffing levels can lead to long waiting times and low quality of service. On the other hand, high staffing levels can be costly. An important question is which goal to pursue in such optimization problems, e.g., whether to minimize expected costs, minimize the probability of delay, or other performance measures. Also, different constraints could be imposed on the solution.

This thesis should provide an overview of the literature regarding the optimization of staffing in emergency departments. The underlying problems should be classified based on the underlying model assumptions. The utilized objective function(s) and constraints should be explained in detail. Moreover, the optimization problems must be classified with respect to the dimensions of the variability cube (Stolletz and Tan, 2024). A critical assessment of the presented literature concludes this thesis.

Literature: de Vericourt and Jennings (2011)

11. Car Sequencing - Ant Colony Optimization

The car industry is one of the largest industries in the world. The German automobile industry alone generated over 400 billion € in revenues in 2021. One key factor for the success of many companies in this field is the mass customization of production: Brands offer a wide variety of product variants to satisfy customer preferences. Customers can decide on features as, e.g., the color of the car, the motor, the tires, assistance systems, heated seats, and even whether the model name should be displayed on the exterior or not. To produce many different variants, manufacturers have to adjust their production processes. Changing between different variants requires setups, which in turn can increase costs and degrade capacity. Thus, an optimal sequencing of product variants in operational planning can help to decrease costs while increasing the efficiency. To determine optimal sequences, often heuristic approaches are used, such as ant colony optimization.

This thesis describes the underlying problem and the presented heuristic optimization approach of the base paper in detail. Furthermore, the paper should be briefly put into context within the related literature. A critical assessment of the heuristic concludes the thesis.

Literature: Gagne et al. (2006)

12. Considering Fairness in Personnel Planning

When doing workforce planning, managers are often confronted with different challenges. Besides creating feasible schedules, fairness considerations are relevant. Employees want to be treated in a fair manner - but as fairness can be a subjective topic, the question is which objective to pursue. Some basic intuition could be: Treating all employees the same. But this might be neither feasible nor optimal nor desired by the employees. Another base policy could be to ask employees to rate shifts (a lower rating thereby indicating a higher preference), and then minimizing the sum of assigned preferences ratings. This could lead to situations in which many employees get their highest preference, while few others get a very low preference. Thus, the literature regarding scheduling considers a variety of measures and objectives to incorporate fairness into their models.

The goal of this thesis is to provide an overview of the scheduling literature that incorporates fairness aspects into optimization models. Fairness measures should be motivated and characterized. The literature should be classified by the applied fairness measures and the underlying assumptions. A critical assessment of the considered fairness measures in the presented literature should conclude this thesis.

Literature: Karsu and Morton (2015)

13. **Shift Scheduling: Prescriptive Analysis for Fair Schedules**

When doing workforce planning, managers are often confronted with different challenges. Besides creating feasible schedules, fairness considerations are relevant. Employees want to be treated in a fair manner - but as fairness can be a subjective topic, the question is which objective to pursue. Some basic intuition could be: Treating all employees the same. But this might be neither feasible nor optimal nor desired by the employees. Another base policy could be to ask employees to rate shifts (a lower rating thereby indicating a higher preference), and then minimizing the sum of assigned preferences ratings. This could lead to situations in which many employees get their highest preference, while few others get a very low preference. Thus, the literature regarding scheduling considers a variety of measures and objectives to incorporate fairness into their models.

This thesis analyzes an optimization model incorporating fairness aspects into the shift scheduling of physicians. The mixed-integer linear programming model (MIP) proposed by Stolletz and Brunner (2012) should be described and briefly positioned within the existing body of literature. The model will be implemented using an optimization tool (student's choice) such as Python's DoCPLEX, GAMS, or AMPL. A sensitivity analysis will be conducted, focusing on parameters like minimum and maximum shift length to assess their impact on optimal shift scheduling and provide managerial insights into shift scheduling under fairness considerations.

Literature: Stolletz and Brunner (2012)

Prerequisite: Familiarity with mixed integer programming model implementation on platforms such as Python-docplex, GAMS, AMPL, etc.

Literatur

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