Book of Abstracts

12th Logistics Management Conference

September 15th-16th, 2021
Dresden

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Chair of Business Management, esp. Industrial Management

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Preface

This book of abstracts contains information about the 12th conference Logistics Mangement (LM2021) of the Scientific Commission for Logistics (WK-LOG) of the German Academic Association for Business Research (VHB). The LM conference series is continued every two years at different places in Germany. It aims at providing a forum for scientists and practitioners in business administration, IT and industrial engineering to present and discuss new ideas and technical developments related to the management of logistics systems. LM 2021 is hosted by the Technical University Dresden. Previous LM conferences were held in Bremen (1999, 2013), Aachen (2001), Braunschweig (2003, 2015), Dresden (2005), Regensburg (2007), Hamburg (2009), Bamberg (2011), Stuttgart (2017) and Halle (Saale) (2019). LM 2021 has invited two keynote speakers to examine ongoing developments:

- Christian Bierwirth (Martin Luther University Halle-Wittenberg)
- Alexander Hohlfeld (Deutsche Bahn AG)

In addition to the keynote talks, 34 presentations were given at LM 2021 of which 16 present a full paper published in the corresponding proceedings. The abstracts of all talks are provided in this book together with organizational information about the conference.

Dresden,
September 2021

Udo Buscher
Rainer Lasch
Jörn Schönberger

Acknowledgements

The editors express their gratitude to all of the authors and to everybody who has contributed to this conference. In particular, we thank Springer for the easy and uncomplicated collaboration in the editing and publishing process. Our special gratitude goes to DHL for awarding the best full paper contribution of LM 2021. Furthermore, we would like to thank Christin Peschel, Johannes Sarter and Michael Hölscher for their support in the organization and preparation of the conference. We also gratefully acknowledge the efforts of the program committee for reviewing the contributions submitted to the conference. The LM 2021 program committee consists of

Prof. Dr. Christian Bierwirth, Martin-Luther-Universität Halle-Wittenberg
Prof. Dr. Ronald Bogaschewsky, Julius-Maximilians-Universität Würzburg
Prof. Dr. Udo Buscher, Technische Universität Dresden
Prof. Dr. Jan Dethloff, Hochschule Bremen
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Prof. Dr. Wolfgang Stölzle, Universität St. Gallen
Prof. Dr. Axel Tuma, Universität Augsburg
Prof. Dr. Guido Voigt, Universität Hamburg
Prof. Dr. Carl Marcus Wallenburg, WHU – Otto Beisheim School of Management

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1 Overview - Scientific Program

	Wednesday 15.09.2021		Thursday 16.09.2021	
	Room W-1	Room W-2	Room T-1	Room T-2
09:00 - 09:20	Opening: *J. Schönberger*			
09:30 - 11:00	SCO I	SM I	SCD II	SSCM III
11:15 - 12:00	Keynote I: *A. Hohlfeld*		Keynote II: *C. Bierwirth*	
12:00 - 12:15	Lunch break		DHL Best Paper Award	
12:15 - 13:00			Lunch break	
13:00 - 14:30	SCD I	SSCM I	SCO III	SM II
14:30 - 15:00	Chatroom		Chatroom	
15:00 - 16:30	SCO II	SSCM II	SCRM	SCO IV

SCO = Supply Chain Operations
SM = Supply Management
SCD = Supply Chain Digitalization
SSCM = Sustainable Supply Chain Management
SCRM = Supply Chain Risk Management

The complete access credentials for the relevant *Zoom.us* rooms are:

Room W-1:
Meeting-ID: 835 1455 1117
Password: LM_2021!

Room T-1:
Meeting-ID: 856 6894 6021
Password: LM_2021!

Room W-2:
Meeting-ID: 836 3555 7873
Password: LM_2021!

Room T-2:
Meeting-ID: 885 5497 0968
Password: LM_2021!

The complete access credentials for the chatrooms are:

Link: https://spatial.chat/s/lm2021
Password: LM2021CHAT

1.1 Keynote talks

Two keynote talks will be given. The keynote sessions are scheduled for 45 minutes including 15 minutes of discussion.

- Wednesday 15.09.2021 11:15-12:00, Room W-1

  Alexander Hohlfeld (Deutsche Bahn AG) 🇩🇪
  Qualitäts-/ Pünktlichkeitsmanagement bei der Deutschen Bahn
  Chair: Udo Buscher

- Thursday 16.09.2021 11:15-12:00, Room T-1

  Prof. Dr. Christian Bierwirth (Martin Luther University Halle-Wittenberg)
  Emission oriented management of land-bounded freight transportation
  Chair: Rainer Lasch

1.2 Contributed talks

The contributed talks to the conference are gouped by subject into five thematic streams:

- Supply Chain Operations (SCO)
- Supply Management (SM)
- Supply Chain Digitalization (SCD)
- Sustainable Supply Chain Management (SSCM)
- Supply Chain Risk Management (SCRM)

Contributed talks are presented in parallel sessions, each session respectively consisting of two or three individual talks. They should be no longer than 25 minutes to allow a short discussion after each talk. Talks annoted with the German flag will be held in German.

Supply Chain Operations

Session SCO I:
Wednesday 15.09.2021 09:30-11:00, Room W-1
Chair: Matthias Klumpp

- Max Zien (Martin Luther University Halle-Wittenberg)
  Greenhouse gas emissions of shunting operations - A simulation study

- Sandra Luttermann (University Bremen)
  What is the right home delivery option for your online shopping?

- Ralf Elbert (Technical University Darmstadt)
  Combined hub location and service network design problems – a case study for an intermodal rail operator for strategic network expansion

Session SCO II:
Wednesday 15.09.2021 15:00-16:30, Room W-1
Chair: Kathrin Fischer

- Nadine Schiebold (Technical University Dresden)
  Multi-skilled worker assignment problem in multi-shift cell manufacturing

- Marcel A. Hoffmann (Technical University Dresden)
  Forecasting irregular demand using single-hidden layer neural networks combined with outlier elimination?

- Lorenz Kolley (Hamburg University of Technology)
  A robust berth allocation optimization procedure based on machine learning

Session SCO III:
Thursday 16.09.2021 13:00-14:30, Room T-1
Chair: Udo Buscher

- Manuel Ostermeier (Technical University Munich)
  Last-mile delivery with robots: A mixed truck and robot concept

- Vanessa Völz (Technical University Braunschweig)
  Relocation in one-way station-based car sharing systems: conventional versus partly autonomous vehicles

- Hani Shahmoradi-Moghadam (Technical University Dresden)
  A robust decentralized decision-making approach for mobile supply chains under uncertainty

Session SCO IV:
Thursday 16.09.2021 15:00-16:30, Room T-2
Chair: Janis Neufeld

- Florian Linß (Technical University Dresden)
  An exact approach for a vehicle routing problem with common carrier selection

- Dominic Loske (FOM University of Applied Sciences Essen)
  The impact of human skills in forklift operating: An empirical analysis through multilevel modeling

Supply Management

Session SM I:
Wednesday 15.09.2021 09:30-11:00, Room W-2
Chair: Frank Meisel

- Christian Flechsig (Technical University Dresden)
  The impact of intelligent process automation on purchasing and supply management – initial insights from a multiple case study

- Lorenz Trautmann (Technical University Dresden)
  MAP 4.0 – Proposal for a prescriptive maturity model to assess the digitalization of procurement

- Barbara Himstedt (Kiel University)
  A systematic evaluation of extensions for the shared customer collaboration vehicle routing problem

Session SM II:
Thursday 16.09.2021 13:00-14:30, Room T-2
Chair: Rudolf Large

- Bastian Mrutzek (University Bremen)
  Backend resources and capabilities for SME omnichannel specialty retailers

- Anne Lange (University of Luxembourg)
  Subcontracting and service quality: the case of airlines

- Rudolf Large & Gilles Paché
  (University of Stuttgart, Aix-Marseilles University)
  Attitudes towards logistics and people in logistics: The influence of the covid-19 crisis

Supply Chain Digitalization

Session SCD I:
Wednesday 15.09.2021 13:00-14:30, Room W-1
Chair: Rainer Lasch

- Frauke Hellweg (University of Münster)
  Preconditions and challenges in the digital transformation of supply chains: Findings from academia and practice

- Sven Reimers (Hamburg University of Technology)
  The roles of small and medium-sized enterprises in blockchain adoption

- Jacob Lohmer (Technical University Dresden)
  Blockchain technology in operations & supply chain management: a content analysis

Session SCD II:
Thursday 16.09.2021 09:30-11:00, Room T-1
Chair: Michael Eßig

- Sandra Lechtenberg (University of Münster)
  Digitalization's effects on transport planning and specifically the transport coordinator's role

- Kübra Ates (Bundeswehr University Munich)
  Smart contract: A literature-based analysis and development of a taxonomy framework

- Josephine Thums (Georg August University Göttingen)
  Air transportation management and digital work at airports: developments and challenges

Sustainable Supply Chain Management

Session SSCM I:
Wednesday 15.09.2021 13:00-14:30, Room W-2
Chair: Herbert Kotzab

- Larissa Lößer (Merseburg University of Applied Sciences)
  Characteristics and environmental orientation of modality concepts

- Henning Preis (Technical University Dresden)
  Evaluating setup options of electric vehicles for optimized last-mile delivery systems

- Christopher Münch (Friedrich-Alexander-University Erlangen-Nuremberg)
  Towards sustainable freight transportation - A risk framework application to truck platooning

Session SSCM II:
Wednesday 15.09.2021 15:00-16:30, Room W-2
Chair: Stefan Seuring

- Beverly Grafe (Hamburg University of Technology)
  One fits all? Devising product attributes for circular supply chain strategies

- Alexander Rapp & Adina L. Simonovic (University of Stuttgart)
  Let's get greener! Environmental strategies of logistics service providers

- Stefan Seuring (University of Kassel)
  Sustainable value creation through information technology-enabled supply chains in emerging markets

Session SSCM III:
Thursday 16.09.2021 09:30-11:00, Room T-2
Chair: Ralf Elbert

- Sonja Rosenberg (Karlsruhe Institute of Technology) 🇩🇪
  Dynamic reverse network planning for used electric vehicle traction batteries in germany

- Maria Beranek (Technical University Dresden)
  Pricing decisions in a two-period closed-loop supply chain game under asymmetric information and uncertainty

- Laura Zöllner (University Bremen)
  Reverse logistics challenges in the textile industry in the year 2035

Supply Chain Risk Management

Session SCRM:
Thursday 16.09.2021 15:00-16:30, Room T-1
Chair: Jörn Schönberger

- Till Sahlmüller (University of Münster)
  Towards resilient supply chain structures

- Lucas Stampe (University of Münster)
  Risk indicators and data analytics in supply chain risk monitoring

Abstracts

Keynote Talks

Qualitäts-/ Pünktlichkeitsmanagement bei der Deutschen Bahn

Alexander Hohlfeld

Deutsche Bahn AG

Abstract Die Pünktlichkeit der Züge ist für Reisende und Kunden im Güterverkehr das TOP Qualitätsmerkmal. Sie wird durch die Haupthebel Kapazität und Verfügbarkeit der Elemente im Bahnsystem beschrieben. Der Schwerpunkt des Vortrages liegt auf dem Mess- und Steuerungssystem zur Pünktlichkeit. Zudem wird auch auf die wesentlichen Herausforderungen bei der Umsetzung von Maßnahmen eingegangen.

Emission oriented management of land-bounded freight transportation

Christian Bierwirth

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Abstract Passenger and freight transportation is responsible for about 14% of the global anthropogenic greenhouse gas (GHG) emissions, with a share of up to 25% in highly industrialized economies. A lot of political activities target at cutting the GHG emissions caused by the transport sector. Noteworthy are, among others, the implementation of highway tolls for heavy trucks, increasingly strict standards for exhaust systems of combustion engines, governmental promotions of electric vehicles and rail transportation, and the stimulation of a public debate on GHG taxation in general and in particular for freight transportation. In this talk we take a look at upcoming challenges for actors in the freight transport sector and at new management tools and instruments available for balancing economic and ecological requirements. The review includes calculation models for GHG emissions of transport processes, approaches for emission oriented transport planning and vehicle routing, emission accounting and GHG reporting standards for the transport sector, advances in implementing collaborative and intermodal transportation and recent ideas on introducing eco-labeling in freight transport markets.

Abstracts

Supply Chain Operations

Greenhouse gas emissions of shunting operations - A simulation study

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Abstract Marshalling yards are nodes in rail networks where incoming trains are decoupled and sorted to outbound trains. An algorithmic approach to sort wagons of incoming trains is to apply sorting schemes. Well investigated sorting schemes are *Sorting by train, Sorting by block, Triangular Sorting and Geometric Sorting*. Throughout the applying of sorting procedures greenhouse gases are emitted, e.g. by shunting locomotives. A simulation study is conducted in which emissions in marshalling yards can be calculated. For this purpose a formula based analysis of the sorting schemes is carried out. The simulation shows that *Sorting by block* performs best w.r.t. less emissions for most scenarios. On the other hand *Geometric Sorting* is the worst sorting scheme, i.e. for most scenarios emissions are higher in comparison to other sorting schemes.

What is the right home delivery option for your online shopping?

Sandra Luttermann, Caroline Buschmann, Michael Freitag, Herbert Kotzab, Jonas Tiggemann, Markus Trapp, Martin Weßling

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Abstract Although retailers and logistics service providers offer various last mile delivery options, the level of individualisation regarding integrating consumer demands and expectations for home delivery is currently low. In order to offer such individualised delivery options, it is necessary to understand consumers' home delivery needs and wants. Accordingly, this paper examines consumer preferences regarding delivery options, focusing on online grocery retailing using a discrete choice experiment approach. Our results show that consumers can derive high ben- efits from the individualization of delivery options, especially in the areas of vehicle type and place of delivery. Also, packaging and delivery time are relevant delivery options for consumers but considered to be less useful than transport vehicles and place of delivery, while consumers do not prefer the selection of a time window on the day of delivery.

Combined Hub Location and Service Network Design Problems – A Case Study for an intermodal rail operator for strategic network expansion

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Abstract In intermodal transport, different modes of transport are combined to benefit from cost savings and simultaneously ensure reliable operations. Hub location problems (HLPs) address the location of hub facilities, but as well include abstract network design decisions to provide feedback on location selection. Service network design problems (SND) involve the service planning decisions including all decisions on choosing the transport services and modes to move commodities as well as the flow planning decisions addressing the movement of commodities throughout the network. Both HLPs and SNDPs are well-known problems that have been extensively studied in the scientific community. Despite strong interdependencies, there has been little research on the integration of the two problems so far. We study the integrated planning of hub locations and the design of a service network. We consider several real-world constraints such as multiple transhipments of requests at hubs, transport time limits for requests, request splitting, and minimum utilization for direct connections. We solve the combined problem with a Tabu Search (TS) and conduct a real-world case study for a German intermodal rail operator.

Concerning the HLP, there are several good reviews. Alumur et al. identify key gaps in the literature that provide opportunities for better models. These are the incorporation of time in HLPs, a stronger link to real-world problems, integration of hub location with other problems, and the use of real data. Several reviews also exist for the SND. Repeatedly mentioned research gaps are the extension of the scope of the models and efficient solution procedures. Rothenbächer et al. are the first to consider both, HLP and SNDP, in a combined model. At first, they present studies with a higher degree of integration, then present a combined model and solve it with a branch-and-price-and-cut algorithm.

We assume an intermodal operator intending to determine hub locations for his network. As feedback for the hub selection, a fixed service schedule over a given planning horizon (e.g. one week) is developed. The planning horizon can be divided into discrete planning periods of equal length (e.g. one day). The geographical intermodal network is represented by a graph and can be transformed into a time-space graph representation (physical network is repeated in each planning period). A set of transport requests is given. Each request consists of several containers, its origin and destination location, a start period, and the maximum number of periods

until delivery is due. There are two possibilities for transporting a request: transport through the hub network and direct transport from origin to destination. There are two types of hubs: *fixed* and *potential* ones. Fixed hubs are open and may be used in any solution. In addition, several potential hubs are available and may be opened and used. Since the intermodal operator does not operate the hubs, but only purchases the service there are no fixed costs for the hub opening. At any point in time, an unlimited number of trains may use a rail link. The number of trains used in the planning period determines the transport capacity available on the edge. Fixed costs are incurred for each train used. These consist of the service fee for handling the containers and distance-dependent costs. To reflect the asset management, nodes must satisfy the design balance constraints. This means that the number of trains leaving a node in a period must match the number of trains arriving. Additionally, variable costs for the actual capacity utilization of the train are occurring. Direct transports must have a minimum capacity utilization due to operational constraints. Overall, the problem is to decide on the routes of the requests, the usage, location and allocation of hubs, and the number of trains operating between nodes. The objective is to minimize the overall costs for fulfilling all requests, either by direct transport or transport through the hub network. We classify our model as a p-median HLP with an integrated dynamic service network design problem, as we consider scheduling aspects for services. We develop a hierarchical solution procedure. At the first level, we perform a TS, inspired by Abyazi-Sani & Ghanbari and Ish-faq & Sox, to determine the hub selection. To evaluate this selection, we solve the resulting SNDP with CPLEX.

In the real-world case study, we analysed the network of one of the largest German intermodal rail operators involved in maritime hinterland transport. The rail services connect 22 hinterland nodes in Germany, Austria, and Switzerland with seven port nodes in north-western and southern Europe. Currently, the operators' portfolio consists mainly of transports to the northern ports. In the course of a network expansion, the service to the western and southern ports is to be increased. There are nine potential hub nodes. The planning task of the intermodal operator is to select appropriate hubs and define a schedule for the services from the hinterland nodes to the ports and vice versa. The services are operated within a weekly, periodical schedule. To reflect long-term demand developments and the distribution of transport flows between the ports, several scenarios were analysed.

The use of hubs can greatly reduce transport costs. Since there are no costs associated with the opening of hubs in the model, the objective function naturally decreases as the number of hubs increases. However, it can be observed that this cost saving is increasingly smaller. Even with only two hubs, a very good solution can be achieved for each scenario. However, this specific scenario solution is not necessarily suitable for other scenarios. Solutions with three hubs are very good across different scenarios and are suitable to adequately take into account the demand and distribution development. As a future research opportunity, we aim at improving our solution procedure.

Please note that due to a non-disclosure agreement with the intermodal operator no absolute numbers can be provided.

Multi-skilled worker assignment problem in multi-shift cell manufacturing

Felix Tamke, Nadine Schiebold

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Abstract We study a multi-skilled worker assignment problem with multiple shifts in cell manufacturing. The problem is motivated by a real planning problem in protective device manufacturing. Two assignment decisions must be made simultaneously: Requested orders and multi-skilled workers are assigned to production cells and shifts. Specifically, a certain number of workers process orders in one production cell, whereby the processing times of the orders vary depending on this number of assigned workers. We also take into account family setup times, invalid worker-cell combinations, and a limited number of possible shifts for each order to process. A 0-1 integer linear programming model that minimizes the total number of cells opened for production in all shifts is introduced. The model is tested using real-world data. We show that the generated solutions are suitable to support production planners and can be used to reveal problems of the production such as lack of workers and skills or disruption-prone cells with a high utilization.

Forecasting Irregular Demand Using Single-Hidden Layer Neural Networks Combined with Outlier Elimination

Johannes Meinig, Marcel André Hoffmann, Rainer Lasch

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Abstract The inventory management and production planning of parts with irregular demand patterns are challenging for manufacturing companies. These patterns often occur in the strategically critical spare parts sector, where the inventory and capital commitment costs are high. For this reason, an accurate forecast can improve service levels and ensure efficient stock keeping. However, due to the unique characteristics of spare part demand patterns, precise demand forecasting is often a much more difficult challenge than the forecasting of primary product demand. This is because spare parts demand is often characterized by a high degree of sporadicity and significant fluctuations in demand level. Classical statistical forecasting methods for calculating demand, such as the moving average, do not explicitly consider these specific characteristics of spare parts demand in their calculation and can therefore often only achieve moderately satisfactory results. More specialized calculation methods for determining spare parts demand, such as the method of Croston (1972), and its modification of Syntetos and Boylan (2005) or bootstrapping methods, can usually achieve better results in that case, but with increased calculation effort.

However, even those more specialized approaches are increasingly facing new competition due to the advancing developments in artificial intelligence (AI). The rapid market growth in operational AI applications and their optimization potential in data analysis processes underline the great relevance of these developments for operational spare parts demand forecasting. In particular, forecasting models based on artificial neural networks (ANN), which derive a forecast from past demand values via machine learning, significantly outperform statistical benchmark methods according to some quantitative studies. However, with some other quantitative studies, the significant accuracy improvement could not be confirmed. This contradiction in the literature and the still relatively small number of publications underline the necessity to conduct further quantitative studies on the topic. In addition, existing studies show a lack of differentiation, e.g., concerning unique demand characteristics. Consequently, a quantitative study with several differentiation features was carried out in this study using real data originating from a mid-size mechanical engineering company.

This paper aims to compare the prediction results of various ANN configurations and classical forecasting methods for the different demand categories according to

Syntetos et al. (2005), which means that erratic, lumpy, smooth and intermittent demand patterns are regarded separately. In this study, eleven statistical forecasting methods are compared with eight single-hidden layer neural network configurations, which shows that the extent of included methods is more significant than in most existing studies on this topic. In further studies, it could be confirmed that simple neural network architectures with only a few hidden neurons often work best for this kind of calculation problem, which is why the number of hidden neurons was varied between one and four. The previously primarily successful learning algorithms are Backpropagation and Levenberg-Marquardt and were applied in this study to clarify further the various impacts of the neural network architecture and learning algorithms. Furthermore, the impact of a special outlier elimination on the forecasting performance of ANN and statistical forecasts is examined, since especially in the spare parts sector, outliers often distort the calculation of demands. The demand calculations in this study are mainly based on 36 monthly past demand values from a sample of 24 spare parts. Finally, the accuracy of the different forecasting methods has been measured considering six future demand values to obtain results that are as meaningful as possible.

This quantitative study shows that ANN have great potential to optimize the forecast of irregular demands. The ANN with Levenberg-Marquardt algorithm and four hidden neurons can achieve the best result for erratic and intermittent demands, with a lead of 1.4% and 49.7% in terms of MAPE (Mean Absolute Percentage Error) mean consideration. However, the Syntetos-Boylan approximation (smoothing parameter $\alpha = 0.2$) dominates for lumpy demand patterns and the moving average (with a past horizon of 3 years) for smooth patterns. Considering lumpy demands, the previous research results of superior ANN forecasting results could not be confirmed, as classical calculation methods showed a better forecasting performance in this demand category compared to ANN in our research. Regarding intermittent demand patterns, the superior ANN forecasting results achieved by Sahin et al. (2013) could be confirmed, whereas the best ANN in our study also outperformed all classical methods at erratic demands.

It could also be shown that the proposed outlier elimination (OE) improves the accuracy by 8.1% on average of all forecasting methods and by 15.8% on the ANN average. Consequently, the accuracy of ANN methods increased significantly more than classical methods due to the proposed OE. This suggests that ANN benefit more from the OE and can improve their relative accuracy even greater.

A robust berth allocation optimization procedure based on machine learning

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Abstract In berth allocation planning, container vessels are to be assigned to berthing locations and times at the quay of a container terminal. Terminal operators often aim to provide the best possible service quality to the shipping companies, i.e. especially short waiting times. However, the actual arrival times of vessels are uncertain due to external influences, e.g. wind and current or technical defects, which impedes the planning and may lead to conflicts with respect to scheduled berths. In this work, Machine Learning techniques are applied to enable the determination of patterns in AIS data and hence to develop forecasts of the arrival times. Moreover, with a robust optimization approach based on Dynamic Time Buffers, uncertainty is proactively considered in the planning phase, resulting in a robust berthing schedule. The results of this new approach are evaluated from an ex post perspective using real ship data and actual ship arrival times. It is shown by a numerical study that the average number of conflicts can be reduced significantly by this approach and that the new concept improves the schedules' robustness.

Last-mile delivery with robots: A mixed truck and robot concept

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Abstract The last mile in order fulfillment is an essential challenge for retailers and logistic service providers. While attended home deliveries are convenient for customers, they account for a large share of logistics costs. The volume of online orders and attended home deliveries constantly increases, which leads to an increasing volume of traffic. Especially in dense urban areas this contributes to traffic congestion and pollution.

Delivery by truck and robots is a promising approach to address these issues as well as to flexibly accommodate customers' time window preferences. Autonomous delivery robots can transport a single parcel or grocery bag to customers. The small robots transport an order (e.g., parcel or a grocery basket) to a single customer within a given time window. Due to their lower speed and limited range, delivery robots are combined with specialized trucks to enable a fast and efficient delivery process. This means that a truck transports the corresponding goods for delivery together with robots and releases the robots at dedicated drop-off locations for the actual home delivery. Once the robot arrives at the door, the customer is notified and can unlock the freight compartment to retrieve his order. As in this setup a large part of the distance is covered by the robots and walking and waiting times are eliminated, the traffic impact is potentially reduced compared to truck only deliveries. Mercedes-Benz (2021) has tested such a concept and has shown that it potentially decreases lead time and traffic. Baum et al. (2019) predict that delivery robots will likely be introduced on a larger scale soon due to their low production costs and limited legal obstacles.

The combination of trucks and robots for the delivery results in a complex routing problem that involves the synchronization of the truck, the movement of robots and the compliance to existing delivery deadlines. Existing literature on truck-and-robot routing focuses on a setting where all deliveries are made by robot and the truck is only employed as "mothership" for robot transport. In practice, however, there are multiple reasons for deliveries requiring human interaction and therefore final delivery by a person. For instance, a delivery by robot may not be possible for bulky, highly valuable or hazardous goods that must be handed over by a delivery person. Moreover, even when an order is suitable for robot delivery, the possibility of choosing between truck or robot increases routing flexibility and may yield cost reductions. To date, there is no approach integrating direct truck deliveries into the

truck-and-robot concept, which is essential for a real-life application. If direct truck deliveries are not included, not all orders can be processed on the truck-and-robot tour and an additional tour for classical truck delivery would be required. A new approach that provides this additional flexibility is therefore needed. We close this gap in literature by proposing the Mixed Truck and Robot (MTR) delivery concept, leading to the Mixed Truck and Robot Routing Problem (MTR-RP). This generalized problem contains complex new dependencies, as it requires the truck (not only the robots) to meet time windows along the tour.

The MTR-RP generalizes the NP-hard truck-and-robot routing problem and therefore constitutes an NP-hard optimization problem by itself. Since even small instances of the problem cannot be solved with commercial solvers, we propose a tailored solution approach that is based on a General Variable Neighborhood Search (GVNS) framework. Our approach simultaneously determines the routing of a truck including direct customer deliveries, the schedule for robot deliveries, and which orders are fulfilled by truck or robot if both options are eligible.

In our numerical experiments we show that our approach effectively solves the generalized truck-and-robot routing problem with truck deliveries and outperforms existing approaches for the case of robot deliveries only. Compared to separate tours for each delivery mode, logistics costs can be reduced by 22%. This highlights the need for an integrated planning approach. Compared to classical truck delivery (using only delivery trucks), the system saves 43% of the costs and 45% of the truck emissions. Further sensitivity analyses identify key drivers of costs and logistical performance and show the robustness of our approach across different settings.

Relocation in one-way station-based car sharing systems: conventional versus partly autonomous vehicles

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Abstract Our aim with this paper is to apply platoon relocation in a large-scale one-way car sharing system. We analyze the system performance in terms of realized customer trips and relocation costs with regard to conventional, platoon or none relocation tours. We analyze the efficiency potential of platoon relocation on simple theoretic instances that mimic demand and city structures. In these examples, the platoon approach can be up to 60% more efficient in relocating cars compared to the conventional one. We apply a time-expanded network formulation to a self-designed case study from the city of Hanover. In order to cope with runtime restrictions, we delete redundant network arcs. Our results show that in the large-scale Hanover case example, the platoon tours lead to a moderate increase of customer trips and reduced relocation costs.

A German mobility study found that private cars on average are used for 45 minutes per day and no more than 10% of all cars are used simultaneously. Therefore, cars are suitable candidates for sharing systems. If one-way rentals are allowed, meaning that the pick up station can differ from the return station, the vehicle distribution over all stations will be affected. Performing relocation of the vehicles can readjust unwanted car allocations to meet upcoming demand.

Numerous studies address the relocation problem of station-based car sharing systems for one-way rentals, see Illgen and Höck (2019) for detailed literature summary. Especially operator-based relocation, electric vehicles and staff allocation have been studied intensively. Furthermore, the integration of fully autonomous cars in sharing systems has been considered. Boldrini and Bruno (2017) heuristically tackle a specific stackable car sharing relocation problem where up to seven cars can be physically connected and relocated collectively by one driver. Similar to Boldrini and Bruno (2017), we study a relocation process where one employee can relocate several cars at a time. Our approach is based on partly autonomous platoons, composed of a manually driven front car followed by a few autonomous cars, instead of mechanically linking the cars. In contrast to Boldrini and Bruno (2017), who use heuristics to identify and match shortages and overflows to define periodic relocation tasks, we use an accurate network model and form relocation tours with regard to an objective function. The platoon relocation, as well as the stackable relocation approach, could serve as a bridge technology before fully autonomously driving cars will be market-ready in the future. Operating and safety problems, such as inter-

actions with other traffic participants, still have to be handled. Partly autonomous platoons are not exposed to these challenges since they are manually operated and act as one traffic participant. We compare the efficiency of conventional and partly autonomous relocation approaches in the context of station-based one-way car sharing systems. We aim to answer the question: does the platoon relocation tour model, applied to a large-scale example, live up to efficiency expectations based on theoretical deliberations? Our main contributions are as follows:

1. We formulate a time-expanded network model for platoon based relocation in station-based one-way car sharing systems.
2. We theoretically compare the relocation cost efficiency of platoon and conventional relocation tours on the basis of small artificial instances.
3. We apply our model to a self-designed realistic case study of the city of Hanover. We analyze the car sharing system's performance in terms of realized customer trips and relocation costs with regard to conventional and platoon relocation tours.

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A robust decentralized decision-making approach for mobile supply chains under uncertainty

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Abstract The mobile supply chain (MSC) concept has its origins in the Distributed Manufacturing System (DMS) concept, which tries to produce a product family locally. In MSCs, a truck can carry the so-called mobile factory (MF) to provide on-site service for geographically dispersed customers. One of the main advantages of this concept is the opportunity to share (rent) expensive assets (machines), because these machines have a low or temporary usage rate at manufacturing sites (MS), and they are not needed continuously.
The idea of a Shared Factory is built on the concept of the sharing economy and social manufacturing, which aims to share manufacturing resources and capabilities. These concepts enable people to share services and facilities in a coordinated Peer-to-Peer (P2P) method. The best examples of this concept are Uber in transportation and Airbnb in the hotel industry. It can be expected that sharing resources (e.g., production machines) will lead to more sustainable and productive supply chains. The studied problem in this paper is inspired by a real-world application in the chemical industry. As illustrated in Fig. 1, some critical production equipment (e.g., reactor) are embedded in an MF. The MF can be carried by truck to produce a product family whenever and wherever required. It can produce different intermediate products which can be used in various manufacturing steps in the semiconductor industry or similar industries.

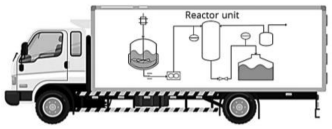

Fig. 1 Schematic of a mobile factory

Because of the relatively low production rate, this expensive and high-tech equipment is not needed at production sites all the time. Hence, sharing this equipment would be a wise decision by the main supplier of the products. The supplier company

(MF owner), which is a chemical company, can control the MF production remotely via controllers. Using this idea, the supplier can enhance its service level, minimize production costs, know-how leakage, and avoid extra transportation costs.
The MSC is inherently a complex multi-agent decentralized problem. The production processes at MSs cannot be completed if an MF is not available there. On the one hand, the mobile factory service provider (MFSP) aim to minimize transportation and operating costs. On the other hand, production managers at MSs try to deliver their own customers' job orders in time. In many cases, these agents' goals can be in conflict, where the fleet manager cannot meet the production managers' demanded service in time.
In this research, a robust decentralized decision-making approach is proposed for MSCs under uncertainty. In order to implement decentralization, an analytical target cascading (ATC) is utilized, which decomposes a centralized model into subproblems. Accordingly, the MF's fleet manager is chosen as the upper level agent, and production managers are considered as lower level agents. Furthermore, since service times at MSs are uncertain, three uncertainty scenarios are developed to address optimistic, realistic, and pessimistic scenarios of data realization. Finally, a scenario-based robust optimization approach is used to tackle the problem uncertainties by reformulating a robust facility routing problem. Using the proposed concept, all agents can reap the benefits of decentralization, robustness, and service flexibility provided by MFs. In this research, some gaps in the mobile supply chain scope are fulfilled, with contributions as follows:

- Presentation of a robust optimization model in the field of the shared/mobile factory.
- Proposal of a coordinated method for MCSs which takes into account the MF routing and production scheduling problem.
- Suggestion of a decentralized decision-making approach for MSCs based on ATC.
- Contrary to simple production routing problems, the production process is performed at the customer's location instead of the depot point.

An exact approach for a vehicle routing problem with common carrier selection

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Abstract Currently, companies typically outsource distribution to external carriers to reduce costs and increase performance and flexibility. In a highly competitive freight-transport market, the freight rates of multiple carriers depend on different factors. Every carrier has its individual pricing scheme for transportation, which often depends in a non-linear way on distance, load, and/or time. In this paper, we consider a problem suggested by a partner in the corrugated-packaging industry. Here, a com- pany, as a shipper of goods to its customers, develops an operational transportation plan and subcontracts transportation requests to external carriers with known tariff functions. The knowledge of the different tariff functions is exploited to generate a cost-efficient allocation of all transportation requests. Therefore, the shipper selects the carriers and assigns requests in order to minimize its shipping costs.

The distribution of goods on an operative level is dealt by the vehicle routing problem (VRP) as one of the most studied optimization problems in Operations Research. The optional outsourcing of distribution in the context of the VRP is introduced as the vehicle routing problem with private fleet and common carrier. We introduce multiple common carriers that fulfill the routes to the shipper's customers. Moreover, since the vehicles do not need to return to the depot, we are faced with an open VRP. In addition, we consider time windows for the depot and each customer.

In this paper, we consider three different types of tariffs offered by three different carriers. The first tariff strictly refers to the total travel distance and uses a cost factor per traveled distance unit. The second one uses ranges for the values of total travel distance and ranges for the values of carried loading per tour. The combination of these ranges results in a freight matrix with fixed costs depending on distance and load. The third tariff is based on the distance-volume product for each order of a tour. We develop a mixed-integer program for freight-cost optimization for each tariff. In addition, we introduce an optimization model for the carrier selection problem that minimizes the total transportation costs when multiple carriers can be engaged. We also present valid inequalities that are added in a branch-and-cut algorithm to strengthen the model and to speed up the solution process.

Two different data sets based on real-world data are used in the computational experiments to examine the characteristics of the routes generated by freight optimization with different tariffs. While the customers in the first data set are randomly located,

the customers in the second data set are more clustered. It turns out that in the more-clustered data set, more customer combinations become feasible and thereby, the solutions become more diverse than in the randomly located data set. We also show that the application of different tariffs has a strong effect on the structure of the obtained optimal solution. In particular, the number of vehicles used varies between the different tariffs and, accordingly, the average volume utilization and distance traveled per vehicle. In our experiments the tariff with a freight matrix most often leads to the lowest costs among all tariffs.

The experiments on optimal carrier selection demonstrate that considering different tariff calculations simultaneously leads to a cost-efficient allocation of transportation orders to the different carriers. Contrary to the experiments with single carriers, the carrier using a tariff based freight matrix is chosen least among all carriers in the allocation. This is primarily due to the relatively high costs at low vehicle utilization. Finally, we show that cost-efficient allocation to multiple carriers leads to huge cost savings even compared to the best single carrier. Here, the customers' spatial distribution also has an impact on the cost savings. While the cost savings average 28% in the randomly located data set, the average cost savings in the clustered data set are 11%. These results show that considering different carrier tariffs during optimization has high potential and should be further investigated.

The impact of human skills in forklift operating: An empirical analysis through multilevel modeling

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Abstract Human operators will remain to play an essential role in picker-to-parts order picking systems, in spite of increasing digitalization and automation of warehouse processes. While manual order picking is a laborious and cost-intensive task in warehousing, it is extensively examined in the logistics and supply chain management literature. However, the operational and individual performance of forklift operators has received little attention yet. We aspire to close this gap by formulating a multilevel model with batch execution time as the dependent variable and source level of operation, target level of operation, filling level of the palette, necessity to correct replenishment quantities, as well as the travel distance as independent variables on the first level. For the second level, we use forklift operators to quantify whether or not the individual heterogeneity in skills is impacting the performance of forklift operators. We find that 15.1% of the variance among the batch execution time results from the skill heterogeneity of individuals. In a further simulation, we show that this method can be used to assess the performance of order pickers through a multi-dimensional parametric production frontier analysis. Our findings are highly relevant for logistics management for example in forecasting the necessary capacity of forklift operators in a warehouse or build bonus systems that are based on more than existing two-dimensional measures such as process time per operation.

Abstracts

Supply Management

The impact of intelligent process automation on purchasing and supply management – Initial insights from a multiple case study

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Abstract The Covid-19 pandemic drives the need for Intelligent Process Automation (IPA). However, the technology's adoption for purchasing and supply management (PSM) is still in the initial stage and has hardly been explored. Therefore, this empirical multiple case study builds on 19 organizations, including private and public procurement departments, consultancies, and IPA providers, to examine the impact of IPA on the PSM function. The findings provide comprehensive insights and reveal suitable operational and strategic application areas as well as several benefits related to IT systems and data, operational efficiency, process quality, and employee satisfaction. The study also identifies various technological, organizational, and environmental challenges that need to be overcome for further IPA adoption. Therefore, future research directions and managerial implications are outlined.

MAP 4.0 – Proposal for a prescriptive maturity model to assess the digitalization of procurement

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Abstract The digitalization of supply chains offers great opportunities, especially with regard to procurement. To effectively implement innovative concepts, it is necessary to evaluate procurement departments' current situations and create target-oriented recommendations for action. Suitable maturity models can help to achievethese goals effectively. However, most existing models do not consider the specifics of procurement and Industry 4.0 technologies and fail to define realistic digitalization goals. In this paper, a model called MAP 4.0 is proposed to assess procurement organizations' maturity and derive realistic target conditions. A qualitative and deductive methodology is applied to analyze existing maturity models. Based on the findings, the maturity assessment model MAP 4.0 is developed according to the methodology of de Bruin et al. (2005). By focusing on the specific field of Procurement 4.0, the requirements and needs can be considered in more detail. In addition, target states and recommendations for actions can be developed. The model includes the relevant dimensions of digitalization and defined weighted items for measurement. In this way, the study lays the foundation for future research, provides valuable insights for procurement managers, and can contribute to the digitization of procurement.

A Systematic Evaluation of Extensions for the Shared Customer Collaboration Vehicle Routing Problem

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Abstract Especially in cities, where several carriers operate in the same area, many of the daily tours of competing carriers overlap due to the proximity of their customer base. Due to this and because the size of the individual transport orders is rather small, the possibility of collaboration has gained increasing attention in this logistics industry. In this context, we deal with opportunities for horizontal collaboration where carrier companies are working together such that customers who demand goods from more than one carrier are shared and can be served completely through one of the partners. While most papers in this research area use strategies in which carriers or forwarders offer all their customers to the collaboration, Fernández et al. (2018) developed a model in which carrier companies are working together such that only customers who demand goods from more than one carrier are shared for being served through just one of the partners. This particular model, the Shared Customer Collaboration Vehicle Routing Problem (SCCVRP) is taken up here and extended in three ways. Thereby, we conduct systematic experiments that assess the impact of each such extension on the collaboration based cost savings in comparison to the original model, compared to a non-collaborative solution, and mutually among the extensions.

In the basic SCCVRP, a setting is considered where a given set of customers have to be served by a set of carriers. Each carrier has one depot from which shipments are delivered to customers using the carrier's own vehicles. It is assumed that a part of the customers, the so-called shared customers demand goods from more than one carrier. In order to save costs, the carriers agree to collaborate in a sense of sharing orders within a centralized vehicle routing. The task is then to decide about vehicle routes for serving all customers, where shared customers may be served by a single carrier to reduce overall travel cost of the collaborating carriers. Extensive computational experiments on more than 100 test instances show that in the basic version of the SCCVRP cost savings of 12.22 % to 38.56 % can be achieved if carriers collaborate by exchanging customers compared to the solution where each carrier serves its own customers exclusively. In these solutions, we observe that the distribution of the cost saving among the collaborating carriers can differ drastically and some carriers may even carry higher cost in the collaborative solution. To avoid this, we propose as a first extension a cost restriction to make sure that no carrier

is worse off in the collaboration solution compared to its isolated route planning. We therefore guarantee win-win-solutions for the involved carriers. Our computational experiments show that this only comes with slightly reduced savings from customer sharing. As a second extension, we add time windows that play a major role in service-orientated distribution systems. While the absolute costs of a solution may then exceed those of the SCCVRP without time windows, the relative saving obtained through collaboration in the SCCVRP-TW is up to 45.53 % and, thus, even higher than in the baseline version of the model. Our final extension addresses freight transfers among the collaborating depots. Contrasting Fernández et al. (2018), who included this into their model under the very strong assumption of unlimited vehicle capacity, we propose here a model extension that explicitly respects vehicle capacity and, thus, decides on the number of vehicle trips being required for inter-depot transfers. As these transfers come at a cost, collaboration is no longer attractive for some of the test instances. For those instances where collaboration still plays a role, the achieved cost savings still ranged from 2.75 % to 22.26 %.

The model variants presented thus show that freight carriers can gain cost advantages through collaboration in various settings. Even under costly inter-depot freight transfers, collaborations can be efficient, although savings will then be lower. Models such as the SCCVRP with a cost restriction can help to establish trust and motivate carriers to participate in collaborations. Furthermore, in settings where time constraints play a role, collaborations are particularly rewarding. Although this paper achieves a systematic comparison and evaluation of three extensions of the SCCVRP, there is still a number of further extensions that might be considered in future research. Such open extensions are, for example, to investigate the impact of limited fleet sizes or heterogeneous vehicles that differ in their capacities and cost, the distribution of the saved costs among the collaborating partners, or time-dependent travel times that may be of importance especially in the SCCVRP-TW. It could also be interesting to test whether the results change if not only operational but also fixed costs as well as profits are included in the considerations.

Backend Resources and Capabilities for SME Omnichannel Specialty Retailers

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Abstract Dynamic changes through increasing digitalisation and high-level competition are defining the retailing industry. The customers can inform themselves from everywhere, at any time, with every device and from every company they want to get information from. Therefore, the concept of omnichannel (OC) retailing is integrating online as well as offline touchpoints of a company to satisfy customers across all channels. This concept's purpose is to counteract diverging customer behaviour to retain customers or acquire new customers. The concept is particularly necessary for small and medium-sized enterprises (SMEs) in niche sectors, for which the pressure on the market appears even higher, but also cannot afford to try something that does not work. Especially under the conditions of the Covid-19 pandemic, where retailers on the whole world are facing the most disruptive challenge of this century, the concept of connecting online and offline channels is more relevant than ever. Companies need certain resources and capabilities in the field of logistics to provide omnichannel services such as click&collect or instore-orders. The notion of the resources is based on the Resource-Based-View (RBV) introduced by Barney (1991) and the provision of different categories in the context of retailing from Grant and Nippa (2006), of which the backend resource categories form the focus of this work. Capabilities are based on the notion of the Dynamic-Capabilities-View (DCV) in-troduced by Teece et al. (1997) and the backend capability categories of the omni-channel retailing capabilities wheel presented by Mrutzek et al. (2020). The purpose is to identify critical backend factors for SME specialty retailers to offer OC services. This leads to the question of which backend resources and capabilities are important for providing omnichannel services as SME specialty retailers?
The methodical approach of this study are interviews conducted with experts from companies that are SME specialty retailers that distribute through online and offline channels and offer more than two OC services. In total, six interviews were conducted with guideline-based interviews. For the analysis of the interviews, the category-based qualitative text analysis according to Kuckartz et al. (2016) was chosen. The basis are the six backend resource and capability categories: operating, financial and warehouse resources as well as capabilities regarding supply chain management (SCM), innovativeness and the omnichannel environment. The statements are then classified into these categories. This allows the importance of individual categories to be highlighted descriptively and also allows an analysis of the content

of the individually assigned statements within the categories.
The concept is service-oriented and linking different customer touchpoints, integrating such a customer-oriented concept in the backend requires more the existence or development of capabilities than resources. This is also reflected in the results of the interviews. In the area of SCM, the flexibility and adaptability of transport systems are particularly important. In combination with good supplier communication, this makes it possible to exploit previously unused OC potential, especially after actions to control the Covid-19 pandemic have limited commercial activities (dropshipment, click&collect, delivery by bicycle). In the area of the OC environment, the development of new and adaptation of existing channels is mentioned to offer more products and reach more customers. The most important backend resource is a sufficiently large, central storage room that can be used by all channels. Due to limited capital, SMEs cannot invest arbitrarily in backend resources, why they have to utilize their potential with capabilities.
The major contribution of this paper is the linkage between omnichannel retailing resources/capabilities and SME companies operating as specialty retailers. This group of companies have a limited budget and can only focus on the most important success factors and implement only omnichannel operations and processes that are worth the investment.
The focus of the interpretation of the results of the expert interviews was more descriptive than qualitative, which should be a superior part of future research. In this paper, we concentrated on the backend resources and capabilities of SME specialty omni-channel retailers. In the future, a holistic approach analysing the retailer's whole resources and capabilities base could be a valuable contribution to this study.

Subcontracting and service quality: the case of airlines

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Abstract Subcontracting increases specialization among firms, facilitates scalability of operations and gives access to additional capabilities. By allowing specialization, however, subcontracting carries the risk of knowledge loss and restricts learning as the firm focuses its own activities but relies on external parties for others.
One specific challenge when subcontracting activities to suppliers is to safeguard product quality. Hierarchical controls are suggested for this purpose: Lin et al. (2014) identify a tight relation between the level of integration and product quality – integration has a positive impact on product quality, inversely stating that firms may expect lower product quality from subcontractors. Ensuring the desired output quality in subcontracting is even more difficult when services are subcontracted. It is impossible to control the quality of a service before it is produced and the service commonly directly involves the customer. Feng et al. (2019) suggest that neither specification of service levels, nor incentivation of high service levels in contracts are sufficient to achieve the desired outcome in all circumstances. This is even aggravated in situations in which the efficiency effects of subcontracting are especially important, which is in specifically competitive environments. But also here, delivering the promised quality levels is essential.
The aviation context allows us to study the effect of outsourcing on service quality empirically. Main carriers may subcontract short haul flights to regional carriers. Flight on-time performance is an established metric for service quality in passenger transportation, and we can observe it at a high granularity. Furthermore, subcontracting relationships are readily observable in the dataset when operating and marketing carrier for a flight differ. A number of competitive characteristics can be observed from schedule information. We collected information about organizational integration of airlines. Hence, the aviation context allows us to gain insights on subcontracting and service quality.
We investigate how types and configurations of an airline's subcontracting arrangements affect their service quality. The organizational dimension includes vertical integration with the mother firm and full independence between marketing and operating carrier. Thus, we look at the role of type and degree of organizational integration. Further, we address competition between subcontracting partners as well

as across carriers. We provide an empirically grounded analysis of airline subcontracting that complements extant formal models of subcontracting relationships.

We rest our analysis on the domestic on-time performance dataset of the US Bureau of Transportation Statistics. Our dataset is a US domestic one. Hence, we observe that regional carriers act as operating carriers for specific flights by another marketing carrier, which establishes the subcontracting relation. Whenever a flight is operated by another airline than the marketing carrier itself, we consider it as a subcontracted flight. We develop and analyze a linear regression model for flight on-time performance.

We observe several effects from our model. We note that the operating carrier's on-time performance is higher for integrated regional carriers than for independent carriers. We also find evidence that the operating carrier has a higher on-time performance when confronted with competition by the marketing carrier himself on route. The on-time performance further increases with the number of marketing carriers on a route, yet it decreases with the number of operating carriers, which we attribute to operational issues related to congestion. Hence, our finding are consistent with past observations that vertical integration and operational competition reduce delays.

With that, it seems that both competition as well as degree of organizational integration improve on-time performance and thereby quality of service. Moreover, we identify in the subset of regional carriers that they improve in on-time performance as they serve an increasing number of customers, which stands in contrast to a benefit of vertical integration. Thus, while we observe multiple drivers of increased on-time performance that coincide with past results and managerial intuition, we identify a conflict between the intention to increase on-time performance by fostering competition between carriers and simultaneously benefiting from increased on-time performance created from a high degree of integration. Ongoing work explores if there are multiple efficient organizational constellations to be observed in the dataset; that is some vertically integrated airline-within-airline constructs as well as high service independent regional airlines.

Our study is the first to address empirically the subcontracting relationship of regional and main carriers with respect to their service quality. Beyond the aviation context, it has the potential to guide practitioners in creating quality-oriented service subcontracting relations.

Attitudes towards logistics and people in logistics: The influence of the Covid-19 crisis

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Abstract From a logistics researcher's perspective, it is surprising and disturbing that many people hold negative beliefs about logistics and therefore negative attitudes towards logistics, although each one of them constantly benefits from the services of logistics. The logistics industry is indispensable to society, the economy as well as for each individual. Consequently, everyone should be aware of the essential importance of logistics. Nevertheless, people usually report negative experiences such as late deliveries as well as congested motorways, excessive land use, late night working and poor working conditions for bicycle couriers. The dark side of logistics seems to be extremely present in the use of space on the outskirts of cities. To supply stores, pick-up points and consumers' homes, it relies on unsightly warehouses that look like "shoeboxes". Many people associate negative or at least unattractive images with logistics. Moving products is perceived as a major source of pollution, noise exposure and accidents of varying degrees of severity. More generally, logistics appears to be contrary to sustainable development approaches, to the point of being obliged to communicate strongly regarding sustainability approaches which companies undertake to prove that they are acting in a more environmentally responsible manner. Certainly, such attitudes are often based on prejudice. Prejudices are selective, oversimplified and unfounded beliefs about things or a particular group of people. In particular, stereotypes concern people's beliefs about the attributes of social groups such as people forming a distinct vocational group. This especially applies to blue collar categories including truck drivers and warehouse workers. Stereotypical thinking intensifies negative perceptions of logistics and individuals employed in logistics. Even if we claim that stereotypes are not accurate, prejudices against logistics influence public opinion and exert pressure on political decision-makers. Consequently, local authorities prefer to see warehouses set up elsewhere rather than on their own doorstep. Furthermore, negative attitudes towards logistics also influence private decisions of individuals, for example career choices. A well- known consequence of this effect is the shortage of truck drivers in many economies. At the same time, the main subject selection by students shows the crucial role of individuals' beliefs about logistics and people working in the field of logistics. Maloni et al (2016) emphasize that the selection of a logistics major is driven by positive statements of family members and business professionals as well as the presence of positive messages on the Internet. The existence of such positive messages about logistics is questionable.

However, the recent Covid-19 health crisis should underline the existence of the luminous or even resilient side of logistics on at least two levels. The first level is the day-to-day management of the distribution and supply systems, both for physical stores, for virtual stores (Internet) and for home delivery platforms. During the various periods of lockdown, consumers were able to access convenience goods, buy cultural products online and have meals delivered to their homes. Behind this logistics are people who, despite the risk of coronavirus contamination, have ensured the continuity of supply chain operations. Consequently, logistics professions such as transportation and material moving occupations are frontline occupations in the Covid-19 crisis. Nevertheless, the occupational prestige of these logistics jobs is very low in comparison to other frontline occupations such as sales assistants or geriatric nurses.

Even if people are unable to recognize the vital necessity of consumer goods' distribution during the Covid-19 crisis, they should at least be aware of what logistics is doing for the healthcare system. Specialists in healthcare supply chains know that logistics is an essential feature of efficient healthcare organization. At the height of the Covid-19 crisis, it should have become clear to everyone that logistics saves lives, in particular by organizing patient transfers between hospitals or by creating new capacity in a brief period of time to accommodate patients who could not be transported. In short, logistics came to the rescue of public health systems which have treated hospitals like hotels, operating under strict financial objectives, including reducing bed capacities over the years. Once the peak of the crisis had passed, and after the launch of the Pfizer/BioNTech and Moderna vaccines, it also became clear that mass vaccination would require exceptional logistical organization in the context of an unprecedented ultracold chain.

Consequently, the purpose of this ongoing research is to examine the influence of the Covid-19 crisis on peoples' attitudes towards logistics. The focus is on the question of how people's experiences in the pandemic affect their job stereotypes and the perceived prestige of frontline occupations. Previous research provides first insights but no conclusive answers to this question. Therefore, further research is needed.

Abstracts

Supply Chain Digitalization

Preconditions and challenges in the digital transformation of supply chains: Findings from academia and practice

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Abstract Digital technologies are omnipresent in today's world, and successful involvement in the digital transformation becomes increasingly important to companies from all industries. To stay competitive, companies are pressured to rethink their supply chains and adapt. However, the topic of digital supply chains is still in its infancy. The goal of this paper is to shed light on the preconditions and challenges regarding the transformation. The different areas of the digital transformation of supply chains, namely the strategic, organizational, process & method, and technological area are considered. Preconditions and challenges for companies in the digital transformation of their supply chain are extracted from literature with literature reviews and followingly discussed with practitioners to capture the magnitude of the transformation process. Furthermore, differences between academia and practice are revealed, and future research opportunities are identified.

The roles of small and medium-sized enterprises in blockchain adoption

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Abstract Despite the growing maturity of Blockchain technology and an increasing deployment in Supply Chain and Logistics, many small and medium-sized enterprises (SMEs) struggle to use the technology for their benefit. Based on 27 expert interviews, we develop a typology of Blockchain adoption approaches for SMEs and discuss their implications. We find that SMEs can approach the technology as either an Observer, a Cooperator, or a Technology Provider based on their technological expertise, the expected relevance of the technology for their organization, and their market power.

Blockchain technology in operations & supply chain management: a content analysis

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Abstract Blockchain technology has received increasing attention in industry and research lately. Various research approaches are emerging from different scholarly backgrounds, where an interrelation of research areas and current trends have not been adequately considered in a systematic review to date. Therefore, we use a data-driven content analysis approach in this study to examine previous research on blockchain in operations and supply chain management to identify patterns and trends in publications. We investigate the extent to which blockchain technology has been considered in scholarly works, structure the research efforts, and identify trends as well as promising research opportunities. Quantitative and qualitative content analysis is conducted on an extensive literature sample of 318 articles. Results indicate an optimistic attitude towards the technology due to the expected and confirmed potentials such as tracking and tracing abilities, efficiency increases, and trust-building. Research opportunities are also indicated, especially through a combination of technological research with value-adding use cases for blockchain technology.

As an emerging technology, blockchain has experienced considerable attention and hype in recent years, both in industry and research. Potentials such as facilitated transparency, secure communication, and unalterable transactions in the B2B environment have been identified and implemented in various applications and proof of concepts. Practical applications for operations management (OM) and supply chain management (SCM) include efforts from the digitalization of global sea freight, to the additive manufacturing sector, and IoT-related concepts. As these representative examples show, blockchain technology is located at the intersection of information technology (technology aspect), cryptography (security aspect), and economics (application aspect). Although this interdisciplinarity exists, research is mainly conducted in traditional scientific silos, detached from each other. Networking between these subject areas and collaborative research efforts still fail to meet expectations.

Previous literature reviews usually focused only on the respective aspects that correspond to the authors' research background. The interrelation of the research areas and current trends have not been sufficiently considered so far. This study analyses the available scientific literature on blockchain technology in OM and SCM with a comprehensive and interdisciplinary perspective.

We conduct a quantitative and qualitative content analysis of an extensive literature sample of 318 publications using MAXQDA analysis functionalities. Content analysis (CA) is a valuable method to identify patterns and trends in publications and is suited for large literature sets. Contrary to rather subjectively created literature reviews, the CA is data-driven and can be based on predefined, unbiased recording units. CA is a useful research method in social sciences, OM and SCM. We contribute to the state-of-the-art by classifying and structuring research on blockchain technology in OM & SCM. Besides, we explore blockchain concepts and topics that have been identified as promising in research. We further highlight future research opportunities that remain to be addressed. A conceptual research framework is used to assess publications, including categories such as research focus, industry focus, scientific method, theory, interfaces, business areas, potential, barriers, adoption, consensus, platform and others.

Findings indicate that potentials take a greater share than barriers with tracking and tracing abilities, immutability, trust, cost savings, transparency increases, and smart contract automation potential as the most significant. Barriers prevail in terms of governance issues and regulatory uncertainties. Few articles are theory-driven, and OM is less researched than SCM, whereas industry focus has been on food, agriculture, and pharmaceutics. Methodological approaches are still mainly conceptual and qualitative. Promising interfaces to other technologies include IoT and RFID. Sustainability applications are also an emerging topic.

Future research opportunities are identified in the area of SC risk management, the combination of technological research on the use of blockchain in OM & SCM with value-adding use case assessment to increase the technology's adoption potential, research on the tokenization of assets and new emerging business models as well as research on the impact of blockchain technology on the sustainability of supply chains.

A novel approach is employed to analyze a large dataset of publications on blockchain technology in OM and SCM that allows to identify research trends and future research directions. A broad overview of the subject is provided that does not exclude relevant articles from related research disciplines. We also supplement the reader with an extensive appendix including more data analysis and the detailed results for all recording units and categories.

Digitalization's effects on transport planning and specifically the transport coordinator's role

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Abstract Road freight transport has become a vital part of today's life, and its importance will only rise in the future due to developments such as increasing e-commerce orders. Transport planning has become more complex and has to deal with many difficulties such as demand volatility, high customer expectations, or the consideration of legal regulations. The fastchanging environment makes dynamic and highly reactive planning, typically done by the transport coordinator, necessary. Incorporating technology is a promising way to deal with the complexity and dynamic environment of transport planning. Indeed, more data and computing power is available than ever before, and developments coined under "digitalization" are transforming transport planning. Before understanding the benefits digitalization can have, examining its influences on the industry, the roles participating in transport planning, and their relationship is necessary. Hence, this paper establishes an overview of roles associated with transport planning, identifies digitalization's effects on transport planning and specifically the transport coordinator, and then provides an updated overview of roles considering these effects. The results show that new relations and roles are important for transport planning. The role of the transport coordinator itself is transformed mainly due to the emergence of platform-based business models.

Smart contract: A literature-based analysis and development of a taxonomy framework

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Abstract So far, the term 'smart contract' is mainly reflected in research addressing technology, IT applications or peculiar businesses like stock exchange or bitcoin. However, a smart contract is an issue of purchasing and supply management (PSM) due to its potential to connect suppliers with customers through state-of-the-art digital means. Thus, we identify the need to define the concept of smart contracts within the PSM domain. Therefore, the main research aim is to clarify the construct of a smart contract. The core finding is that a deconstruction of existing definitions reveals peculiarities in the perspectives and domains but gives insufficient validity to PSM analysis. Thus, the result of this research is a definition proposal for smart contract. The implications of this analysis could pave the way for a wider discussion of how smart contracts affect PSM outside the typical blockchain and bitcoin arenas.

Air Transportation Management and Digital Work at Airports: Developments and Challenges

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Abstract The air transportation sector and airports are a fundamental hub for passenger and cargo traffic. The largest German airports also represent an essential international interface for the economy and society. In 2019, Frankfurt Airport was ranked as the fourth largest airport in Europe and even placed on rank 15 worldwide. Due to the Covid19 pandemic, the airport sector suffered a significant challenge in 2020. Passenger traffic at German airports has decreased by 73% compared to 2019. Cargo traffic also fell by 6% in 2020 compared to the previous year, but is slowly recovering and has been rising over the last months of 2020, which can be seen as an early indicator of dynamic economic development. Due to the global pandemic and the requirements of human contact reduction, the significance and importance of digitalization has become visible in almost all areas of supply chain management as well as within air transportation. New technologies play an essential role in the air transportation sector. For this reason, it is the aim of this paper to analyze and understand the impact of new digital technologies in the working environment of airports. The contributions are twofold: (a) We examine the changes and developments in digitalization at airports and (b) we identify impacts of digitalization and new technologies on the professional groups of pilots, flight crew members and security staff at airports.

In recent years, digitalization processes have taken place in many different areas within air transportation and at airports. The process included applying automated processes, making information available on a digital basis and using artificial intelligence (AI). There are many examples of digital technologies at airports, such as using AI for the maintenance of airplanes, self-check-in systems for passengers, or screening technologies to support airport security. The use of new digital and global networks, such as ATN (Aeronautical Telecommunication Network), leads to improved communication with reduced interpretation errors for the take-off and landing system, but also to a reduction in fuel consumption and shorter flight times with a shorter flight route. During the flight, the Flight Management System (FMS) defines the flight path and instructs the pilot on an appropriate flight route according to the flight plan and meteorology. In this process, the pilot controls the FMS and can also give direct instructions . Instrumental Landing Systems (ILS) are playing a significant role for pilots during aircraft landing. ILS facilitates automatic landing and minimizes accidents as a result. Before applying and using ILS, sometimes it

was difficult for pilots to land in adverse weather conditions and zero visibility. Also, IT innovations help assess weather conditions by making meteorological observations and giving predictions. With the emergence of new and increasingly intelligent technologies, there is a coexistence of digital automated and human decision-making capabilities at work for the analyzed professions.

The development of a conceptual framework can help to investigate the interaction between digital technologies and staff in airports. By taking a look in an airplane's cockpit, there are many instances involved in the decision-making process: The pilot, the co-pilot, the autopilot and the flight management system (FMS). Re- garding this scenario, two digital technologies interact with two humans and collaborate with each other. The FMS suggests a flight path to the autopilot, which then operates it. The pilots can also manually set a heading or speed of the aircraft via the cockpit control panel. For most of the flight duration, the route is programmed by the autopilot and FMS, so the pilots are responsible for monitoring the autopilot and checking the FMS to ensure that all recent changes have been coded. The pilots have to decide in which case they deviate from the suggested paths. To do so, they additionally have to coordinate between themselves. A complex decision-making situation arises between digital applications, humans and digital devices and humans among themselves. In case of errors, there is a high potential of damage in an airport. Maintaining the organization's performance in case of accidents is of high necessity. For this reason, airports can be characterized as high-reliability organizations (HRO), as they have very challenging work requirements. In relation to the described scenario with pilots, autopilot and FMS, questions and hypotheses about the interaction between digital technologies and humans in critical decision-making situations can be derived. For the future development of digital technologies cooperating with humans within an advanced working environment in air transportation management, further research of the interaction between human and digital technologies is necessary. This is due to the fact that coordination between technology and human workers is critical to operational processes. In particular, the analysis of digital developments in air transportation management is in the interest of further research since airports as organizations are confronted with critical decision-making situations on a daily basis.

With a systematic literature review, digitalization addressing airport professions (flight, ground and security staff) will be analyzed and presented in the context of changes and challenges. To conduct the literature review, full papers with specified keywords are extracted within Sciencedirect and Ebsco. For a future investigation regarding the impact of digitalization on working conditions, this literature review is the next step to provide an overview of digital changes and challenges in airports.

Abstracts

Sustainable Supply Chain Management

Characteristics and environmental orientation of modality concepts

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Abstract Different modality concepts for freight transportation have been developed over the past decades. One inherent emission reduction strategy they all include, by definition, is the strategy of modal shift. Several literature reviews are made to identify main characteristics of multi-, inter-, co- and synchromodality with a special focus on the most current concept of synchromodal transportation. The analysis further focuses on the environmental orientation (sustainability, emission reduction and modal shift) of the concepts. The emission reduction importance for modality concepts is analysed, to determine if they can be used by different actors in the transportation chain to reach emission reduction and to ascertain if courses of action for low-emission transportation planning can be deducted. The differences between the modality concepts are not very distinct, emission-reduction is expected to be achieved by using these concepts and courses of action are usually developed in form of methods or tools for specific problems and users. They are difficult to access or transfer onto other cases or user. A standardized process usable for different Logistic Service Provider is needed.

Evaluating setup options of electric vehicles for optimized last-mile delivery systems

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Abstract The steady growth of e-commerce activities, especially driven by the current pandemic situation, increases the demands and complexity of last-mile delivery systems and their impact on the environment and the quality of urban life. Sustainable solutions for city logistics include converting the vehicle fleet to electric drives and adapt the vehicle design. This results in new challenges for the vehicle dispatching and route planning. The daily operating scenarios of the vehicles are planned on the basis of the well-known Vehicle Routing Problem (VRP) algorithms, which, in the case of the using electric vehicles (EVRP), also include the consideration of range restrictions and intermediate recharging stops. The performance characteristics of electric vehicles are important parameters for the EVRP. In particular, the size of the battery and the technical setup influence the range and the remaining payload of the vehicle and thus have a decisive influence on the result of the route optimization and the vehicle deployment. Logistics companies are therefore faced with the task of selecting the right vehicle setup to achieve optimal operational results.
The paper presents the basic modeling approach of the EVRP with recharging stops and range constraints. A large set of problem instances of the EVRP was created based on practical experiences of parcel delivery services in urban areas. Furthermore, the relevant performance parameters of electric vehicles for last-mile delivery are identified and their influence on the routing results and operating costs of the last-mile delivery system is investigated. To this end, the set of problem instances of EVRP involving different vehicle setups are calculated using the standard solver CPLEX in order to compare the results.
It is shown that as the shipment mass increases, the influence of a proper battery sizing is growing. For each delivery scenario, an optimal battery size can be determined that represents the best possible balance between vehicle range and remaining payload. This minimizes the number of vehicles to be used, optimizes their routes and thus reduces operating costs. The inclusion of recharging stops in the tour depends largely on the charging technology used and the associated charging performance, which affects the stop times and thus the routing results. As an outcome, route plans without intermediate recharging and the using of fast charging technology dominate the scenarios. The paper summarizes the findings of optimal vehicle characteristics for different delivery scenarios and derives practical usable suggestions for the optimal setup of electric vehicle fleets.

Towards sustainable freight transportation - A risk framework application to truck platooning

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Abstract Different modality concepts for freight transportation have been developed over the past decades. One inherent emission reduction strategy they all include, by definition, is the strategy of modal shift. Several literature reviews are made to identify main characteristics of multi-, inter-, co- and synchromodality with a special focus on the most current concept of synchromodal transportation. The analysis further focuses on the environmental orientation (sustainability, emission reduction and modal shift) of the concepts. The emission reduction importance for modality concepts is analysed, to determine if they can be used by different actors in the transportation chain to reach emission reduction and to ascertain if courses of action for low-emission transportation planning can be deducted. The differences between the modality concepts are not very distinct, emission-reduction is expected to be achieved by using these concepts and courses of action are usually developed in form of methods or tools for specific problems and users. They are difficult to access or transfer onto other cases or user. A standardized process usable for different Logistic Service Provider is needed.

One Fits All? Devising Product Attributes for Circular Supply Chain Strategies

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Abstract In contrast to the current linear economic model, the Circular Economy proposes an economic system made of closed material loops. For technical materials like metal or plastics, it aims to keep material value at the highest possible level by reusing, repairing, and remanufacturing entire products or recycling the individual materials. Thus, the Circular Economy intends to increase sustainability by eliminating waste. Promoting sustainability and decoupling economic growth from primary raw material usage are societal needs that have become more pronounced in recent years and are reflected in the legislature.

Even though the Circular Economy seems to be primarily about material flows, an effective information exchange between companies that have not established communication channels until now is a critical success factor. Companies that are responsible for, e.g., repairing or remanufacturing used products, need specific information from manufacturers about the product to perform their job. For high-quality recycling, recycling companies require information about material properties and ways to disassemble the product. In practice, such information exchanges are not established yet. One way to address this problem is by creating digital product twins. A digital twin represents a material or immaterial object from the real world. The information that a Circular Economy-focused digital product twin should provide depends on the material cycle as a recycler potentially needs other information than a remanufacturer. Thus, a product categorization is needed that allows to derive the information requirements for different material cycles.

First approaches exist: Parajuly and Wenzel (2017) focus on the waste of electrical and electronic equipment (WEEE) material stream, provide an overview of product end-of-life options and relate them to product attributes. However, to the best of our knowledge, existing literature does not provide a generic approach to connect product attributes to material cycles for a Circular Economy.

For this research, we use a mixed-methods approach. First, we plan to conduct a literature review to identify existing product categorizations and possible product attributes. Based on this, we will derive a list of product attributes and relate them to the different material cycles. These findings will then be mirrored individually with experts from various stages of the value chain. We plan to amend the results

with requirements for digital twins and supply chain functions in a subsequent focus group workshop. Ultimately, we aim to provide a unified catalog of product attributes that allows assessing products regarding their requirements for the material flow of a circular supply chain. Companies can use the catalog to design digital twins and their supply chain for the individual material cycles.

Let's get greener! Environmental Strategies of Logistics Service Providers

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Abstract In recent years, public opinion and political debate has been largely determined by topics such as climate change, environmental protection and sustainable development. In this context, logistics service providers (LSPs), as a pivotal part of supply chains, have become the subject of the public sustainability discussion. Consequently, logistics research has increasingly dealt with the question of which practices LSPs can implement to contribute to the sustainable development and thus meet the requirements of government and customers. However, this merely reactive approach falls short and tempts LSPs to adopt environmental practices based on a short-term perspective, without having a clear long-term environmental strategy in mind. In turn, this can ultimately result in a loss of valuable resources and competitive advantages. Due to the uncertainty about how best to translate these environmental practices into competitive advantages, the main research objective of the study is to support LSPs in developing proactive environmental strategies.

For this purpose, the comprehensive framework of Orsato (2006, 2009) was applied to LSPs. This approach incorporates the ideas of Porter's (1980) generic competitive strategies and ultimately distinguishes four different environmental strategies (eco-efficiency, beyond compliance leadership, eco-branding, environmental cost leadership) along the two dimensions of competitive advantages (*lower costs* vs. *differentiation*) and competitive focus (*organizational processes* vs. *products and services*). Due to the suspected influence of industry structure on the selection and implementation of environmental strategies, Orsato (2006) emphasizes the need for an industry-specific analysis of his framework. Furthermore, as the logistics industry is not homogeneous and a broad array of different logistics services is offered, a segmentation of the industry is crucial in order to study the competitive environmental strategies accurately. In the following, we use the criteria "key logistics activity" and "degree of bundling" to characterize the segment called "advanced logistics services in warehousing (AW)" as a relevant example.

To achieve *lower costs* within their *organizational process*, the providers of advanced logistics services in warehousing (AWPs) can pursue an **eco-efficiency** strategy and implement various practices regarding warehousing (e.g. efficient land use, energy-efficient heating), packing management (e.g. reduction of packing material, eco-friendly packing material) reverse logistics (e.g. recycling), and internal management (e.g. employee training). This strategy is predestinated for small and medium

sized AWPs as some of these practices are supported by governmental subsidies. According to Hart and Ahuja (1996), a strategy based on the exploitation of efficiencies has limits. As the level of efficiency increases, additional efforts such as eco-packaging become increasingly cost-intensive. **Beyond compliance leadership** strategy relies on *differentiation* with a competitive focus on *organizational processes*. For the implementation of this strategy, significant investments are required to show the ecological effort to customers and promote an eco-friendly reputation. With regard to AWPs, this typically includes environmental practices, such as the environmental management system certification according to ISO 14001 or the installation of environmental compliance and auditing programs. This can be supported with the publication of such certificates or accomplishments in general and with the provision of incentives and benefits for green behavior. In contrast, the **eco-branding** strategy, which also relies on *differentiation* but with a competitive focus on *products and services*, requires AWPs to have competencies in brand management and green marketing to an even greater extent. To achieve a price premium from customers, AWPs, for example, can use warehouse designs reflecting sustainability (e.g. greening of buildings). AWPs could also expand their marketing efforts by developing corporate logos (similar to DHL's "GoGreen"), which in turn could help to promote a green image and implement a green corporate or green service brand. Since the implementation of an eco-branding strategy requires significant resources and time, well-established green brands cannot easily be imitated by competitors and thus offer the opportunity of gaining competitive advantages. The combination of the *lowest costs* and the lowest environmental impact represents the strategy of **environmental cost leadership**. Its competitive focus lies upon *products and services* and is "certainly a tough call for most". With regard to AWPs, Lieb and Lieb (2010) suggest that collaborations can provide knowledge, data access, experience and network effects. In comparison to the eco-efficiency strategy, this can reduce costs and the environmental impact of AWPs to an even greater extent. For example, cooperation programs can be used to recycle and reuse materials along the entire supply chain. These environmental partnerships make it also possible to shape public policy through collective power. Moreover, with the development of new green technologies, substantial costs can be reduced in the long run, and unique competitive advantages can be generated, which in the future might also enable AWPs to move to new market spaces.

The framework of Orsato (2006) combined with the elaborated practices for AWPs is a powerful tool for executives to prioritize investments and further to identify and develop necessary competencies (e.g. lean warehousing, innovation management, green behavior, brand management). Starting from this, future research could examine the strategies in other segments such as parcel services or FTL transportation based on case studies. Furthermore, the performance of each strategy should be examined with the help of surveys to verify whether each of the four strategies actually could lead to competitive advantages in the logistics service industry. Based on that, a comparison of the industry segments as well as an examination of cultural differences via a cross-country study is promising.

Sustainable value creation through information technology-enabled supply chains in emerging markets

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Abstract While the impact of Information and Communication Technology (ICT) on logistics and Supply Chain Management (SCM) is recently much discussed, this is hardly linked to emerging economies and Base of the Pyramid (BoP) settings. The paper aims to analyse how ICT enables sustainable value creation in emerging economy Supply Chains (SCs). Objectives of the paper will be reached by deducting explanations from existing constructs from the field of (Sustainable) Supply Chain Management (SSCM), ICT, and BoP markets to empirical findings. Six elements enabling sustainable value creation are identified. (1) SC flows serve as a starting and reference point at which the ICT's influence occurs. (2) BoP challenges represent environmental conditions driving and harming sustainable value creation. (3) ICT services affect SC flows when being adapted to external constraints. Thereby, they counteract BoP challenges and fulfil yet unmet needs. This is operationalised in (4) e-business transactions and (5) SSCM behaviours which serve as sources of value creation.

As an outcome (6) sustainable value can be reached while local conditions are considered.

Applying a case study approach, semi-structured interviews conducted with providers and business users of Mobile Financial Services (MFS) in Pakistan and Sub-Saharan Africa will provide empirical insights into the theoretical framework. Data collection has just started, and findings are expected to provide insights on how ICT can be a promising way of overcoming challenges of informal market environments while enabling new ways of transaction and more sustainable SC operations.

The breadth of issues covered might make it challenging to address all of this in a single empirical study. Consequently, this case study provides a foundation for developing more in-depth empirical research.

As a practical implication, this research tries to explain sources of sustainable value creation, which should enable companies and related actors in BoP contexts to develop solutions for implementing SC-related measures driving e-business value creation and more sustainable SC behaviours.

Bringing empirical research and conceptual frameworks together, this paper offers insights into ICT applications in BoP SCs. Linking SCM, ICT, and BoP to each other is a novel contribution. Giving its wider implications for the future development of emerging economies the topic should receive far more attention.

Dynamic Reverse Network Planning for Used Electric Vehicle Traction Batteries in Germany

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Abstract The ongoing market and technological transformation from internal-combustion engines (ICEs) to battery electric vehicles (BEVs) is seen as one step to decarbonize the transportation sector. The establishment and development of efficient take-back and treatment networks is essential to achieve an overall high sustainability of BEVs as they are necessary to close resource and product loops in a circular economy.

In Germany, due to the growing number of registrations of electric vehicles (KBA 2020), an increasing market for used traction battery systems (BSs) is expected, delayed by their use in vehicles. If a BS reaches its End-Of-Life (EoL) together with the BEV, the dismantling will often take place at an EoL vehicle dismantler as it is common today for ICEs. Other collection points can be BEV workshops if replacements of BSs have to be performed.

The from vehicles dismantled BSs are expected to have a remaining energy storage capacity of 70-80% and must be treated under high-voltage working requirements. Consequently, the following disassembling of BSs into its components such as battery modules or cells, cables and battery casing will regularly not be performed at the place where the battery is dismantled from the vehicle, but at a specialized battery disassembling facility. Such disassembling facilities may perform a manual or automated disassembling and can either include further recovery steps such as recycling or function as a hub where sorting and disassembling of different BSs is performed. The disassembled components are then transported to further recovery facilities.

All necessary transports, including collection from dismantling stations to disassembling facilities but also after disassembling to recovery sites, have to obey dangerous goods regulations.

Currently no commonly used take-back network for used BSs exists in Germany. Developing a corresponding reverse facility location and allocation model (FLAP) can be a way to optimize and analyze alternative reverse structures. FLAPs have been intensively addressed in research but only few authors have considered the EoL treatment of BEVs or their BSs in Germany.

Yükseltürk et al. (2021) present a FLAP model for locating recollection centers of BSs that minimizes the total transportation time of batteries and apply it to Germany.

They assume that the opening of one new recollection center takes place every ten years, but do not consider any kind of capacity restrictions for the recollection centers. Further recovery activities such as recycling are not included in the case study, and by minimizing solely the transportation distance, economic perspectives such as minimization of costs or maximization of profits are not considered.
Tadaros et al. (2020) developed a multi-layer reverse logistic network for BSs and applied it to Sweden. They consider transport cost and fix cost for establishing different types of handling centers such as inspection or recycling centers. A potential drawback is the equal and fixed maximum capacity of facilities.
To reflect a fast-involving reverse network structure, varying capacities among facilities and expanding capacities of facilities seems a promising option to model the dynamic market. We therefore present a reverse network FLAP with capacity expansions of facilitities as well as a two level reverse supply chain consisting of diasassembling centers and recycling facilities. It is applied to Germany as a case study. We further discuss which different reverse network structures may develop within the next years and what influence transport and logistics should have in the network development.

Pricing Decisions in a Two-Period Closed-Loop Supply Chain Game under Asymmetric Information and Uncertainty

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Abstract In times of climate change, growing scarcity of resources and rising competitive pressure on companies, the implementation of sustainability and cost-saving goals is becoming increasingly important. The analysis of so-called closed-loop supply chains (CLSC), in which return flows are considered in addition to the regular forward flows in the supply chain, is therefore gaining growing attention in research. In our contribution we consider returns of used products from the customer back to the manufacturer. These returns can then be used for remanufacturing in the production process. In practice, the incentives to integrate such return flows are manifold. On the one hand, considering reverse flows can offer advantages to the company by reducing costs in the production process. On the other hand, remanufacturing can also be an instrument to respond to the increasing customer demand for green products. However, also legislation or demands from stakeholders can lead to the necessity of integrating return flows into the supply chain. For example, as described in the German Closed Substance Cycle and Waste Management Act, product and waste responsibility is devolved to the individual companies.

In our paper, we use a game-theoretic model to examine a simple closed-loop supply chain consisting of a manufacturer and a retailer. A two-period planning horizon is adopted. In contrast to the existing literature, we consider a novel setting in which both uncertainty and asymmetric information occur in the CLSC.

After the first selling season, the manufacturer offers to take back used products from the customers. When, as considered here, such returns occur for the first time, they may be associated with some uncertainty among the players. From the perspec- tive of the first period, prospective returns are unknown to both players and can only be estimated to a limited extent when taking future profits into consideration. At the beginning of the second period, when the returns are available to the manufacturer, it possibly would like to keep its information about the return rate for itself and use it as an advantage over the retailer. Assuming that returns affect the manufacturer's production costs, the retailer may set a price that is not optimal for the real situation by misjudging the return rate. For the retailer, information asymmetries can therefore result in a strategic disadvantage. Our contribution thus investigates how the presence of asymmetric information affects the pricing decisions of the players

within the closed-loop supply chain compared to the case of symmetric information. However, our analysis makes clear that private information does not always have to be advantageous for the manufacturer as well. It is decisive how the retailer estimates the customers' return rate. If the retailer overestimates returns, it expects the manufacturer to be able to reduce its manufacturing costs more than is actually the case. The retailer then sets a price that is too high, which the manufacturer suffers from. In the other case, if the retailer underestimates the returns, it sets a lower price, so that the manufacturer benefits from private information here compared to the symmetric information case.

Hence, we observe that the manufacturer would take advantage from being able to make the retailer believe that the return rate was low. It always has an incentive to report the lowest possible return rate to the manufacturer, even though it may not have observed it that way. Knowing this, the retailer cannot believe the manufacturer's reports and distrusts it. As a result, without binding contracts, the case of symmetric information can never arise naturally. Then, inefficiencies might arise, putting the players in a worse position compared to the case of symmetric information.

Future research could therefore examine whether it is possible to design a meaningful contract between the two players, forcing the manufacturer to tell the truth in order to overcome those inefficiencies.

Reverse logistics challenges in the textile industry in the year 2035

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Abstract This paper presents three explorative scenarios for reverse logistics in the textile and apparel industry in Germany for the year 2035. The scenarios build upon six key factors which represent technological, legal, societal, and sustainable perspectives. Scenario "Sustainable policies" refers to companies in the textile and apparel industry changing their production philosophy towards sustainability and producer responsibility due to stricter legal recycling regulations. Scenario "Consumer awakening" assumes a rise in backward flows of recyclable apparel due to consumers demanding sustainable fashion and recycled apparel. The third scenario "Profit over humanity" is negative in its basic tone and describes a profit driven production philosophy where sustainable aspects such as recycling-oriented product development are not considered at all by society.

Abstracts

Supply Chain Risk Management

Towards resilient supply chain structures

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Abstract Disruptions pose a significant threat to supply chains, as their impact may have devastating consequences. As a result, the research in supply chain resilience has increased immensely over the last years. This growing research's particular focus is the kind of disruptions supply chains have to face and consequently what capabilities supply chains should inherit to be more resilient. This article focuses on the supply chain structure and investigates how resilience depends on it. Thus, a LR was conducted to identify the vulnerabilities the supply chain structure is exposed to and the strategies that exist to counteract these vulnerabilities and increase supply chain resilience. Findings show that vulnerabilities are manifold and that there is no strategy that in itself leads to supply chain resilience. It is especially crucial first to examine the supply chain structure, identify the specific vulnerabilities to the supply chain and subsequently choose an appropriate strategy.

Risk indicators and data analytics in supply chain risk monitoring

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Abstract This paper seeks to complement the supply chain risk monitoring literature by identifying analytics methods and the risk indicators being monitored for this purpose. This includes the underlying supply chain data used for short-term or even real-time monitoring of risks in supply chain risk management. A systematic literature review is carried out in order to identify risk types and underlying factors considered in the context of risk monitoring. Furthermore, the monitored risk indicators and the data analytics methods applied in their generation, monitoring or prediction, as well as the underlying risk data are examined. The identified works focus mainly on micro risks, where supply and transport risks are the most prevalent. A variety of risk indicators is found to be used including both, qualitative and quantitative, which are often used jointly. Identified data sources range from operational databases to IoT and sensor networks. Moreover, first approaches utilizing predictive analytics methods to anticipate risks are identified. The findings are used to derive promising research topics to further explore this largely underrepresented field within supply chain risk management and pave the way for data-driven risk monitoring.