CHAIR OF PRODUCTION MANAGEMENT
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UNIVERSITY
OF MANNHEIM
Business School

Bachelorarbeitsthemen - BWL

FSS 2021

1. Strategies for the joint optimization of preventive maintenance and buffer allocation in production lines

In maintenance systems, machines are subject to failures that cause disturbances and decrease the productivity of production systems. Therefore, they have to be maintained on a regular basis. In the context of Industry 4.0, preventive maintenance describes the idea of maintaining system components regularly to decrease the probability of failures. At the same time, buffer capacities can be allocated between the workstations of production lines to mitigate the effects of unreliable machines.

In this thesis, a literature review on existing strategies to jointly optimize the maintenance of machines and the allocation of intermediate buffer capacities in production lines is to be conducted. The identified strategies are to be described and structured systematically.

Literature: Nahas (2014); Zandieh et al. (2017)

2. Performance evaluation of production ramp-ups in the automotive industry

The ramp-up of a production describes the phase from the first production of a newly developed product until the target production capacity is reached. Typically, the production volume increases from the start of the production of a new product over time until a stable series production is reached. In addition, the ramp-up phase is often characterized by lower product quality. Suitable performance metrics must be used to evaluate a production ramp-up.

The aim of this thesis is to formally describe the characteristics of the ramp-up phase exemplified by the automotive industry. In a structured review, the performance indicators used in the literature to evaluate the performance of the ramp-up phase are to be identified and organized in a structured manner. This serves as a starting point for a critical discussion of the identified performance indicators with respect to their advantage, shortcomings and gaps in research.

Literature: Doltsinis et al. (2013)

3. **Strategies for efficient ramp-ups of production systems**

The ramp-up of a production describes the phase from the first production of a newly developed product until the target production capacity is reached. Typically, the production volume increases from the start of the production of a new product over time until a stable series production is reached. In addition, the ramp-up phase is often characterized by lower product quality. Therefore, companies pursue the goal of having efficient ramp-up phases. This includes the aim of achieving a short ramp-up time and a steep ramp-up curve to reach high quality and high volume production fast.

In this thesis, a structured literature review is to be conducted that deals with the strategies that are pursued to improve the efficiency of the ramp-up phase of production systems. The literature review serves as a starting point of a critical discussion of the identified strategies.

Literature: Colledani et al. (2018)

4. **Applications of machine learning for the job shop scheduling problem**

The job shop scheduling problem is a common task that has to be solved in the manufacturing industry: a set of n jobs has to be processed on a set of m machines, where each job must be processed on the different machines in a specific order. The problem can be formulated as a Mixed-Integer Optimization Problem but the resulting model is intractable in many cases. In recent years, the application of Machines Learning Approaches to tackle the Job Shop Scheduling Problem have gained increasing interest.

The aim of this thesis is to structure the literature about the applications of Machine Learning techniques on the Job Shop Scheduling Problem. After a detailed description of the Job Shop Scheduling Problem, a literature review is to be conducted that presents and classifies the existing literature based on the used ML-technique, the problem objective and further suitable criteria.

Literature: Weckman et al. (2008); Gonçalves et al. (2005)

5. **Applications of machine learning for the buffer allocation problem**

In the design of manufacturing systems, the Buffer Allocation Problem is a common, but complex combinatorial task. The production units of a manufacturing systems are often aligned in a serial manner, with buffers in between that are capable of storing a limited number of items. As space is limited and causes costs, the capacities of the buffers should be allocated in an optimal way. The Buffer Allocation Problem deals with the allocation of buffer capacities between the workstations of a production line.

First, in this thesis, the Buffer Allocation Problem in production lines is to be described. A review on existing literature that deals with applications of machine learning approaches to tackle the buffer allocation problem in serial production lines is to be conducted. The literature is to be structured with respect to the used Machine Learning Approach, the characteristics of the considered production line and further suitable criteria.

Literature: Spinellis and Papadopoulos (2000)

6. **Optimal operation of pumped-storage hydropower stations: A literature review**

A pumped-storage hydropower station is a special type of power plant that enables to store energy over time in the form of potential energy. The system consists of a lower reservoir from which water is pumped to a reservoir with higher elevation in times of high availability of electricity and thus low electricity prices. In times of electricity shortages, the water can be released to the lower reservoir what drives turbines and generates electricity. Providers pursue an optimal operation of the pumped-storage hydropower station in order to maximize profits or to balance the supply and demand of electricity.

In this thesis, a structured literature review is to be conducted that sheds light on existing models for the optimization of the operation of pumped-storage hydropower stations. Special attention is to be paid on the underlying assumptions, the optimization objective and the constraints as well as the consideration of stochasticity in individual aspects of the model.

Literature: Braun (2016); Alvarez (2020)

7. **Optimal operation of pumped-storage hydropower stations: A numerical analysis**

A pumped-storage hydropower station is a special type of power plant that enables to store energy over time in the form of potential energy. The system consists of a lower reservoir from which water is pumped to a reservoir with higher elevation in times of high availability of electricity and thus low electricity prices. In times of electricity shortages, the water can be released to the lower reservoir what drives turbines and generates electricity. The optimal operations of such a system thus highly depend on the supply and demand of electricity and the resulting electricity prices on the spot and intraday markets.

In this thesis, the student is expected to provide an introduction to the underlying optimization problem for determining an optimal operation of the pumped-storage hydropower station. One of the basic formulations of the problem must be implemented in Python and solved using a standard solver (e.g. CPLEX). For that, reasonable assumptions on relevant data inputs have to be made. A numerical analysis is to be conducted that sheds light on the influence of data inputs and managerial insights.

prerequisite: Basic knowledge of Python; Experience in (mixed-integer) linear programming

Literature: Braun (2016)

8. **A literature overview on categorical multi-skill workforce scheduling**

Labor cost is the major cost in many production and service systems. Several systems require different skills, for example in a call center operators with different languages are needed. One strategy is to hire specialists for each of the skills needed, whereas in some systems, in order to increase the flexibility and to reduce the labor cost, the managers decide to hire multi-skill workers as well.

The aim of this work is to collect workforce planning studies considering *categorical skills*, i.e., in the multi-skill setting, there is no difference in skill levels and the skills of a worker determine which tasks he or she can perform. The student is expected

to classify the relevant papers based on their underlying optimization problem, i.e, assumptions, input data, decisions, objective(s), constraints and underlying variability.

Literature: De Bruecker et al. (2015)

9. **A literature overview on managing manpower requirements in manufacturing systems**

The firms that consider Industry 4.0, with the help of new technologies used in production systems, are able to handle dynamic demand. Because of the dynamic demand in manufacturing systems and hence the need to revise the production plans, dynamic manpower requirements must be managed to operate the production line efficiently.

The goal of this thesis is to review the optimization models related to personnel scheduling in manufacturing systems. The student is expected to classify the papers based on their underlying optimization problems, i.e. the assumptions, parameters, decisions, objective(s) and constraints.

Literature: Ernst et al. (2004)

10. **A literature overview on personnel scheduling considering employees' preferences**

When it comes to planning for human beings, direct costs are not the only factors that must be considered anymore. Many of the research studies in the field of personnel scheduling respect this fact and try to take into account employee preferences (e.g., working together with someone, preference for a specific shift type, specific days off or on and many more) in the final schedule.

This thesis is supposed to provide an overview of the personnel scheduling problems which consider employee preferences in their problems. The papers in the related stream of literature must be classified based on their assumptions and underlying optimization problems.

Literature: den Bergh et al. (2013)

11. **Characterization of Objective functions in Personnel Scheduling**

The task in personnel scheduling is to have the right staff on duty at the right place at the right time. Planners in different organizations, based on the policy of the company and the business environments try to optimize several specific objective functions, e.g., wages, training costs, equity, etc.

The purpose of this thesis is to provide an overview of objective functions used in personnel scheduling. The student is expected to classify the literature based on the objective function used and make a relationship between the underlying optimization problems, assumptions and the application areas to the different utilized objective functions.

Literature: den Bergh et al. (2013)

12. **A numerical analysis on shift Scheduling with break windows**

In order to meet the union regulations as well as to increase the employees' productivity, break windows must be considered when planning the shifts. The shift scheduling problem with break windows decides on the assignment of the employees to the available shifts as well as placement of breaks for the employees. The breaks can be of different types (e.g., relief and meal breaks).

In this thesis, the student must provide an introduction to the shift scheduling problem with break windows. One of the basic formulations for the problem must be implemented in Python and solved using one of the general-purpose MIP solvers at hand (e.g., CPLEX). The student must set up and conduct different meaningful numerical analyses in order to generate managerial insights.

prerequisite: Basic knowledge of Python; Experience in (mixed-integer) linear programming

Literature: Aykin (1996)

13. **Optimization models for integrated staffing and shift scheduling**

Staffing and shift scheduling are two of the main decisions in the process of personnel planning with a high level of inter-dependency between them. The staffing problem decides on the number of employees that should be available in at each point in time considering stochastic variability. Specific schedules are defined in the shift scheduling problem, contingent on the results of the previous step, staffing. Two main approaches have been used in the literature to tackle staffing and shift scheduling problems, namely, the two-step and the integrated approach. The staffing and shift scheduling are modeled sequentially in the two-step approach, i.e., the staffing problem is solved first and the result is fed as input into the shift scheduling model. The integrated approach, on the other hand, optimizes both staffing and scheduling decisions in an integrated fashion.

In this thesis, the student is expected to provide an overview on the papers which propose an integrated approach for staffing and shift scheduling. The research studies must be classified based on their assumptions and underlying optimization problems.

Literature: Kim and Mehrotra (2015)

14. **A numerical analysis on the capacitated production and remanufacturing problem**

Companies have started to remanufacture returned used goods (recoverables) as a second way to meet demand, due to the negative environmental effects of unsustainable manufacturing, which uses scarce natural resources. In addition, several cases can be found in which the remanufacturing costs are lower compared to the case in which virgin material is used.

In this thesis, the student is expected to present and discuss a basic version of the optimization model. The model must be implemented in Python and solved using one of the general-purpose MIP solvers available (e.g., CPLEX). Numerical analyses must be conducted on the model in order to generate managerial insights.

prerequisite: Basic knowledge of Python; Experience in (mixed-integer) linear programming

Literature: Hilger et al. (2016)

15. **Cutoff service levels in operations management**

The management of operations in warehousing, transportation and manufacturing is driven by service levels with respect to on-time delivery. In service level agreements, typically, so-called cutoff service levels (also known as Next Scheduled Deadline (NSD)) are widely used in industry and retail operations. For example, based on a

cut-off time and a deadline, a certain target percentage of orders received until the cut-off time have to be processed until the deadline.

The objective of this thesis is to provide an overview of planning models that consider cutoff service levels used in logistics and manufacturing. The student is expected to describe the assumptions of respective evaluation models and optimization models from the literature.

Literature: Doerr and Gue (2013), Çeven and Gue (2015)

16. **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. Therefore, the possible applications of this concept have to be described. 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)

Literatur

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