4th Conference of the EURO Working Group on Sustainable Supply Chains

June 30 and July 1, 2023

FernUniversität in Hagen, Germany

EWG SUSTSC SUSTAINABLE SUPPLY CHAINS

EURO THE ASSOCIATION OF EUROPEAN OPERATIONAL RESEARCH SOCIETIES

GOR

FernUniversität in Hagen

Welcome

Dear participants,

On behalf of the Organizing and the Scientific Committee and the coordinators of the EURO Working Group on Sustainable Supply Chains, it is my great pleasure to welcome you to Hagen and to Germany for the 4th Conference of the EURO Working Group on Sustainable Supply Chains. During this conference, we will have the opportunity to attend and discuss presentations on state-of-the-art developments and current research challenges related to sustainable supply chain management. The presentations will cover both Operations Research methodologies and applications to sustainable supply chains.

After two successful on-site conferences in Aachen (2016) and Amsterdam (2018), the third conference in 2021 was hosted by the Operations and Logistics Research Group of the Centre of Management Studies, Instituto Superior Técnico, University of Lisbon. Due to the pandemic situation of Covid-19, the conference was not held in Lisbon. Instead, Ana Povoa and her team did an excellent job in organizing a very successful online conference. Fortunately, we will be able to meet in person again this year. We hope you will take the opportunity to meet old friends, make new contacts and strengthen your personal network in the field of sustainable supply chain management.

As is typical for our conferences, also this edition is preceded by a EURO PhD School on Sustainable Supply Chains, hosted on the campus at the FernUniversität in Hagen. The school provides an active forum for PhD students and early career researchers to deepen their knowledge in the application of Operations Research methods for sustainable supply chain management, especially from a multi-criteria and an interdisciplinary perspective. Many of the PhD School participants are also attending our conference. Some of them will present posters on their PhD projects during the conference and will be happy to receive your feedback.

I would like to thank EURO, the German OR Society (GOR), and the FernUniversität in Hagen for their financial support of the conference and the PhD School. In addition, I appreciate that the FernUniversität in Hagen has offered us administrative support and their facilities to host the conference.

I am very much looking forward to meeting you all and hope that you will enjoy the conference.

Karsten Kieckhäfer

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1 Practical information

1.1 WiFi

There are two possible ways to access WIFI at FernUniversität in Hagen. If you have the network "eduroam" at your home university, you can simply use it here as well. If you can't access eduroam, please ask our team for free WiFi vouchers for "FU-Campus".

1.2 Locations

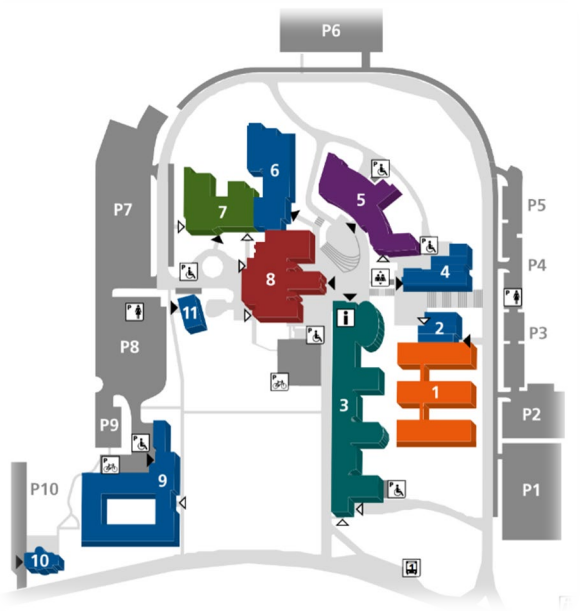
FernUniversität- Hagen

Conference:

Seminar Building (Building 2), Rooms 1–6

Universitätsstr. 47

58097 Hagen, Germany



Neue Färberei

Get together, June 29, 2023:

Dödterstraße 10

58095 Hagen, Germany

Villa Bechem (Building 10, on campus)

Conference Dinner, June 30, 2023:

Feithstraße 152

58097 Hagen, Germany

For a digital version of the campus map, please visit this website or use the QR code: https://e.feu.de/1du

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1.3 Travel information

By car, you can reach the campus quickly via the Autobahn A45. The nearest airports are Düsseldorf or Cologne/Bonn, which are about an hour away, or Dortmund, which is 40 minutes away.

Unfortunately, there is no direct train connection from the airports to the city of Hagen. Arriving at Düsseldorf airport, you have to switch lanes for example in Düsseldorf or Bochum. Arriving at Cologne/Bonn airport, you have to switch lanes in Cologne Messe/Deutz. Arriving at Dortmund airport, you have to switch lanes in Dortmund Holzwickede.

From Hagen main station, you can take the bus lane 514 or 515 directly to FernUniversität, it takes around 20 minutes. The CampusHotel can be reached in the same way, it is located directly across the street from the FernUniversität. The Mercure Hotel can be reached by bus lanes 518, 519 and 527 from Hagen main station, it takes about 20 minutes. To get to FernUniversität from Mercure Hotel, you can take bus lane 527, which also takes about 20 minutes.

To get from Hagen main station to the "Neue Färberei" on Thursday, June 29, you can take the bus lines 512 as well as 511 and 517. From FernUniversität and Campushotel you should take the bus lanes 515, 527 or 540 to reach the "Neue Färberei" within 30 minutes. The Mercure Hotel is within walking distance of the "Neue Färberei".

The Villa Bechem, the location of the Conference Dinner, is on campus and within walking distance of the Seminar Building.

To plan your journey via train or bus in and around Hagen, you can use the homepage or app of VRR: https://www.vrr.de/en/homepage/. You can also use this app to buy a ticket for public transportation in Hagen. If you plan to stay in the city of Hagen and not visit other cities, a ticket for "Preisstufe A" will be sufficient. If you don't want to use the app, you can also buy tickets when you get on the bus (cash only) or at one of the ticket machines at Hagen main station.

For long-distance transportation in Germany check out Deutsche Bahn: https://www.bahn.com/en. If you are coming to Hagen by "ICE" or "IC" you may already have a "City-Ticket", which is often included when traveling longer distances with Deutsche Bahn. Therefore, you would not need to purchase an additional ticket to get to your Hotel or the campus on that particular day. For more information, please visit Deutsche Bahn website: https://www.bahn.com/en/offers/tickets-for-local-transport.

2 Schedule

June 30

Start	Duration	End	Subject	
09:15	00:15	09:30	**Opening** **Rooms 1–3, Chair: Karsten Kieckhäfer**	
09:30	00:45	10:15	**Keynote: The opportunities of the Circular Economy in the wider Rhine-Ruhr region *(Carsten Gerhardt & Andreas Mucke)*** **Rooms 1–3, Chair: Karsten Kieckhäfer**	
10:15	00:30	10:45	**Coffee Break + Posters** **Foyer Seminar Building**	
10:45	01:15	12:00	**Sustainable Supply Chain Design** **Parallel Session 1, Rooms 1–3, Chair: Bruna Mota**	**Sustainable Decision Making Under Uncertainty** **Parallel Session 2, Rooms 4+5, Chair: Stefan Kupfer**
			Optimal design of socially sustainable supply chains through activity analysis and social life cycle assessment *(Lea Franze)*	The environmental impact of switching from deterministic to stochastic modeling in sales & operations planning under uncertainty *(Thorsten Greil)*
			Green hydrogen supply chain network design for sustainable aviation *(Christian Thies)*	Managing payment flexibility in rent-to-own contracts for off-grid energy products *(Jose A. Guajardo)*
			Optimizing sustainable supply chain design and planning with industrial symbiosis: An approach for a fair allocation of costs and benefits *(Rui Alexandre Boavida Afonso de Freitas Dias)*	Queuing joining strategies to control air pollution *(Yael Perlman)*
12:00	00:30	12:30	**Poster Pitch** **Rooms 1–3, Chair: Karsten Kieckhäfer**	
12:30	01:00	13:30	**Lunch + Posters** **Foyer Seminar Building**	
13:30	01:40	15:10	**Food Logistics and Distribution of Perishables** **Parallel Session 3, Rooms 1–3, Chair: Renzo Akkerman**	**Assessment of Sustainability and Resilience in Supply Chains** **Parallel Session 4, Rooms 4+5, Chair: Christian Thies**
			Mobile Deconsolidation Points: A lever for sustainable distribution of perishable goods? (*Michaela Thulke*)	Sustainability of the archimedean drum screen clean-up technology in aquatic ecosystems: A comparative supply chain analysis *(Patricia Rogetzer)*
			Inventory dynamics at the retailer: An economic and environmental analysis of packaging fresh produce (*Marjolein Buisman*)	Measuring sustainability in agri-food supply chains: The role of key performance indicators *(Mafalda Ivo de Carvalho)*
			Quantifying the potential to reduce food waste and increase freshness in a two-echelon divergent single product supply chain *(Rob Broekmeulen)*	Review of metrics to assess resilience capacities and actions for supply chain resilience *(Lukas Meßmann)*
			Enabling sustainable logistics operations to provide more local food in restaurants *(Christian Fikar)*	Assessing the sustainability of supply chain by means of network-DEA: Review and application *(Steffen Hoffmann)*
15:10	00:30	15:40	**Coffee Break + Posters** **Foyer Seminar Building**	
15:40	01:40	17:20	**Multi Objective Supply Chain Design** **Parallel Session 5, Rooms 1–3, Chair: Ana Barbosa-Povoa**	**Repair and Reverse Logistics** **Parallel Session 6, Rooms 4+5, Chair: Rainer Kleber**
			Bi-objective optimization of biomass-to-biofuel supply chains with mobile processing facilities *(Fragkoulis Psathas)*	How can repairers improve their service? Consumer perspective on operational aspects of repair services *(Gernot Lechner)*
			Reducing water consumption with food supply chain design and planning *(Bruna Mota)*	The influence of repair funding programs on consumers' repair decision: Investigating motives for (not) using a repair funding *(Iris Sara Etzinger)*
			Renewable fuel supply chain network design and sustainability: A multi-objective optimization approach *(Mina Farajiamiri)*	Analyzing different implementaons of a funding scheme for encouraging repair *(Marc Reimann)*
			Symbiotic supply chains planning *(Vânia Veloso)*	Optimising the reverse supply network design of end-oflife wind turbine blades under various policy scenarios *(Andrea Tuni)*
19:00	03:30	22:30	**Conference Dinner** **Villa Bechem, Faculty Club, Feithstraße 152 (on campus)**	

July 1

Start	Duration	End	Subject	
09:00	00:45	09:45	**Keynote: Supporting decisions that matter: Assisting Brazilian smallholder farmers to access institutional markets *(Athanasios Rentizelas)*** **Rooms 1–3, Chair: Karsten Kieckhäfer**	
09:45	00:45	10:30	**Jacqueline Bloemhof PhD Thesis Award** **Rooms 1–3, Chair: Renzo Akkerman**	
10:30	00:30	11:00	**Coffee Break + Posters** **Foyer Seminar Building**	
11:00	01:40	12:40	**Session 7: Material Flow Analysis and Closed-Loop Supply Chains** **Parallel Session 7, Rooms 1–3, Chair: Marc Reimann**	**Session 8: Supporting Selection Decisions Towards Sustainability** **Parallel Session 7, Rooms 4+5, Chair: Patricia Rogetzer**
			Sustainable supply chains in the construction industry: A material flow analysis in the Ruhr region *(Pauline Jegen)*	IoT-based temperature monitoring in fresh fruit and vegetable supply chains: stakeholders' perspectives and requirements *(Anna Lamberty)*
			An integrative and prospective approach to material flow analysis: The transformation to hydrogen-based direct reduction of the North Rhine-Westphalian steel industry *(Rainer Radloff)*	Green criterian for supplier selection in the turkish food industry *(Kazim Sari)*
			Closed-loop production planning incorporating eco-efficiency using the example of circular battery production in Europe *(Christian Scheller)*	Intelligent assembly methods: A model to support decision-makers towards more sustainable manufacturing *(Andrea Mencaroni)*
			Determining the influencing factors for operational disposition decisions in closed-loop supply chains *(Sabrina Rinder)*	
12:40	00:50	13:30	**Closing, Farewell, and Lunch** **Rooms 1–3, Chair: Karsten Kieckhäfer**	

3 Poster Session

In the week leading up to our conference, the EURO PhD School on Sustainable Supply Chains was organized on campus at the FernUniversität Hagen. Several of the presentations scheduled at this conference are also held by PhD students that attended the PhD School. In addition, some of the participants prepared poster presentations, which will be briefly pitched as part of the conference program. Below, an overview of the poster details can be found.

Poster 1

Socially Sustainable Design of Supply Chains

Lea Franze and Karsten Kieckhäfer

FernUniversität in Hagen

Poster 2

Life Cycle Assessment of End-of-Life Scenarios for Polyactic Acid

Emine Nil Güreli, Jörn-Christian Meyer, and Grit Walther

RWTH Aachen University

Poster 3

From Linear to Circular: A multiple case study of the electronics industry in the Netherlands

Meihui Jiang, Dr. Stef Lemmens, Dr. Koen Dittrich, and Prof. Rob Zuidwijk

Rotterdam School of Management, Erasmus University

Poster 4

Multi Agent reinforcement learning and graph neural networks for inventory management

Niki Kotecha and Antonio del Rio Chanona

Department of Chemical Engineering, Imperial College London

Poster 5

A non-parametric model for a constrained retail assortment optimization problem

Davide Merolla, Alessio Trivella, and Carlo Meloni

Sapienza Universita di Roma

Poster 6

Reducing waste via crop valorisation – An optimisation approach to redesign agri-food supply chains

Marloes Remijnse, Ahmadreza Marandi, Sonja Rohmer, and Tom van Woensel

Eindhoven University of Technology

4 Collection of Abstracts

Boavida-Dias, R.; Mota, B.; Barbosa-Povoa, A. P. (2023): Optimizing Sustainable Supply Chain Design and Planning with Industrial Symbiosis: An Approach for a Fair Allocation of Costs and Benefits

Broekmeulen, R.A.C.M.; van Donselaar, K.H. (2019): Quantifying the Potential to Improve on Food Waste, Freshness and Sales for Perishables in Supermarkets. International Journal of Production Economics, 209, 265-273.

Bruckler, M.; Wietschel, L.; Messmann, L.; Thorenz, A., Tuma, A. (2023): Review of Metrics to Assess Resilience Capacities and Actions for Supply Chain Resilience

Buisman, M.; Rohmer, S. (2023): Inventory Dynamics at the Retailer: An Economic and Environmental Analysis of Packaging Fresh Produce

Dalay, M.; Sari, K. (2023): Green Criterian for Supplier Selection in the Turkish Food Industry

Etzinger, I.; Reimann, M. (2023): The Influence of Repair Funding Programs on Consumers' Repair Decision: Investigating Motives for (not) Using a Repair Funding

Farajiamiri, M.; Meyer, J.-C.; Walther, G. (2023): Renewable Fuel Supply Chain Network Design and Sustainability: A Multi-Objective Optimization Approach

Ferreira, I.; Messmann, L.; Mota, B. (2023): Reducing water consumption with food supply chain design and planning

Fikar, C. (2023): Enabling Sustainable Logistics Operations to Provide More Local Food in Restaurants

Franze, L.; Kieckhäfer, K. (2023): Optimal Design of Socially Sustainable Supply Chains through Activity Analysis and Social Life Cycle Assessment

Greil, T.; Grunow, M. (2023): The Environmental Impact of Switching from Deterministic to Stochastic Modeling in Sales & Operations Planning under Uncertainty

Guajardo, J. A.; Rashidinejad, E.; Romero G., Zaman H. (2023): Managing Payment Flexibility in Rent-to-Own Contracts for Off-Grid Energy Products

Hoffmann, S.; Kleine, A. (2023): Assessing the Sustainability of Supply Chain by Means of Network-DEA: Review and Application

Ivo de Carvalho; M., Veloso, V.; Carvalho, A.; Relvas, S.; Barbosa-Povoa Ana P. (2023): Measuring Sustainability in Agri-Food Supply Chains: The Role of Key Performance Indicators

Jegen, P. (2023): Sustainable Supply Chains in the Construction Industry: A Material Flow Analysis in the Ruhr Region

Lamberty, A (2023): IoT-Based Temperature Monitoring in Fresh Fruit and Vegetable Supply Chains: Stakeholders' Perspectives and Requirements

Lechner, G.; Kraßnig, V.; Güsser-Fachbach, I. (2023): How Can Repairers Improve their Service? Consumer Perspective on Operational Aspects of Repair Services

Mencaroni, A.; Claeys, D.; Raa, B.; De Vuyst, S. (2023): Intelligent Assembly Methods: A Model to Support Decision-Makers towards more Sustainable Manufacturing

Perlman, Y. (2023): Queuing Joining Strategies to Control Air Pollution

Psathas, F.; Rentizelas, A., Georgiou, P. (2023): Bi-Objective Optimization of Biomass-to-Biofuel Supply Chains with Mobile Processing Facilities

Radloff, R.; Abdelshafy, A.; Walther, G. (2023): An Integrative and Prospective Approach to Material Flow Analysis: The Transformation to Hydrogen-Based Direct Reduction of the North Rhine-Westphalian Steel Industry

Reimann, M. (2023): Analyzing Different Implementations of a Funding Scheme for Encouraging Repair

Rinder, S.; Kraßnig, V.; Lechner, G.; Reimann, M. (2023): Determining the Influencing Factors for Operational Disposition Decisions in Closed-Loop Supply Chains

Rogetzer, P. (2023): Sustainability of the Archimedean Drum Screen Clean-Up Technology in Aquatic Ecosystems: A Comparative Supply Chain Analysis

Scheller, C.; Spengler, T. S. (2023): Closed-Loop Production Planning Incorporating Eco-Efficiency Using the Example of Circular Battery Production in Europe

Thies, C.; Ögruk, A. (2023): Green Hydrogen Supply Chain Network Design for Sustainable Aviation

Thulke, M.; Volling, T.; Kieckhäfer, K. (2023): Mobile Deconsolidation Points: A Lever for Sustainable Distribution of Perishable Goods

Trivyza, N. L.; Tuni, A.; Rentizelas, A. (2023): Optimising the Reverse Supply Network Design of End-of Life Wind Turbine Blades under various Policy Scenarios

Vania, V.; Guadalupe Pinto, M.; Mota, B.; Carvalho, A.; Paula Barbosa-Povoa, A. (2023): Symbiotic Supply Chains Planning

Optimizing Sustainable Supply Chain Design and Planning with Industrial Symbiosis: An Approach for a Fair Allocation of Costs and Benefits

Rui Boavida-Dias[1], Bruna Mota [1], Ana Paula Barbosa-Povoa[1]

[1] CEGIST - Instituto Superior Técnico; diasruipt2@gmail.com

Abstract:

This work explores the design and planning of symbiotic supply chains where the exchange of by-products and Industrial Symbiosis (IS) relations are pursued. An optimisation model is developed to facilitate such decisions, aiming to minimise the total cost and the environmental impact. By exchanging by-products with other firms in an IS network, a focal firm substitutes virgin materials and avoids waste disposal. A game-theoretic approach is utilized to cooperatively allocate costs and benefits between participants in the IS network.

The model optimises decisions concerning raw material procurement, primary product production and inventory control, by-product exchanges with the focal firm (either as origin and/or destination), and waste disposal. For the by-product exchanges to occur, an incentive framework is built within the model: i) The focal firm (manufacturer) has an excess of by-product, that if not exchanged, needs to be disposed of; ii) A feasible match exists between a by-product and material to be substituted; iii) The cost of treating the by-product is greater than the costs of the IS transaction (transportation, and treatment); iv) The cost of supplying the raw materials is greater than the costs associated with the IS transaction. A representative case study is presented to validate the model.

This study aims to bridge two areas that have been explored separately, namely supply chain network and IS decisions (Castiglione and Alfieri, 2019; Turken and Geda, 2020). By integrating these two areas and intrinsically considering a fair allocation of costs/benefits among participants, the proposed approach provides a more comprehensive solution to designing and planning symbiotic supply chains that promote IS.

Quantifying the Potential to Improve on Food Waste, Freshness and Sales for Perishables in Supermarkets

Rob Broekmeulen[1], Karel van Donselaar[1]

[1] Technische Universiteit Eindhoven; R.A.C.M.Broekmeulen@tue.nl

Abstract:

Our study investigates allocation strategies at a retailer warehouse that replenishes a multi-period perishable product in case packs to a set of different stores that face stochastic demand. The objective of the retail chain is to reduce food waste and increase freshness, while maintaining an agreed service level in the stores. Since the warehouse has a high service level target for replenishing the stores, it has to keep safety stock, which results in batches with different ages at the warehouse. We showed in a previous study that the waste at the stores can be significantly reduced by unpacking the case packs at the warehouse and/or increasing the remaining shelf life, especially for stores with a low demand. Unpacking at the warehouse allows the stores to order in smaller quantities, but this increases the order picking costs for the warehouse. We quantified in our new research the potential improvements of allocating only a fraction of the stores with unpacked and/or fresher products to limit the additional supply chain costs resulting from applying these strategies.

Review of Metrics to Assess Resilience Capacities and Actions for Supply Chain Resilience

Martin Bruckler[1], Lars Wietschel[1], Lukas Messmann[1], Andrea Thorenz[1], Axel Tuma[1]

[1] Resource Lab, Center for Climate Resilience, University of Augsburg, Germany; lukas.messmann@wiwi.uni-augsburg.de

Abstract:

Efficiency and profitability are the main drivers of globalization and have led to long and complex supply chains. Recent disturbances such as Covid-19 or the Suez Canal obstruction led to severe supply disruptions and thereby unveiled the vulnerability of global trade. Resilient supply chains are characterized by the capacity to absorb, adapt to, and restore after disruptions. Building upon the established concept of the 'resilience curve', this article explores the interplay between resilience capacities, metrics, and actions in the state-of-the-art literature. We first analyze and harmonize the terminology used to describe capacities as well as the metrics employed to quantify resilience. This results in a set of 17 resilience metrics that describe all characteristics of the resilience curve and can be used to assess the resilience of a supply chain. Subsequently, we propose how these metrics can be applied to quantify the effect of resilience actions. Finally, we analyze which actions are proposed in the literature and classify them according to their relation to traditional supply chain planning tasks. Supply chain decision-makers can implement these actions to strengthen the absorptive, adaptive, and restorative capacities and are provided with guidance on how the strengthening effect of the actions can practically by quantified. Academic researchers can, inter alia, integrate the metrics into multicriteria optimization models and explore the interplay between economic efficiency, environmental and social sustainability, and resilience. In light of climate change and geopolitical tensions, organizations should take anticipatory actions to strengthen their capacities to deal with unforeseen disturbances.

Inventory Dynamics at the Retailer: An Economic and Environmental Analysis of Packaging Fresh Produce

Marjolein Buisman[1], Sonja Rohmer[2]

[1]Otto Beisheim School of Management; Marjolein.Buisman@whu.edu

[2]HEC Montreal

Abstract:

The use of packaging materials for food products and the associated environmental impact has received increasing attention in public discourse over recent years. At the same time, packaging solutions provide functional properties that help to preserve fresh produce and protect food from external damage. Given these trade-offs, it can be very challenging for retailers to make the right decisions, lowering their environmental impact. This is further complicated by the complex nature of inventory dynamics in the case of perishable products, as multiple factors can impact food waste and the environmental impact at the retailer. This research proposes a simulation model to investigate the effect of packaging as well as a variety of other factors on profit, waste and the environmental impact of products. For this purpose, the environmental impacts of three different products and their corresponding packaging solutions were quantified using a life cycle approach, and a number of experiments considering different demand patterns, service level requirements, batch sizes and order policies were carried out. The findings of this research are manifold, highlighting the importance of considering inventory and packaging decisions within an integrated framework. Moreover, while the shelf life extension obtained from the use of packaging has clear economic benefits due to the resulting lower waste levels, the environmental impact varies depending on the considered products, packaging material and environmental indicator.

Green Criterian for Supplier Selection in the Turkish Food Industry

Mustafa Dalay[1], Kazim Sari[1]

[1] Istanbul Beykent University, Department of Industrial Engineering, Turkey; kazims@beykent.edu.tr

Abstract:

Today, social environmental awareness and the sensitivity of companies to the environment have increased significantly. This has allowed the green criterion to take its place in the supplier selection process, as well as traditional criteria such as price and quality. However, it has not been clearly revealed whether or how much importance is given to the green criterion in the supplier selection process, especially for companies in developing countries. For this purpose, the opinions of 50 managers operating in the Turkish food sector were taken and it was investigated how much importance the companies gave to the green criterion in the selection process. Within the scope of the research, multi-criteria decision-making methods were used. The results obtained showed that contrary to our expectations, Turkish food industry companies attach less importance to the green criterion than the other criteria.

The Influence of Repair Funding Programs on Consumers' Repair Decision: Investigating Motives for (not) Using a Repair Funding

Iris Etzinger[1]; Marc Reimann[1]

[1] University of Graz, Institute of Operations and Information Systems; iris.etzinger@uni-graz.at

Abstract:

Repair plays an integral role in the establishment of a circular economy, as it allows a product to be restored to working condition, thus extending its useful life and increasing the intensity of use. However, repair services are not yet widespread. One of the main barriers for consumers are the high repair costs, especially relative to the price of new products, which are the reason for almost 80% of the cases where repairs are not carried out. Repair funding programs are a possible leverage to specifically target this barrier and to promote repair. Since consumers make the final decision to repair or not, they play a significant role in whether a repair funding program actually leads to an increased repair quota. Increasing the repair quota means increasing the number of people who repair as well as the number of repairs per person. Repair funding is thus intended to reach different consumer groups. Therefore, it is necessary to understand the motives, behavior and perceptions related to repair funding programs of the different consumer groups, namely those who already repair and those who do not repair yet. We use semi-structured in-depth interviews with Austrians to investigate (1) what motives consumers have for (not) making use of a repair funding program and (2) what influence a repair funding program has on consumers' repair decision. The study is still ongoing, but we plan to present preliminary results at the conference, focusing on consumers' motives and the potential differences between different groups of consumers.

Renewable Fuel Supply Chain Network Design and Sustainability: A Multi-Objective Optimization Approach

Mina Farajiamiri[1], Jörn-Christian Meyer[1], Grit Walther[1]

[1] Chair of Operations Management, School of Business and Economics, RWTH Aachen University; mina.amiri@om.rwth-aachen.de

Abstract:

Renewable fuels provide a pragmatic alternative to fossil fuels in the transportation sector, helping to achieve net zero emissions by 2050. The controversies surrounding this issue must, however, be considered. Land and water use are among the significant environmental concerns associated with renewable energy development. The purpose of this study is to examine the use of land and water for the extension of renewable resources. To determine the optimal renewable fuel supply chain design for the EU's future alternative fuel demand in the transportation sector, we develop a multi-objective mathematical model. In this paper, we propose a flexible multi-period and multi-stage supply chain that can accommodate multiple feedstocks and multiple products while considering seasonality. We consider economics and environmental impacts by minimizing total system costs, land use, and water use by renewable resources. We use the augmented epsilon constraint method to solve the proposed model providing strongly efficient Pareto optimal sets. Using the results to analyze conflicting objective functions, trade-offs, opportunities, and synergies, we can assist decision-makers in choosing a framework and gaining a better understanding of the future. No single solution can minimize all three performance criteria simultaneously, according to the results. Despite biomass not being a desirable option to conserve water and land, the outcome shows that it has economic value. The results indicate that renewable electricity sources might be the bottleneck in such a supply chain, requiring investments.

Reducing water consumption with food supply chain design and planning

Inês Ferreira[1], Lukas Messmann[2], Bruna Mota[1]

[1]Centre for Management Studies of Instituto Superior Técnico (CEGIST), University of Lisbon, Av. Rovisco Pais, 1049-101 Lisbon, Portugal; bruna.mota@tecnico.ulisboa.pt

[2]Resource Lab, Center for Climate Resilience, University of Augsburg, Universitaetsstr. 12, 86159 Augsburg, Germany

Abstract:

With increasing environmental sustainability concerns, food companies seek to provide healthier and more sustainable products to their clients. However, this often entails conflicting objectives. Agriculture accounts for a significant percentage of global water consumption, and food loss throughout the supply chain further exacerbates water usage. To address these challenges, this work presents a decision support tool based on a multi-objective mixed integer linear programming model for supply chain design and planning, with a focus on food waste and water consumption.

The proposed model considers the entire supply chain, from crop cultivation to market distribution, while accounting for the water stress of each region where supply chain activities occur, and the water use efficiency of production facilities. Key decisions include supplier selection, supply and production planning, product mix definition, and production facility location and allocation. The primary objectives are to minimize water consumption using a life cycle assessment (LCA) based approach that considers water used in various supply chain activities and food waste, while maximizing economic performance.

By employing this multi-objective optimization model, organizations can better assess the impact of different strategies on water consumption and food waste, enabling more informed decisions about sustainable supply chain management. Through the exploration of various trade-offs between water usage and economic performance, food companies can effectively design and plan supply chains that prioritize environmental sustainability while maintaining profitability. This research ultimately aims to contribute to the development of more sustainable food supply chains and promote responsible water usage in the food industry.

Enabling Sustainable Logistics Operations to Provide More Local Food in Restaurants

Christian Fikar[1]

[1]Chair of Food Supply Chain Management, University of Bayreuth; Christian.Fikar@uni-bayreuth.de

Abstract:

This talk provides insights into the development of a model-driven decision support system to facilitate more sustainable logistics operations for local food deliveries to restaurants. In close cooperation with two real-world initiatives in Bavaria, Germany, a simulation and optimization-based decision support system is developed. It allows one to compare various strategies on how to ship food from local farmers to restaurants. Direct deliveries by farmers, pickups by restaurant operators as well as the employment of a third-party logistics provider are included. Additionally, the option of implementing a food hub to consolidate shipments is considered. The focus is set on fresh fruits and vegetables as well as on facilitating both horizontal and vertical cooperation along the supply chain. At the core of the decision support system stands an agent-based simulation to model demand and business relations over time. It is supported by food quality models to estimate spoilage and metaheuristic vehicle routing solution procedures to optimize delivery tours. The various shipment options are evaluated based on the resulting travel distances, impacts on food spoilage and transport-related emissions. First results highlight the great need for better logistics cooperation between farmers and restaurant operators to provide more local food in restaurants in the future.

Optimal Design of Socially Sustainable Supply Chains through Activity Analysis and Social Life Cycle Assessment

Lea Franze[1], Karsten Kieckhäfer[1]

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Abstract:

Driven by due diligence requirements, compliance with social standards is becoming increasingly important in the design of global supply chains. However, due to the often qualitative and subjective nature of the data, social sustainability is rarely examined in the current supply chain design research or often approached in an oversimplified manner. We address this gap by developing a novel network planning approach that incorporates social life cycle assessment, activity analysis, and mixed-integer linear programming. Based on social life cycle assessment, social impacts at each level of a supply chain are computed as medium risk hours associated with a specific process at a specific geographic location. Activity vectors, representing the relevant inputs and outputs of each process from a techno-economic and social perspective, are then derived. The optimization model determines the activity level of each activity, i.e., whether and to what extent a process is used at a specific location. The activity levels are constrained by capacity limits of the locations, which can be adjusted by deciding on capacity expansions. While we consider a cost minimizing economic objective function, the acceptable level of social risk is limited to maximum values for medium risk hours. The approach is applied to raw material extraction and processing in the supply chain of lithium-ion batteries for electric vehicles. The analyses show trade-offs between costs and social impacts, particularly in cobalt mining, where investments in additional mining capacity in Australia and Canada can reduce the social risks associated with cobalt from the Democratic Republic of Congo.

The Environmental Impact of Switching from Deterministic to Stochastic Modeling in Sales & Operations Planning under Uncertainty

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Abstract:

Companies today still employ deterministic methodologies in most of their supply chain planning processes. However, the same companies increasingly express their interest in advanced planning functionality to better handle uncertainty (e.g. probabilistic planning). We reason that adopting such more complex planning approaches might create differing environmental effects – either benefit or harm. Therefore, we investigate a sequential decisionmaking setting for Sales & Operations Planning in which a profit-maximizing firm switches from a deterministic to a stochastic approach. We model the deterministic status quo as a linear program with exogenously defined safety stock – similar to how this part of the Sales & Operations Planning process is carried out in practice. The stochastic approach is modeled as a Markov Decision Process to capitalize on incorporating the value of replanning under uncertainty. For larger instance sizes, we implement a Reinforcement Leaning approximation to obtain a solution. We then compare the policies in a simulator setting – both regarding achieved profit and the associated profit-oriented environmental impact. The environmental impact is merely determined (i.e. not optimized or constrained) to illustrate the worst possible situation in practice at companies today. We argue that the relative difference in environmental impact can greatly deviate from relative change in profit between the two approaches. Thus, switching to stochastic policies might increase profit only slightly but lead to a disproportionally lower (or higher) environmental impact. We furthermore investigate how the revealed forecast data (i.e. the approaches' input) and the variability of the underlying stochastic process itself can affect the environmental impact.

Managing Payment Flexibility in Rent-to-Own Contracts for Off-Grid Energy Products

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Abstract:

The diffusion of technological innovations in developing economies has been facilitated by the use of rent-to-own business models, which give flexibility to customers by allowing them to make incremental payments over time. Understanding the implications of this flexibility is a fundamental revenue management problem for an increasing number of firms operating in these markets. In this research, we study consumer behavior and firm decision-making in the design of Rent-to-Own contracts for the distribution of off-grid energy products in developing economies. We use a dynamic programming model to examine how different contract designs affect consumer behavior and firm performance under uncertainty. We characterize the impact of payment flexibility and its effect on repayment performance and consumer behavior based on an application of Rent-to-Own to the distribution of solar lamps in developing countries, as well as more generally analyze the drivers and impact of payment flexibility for firms operating in these environments.

Assessing the Sustainability of Supply Chain by Means of Network-DEA: Review and Application

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Abstract:

The decomposition of processes into sub-processes and sub-steps provides valuable insights to support decision-making and optimize the overall process operation. However, the evaluation method should be both objective and reliable and include multiple criteria in the evaluation. Data Envelopment Analysis (DEA) is a method for evaluating the efficiency and identifying best practices of organizations, departments or processes, for example. The specifics of the object under investigation can be explicitly considered in the modeling. In order to evaluate multi-level processes, such as supply chains, so-called Network-DEA approaches are receiving increasing attention. The paper provides an overview of network DEA and its relevance to supply chain assessment. Subsequently, the presentation focuses on the assessment of supply chain sustainability. For this purpose, the possibilities as well as the potentials and drawbacks of DEA are demonstrated by means of a practical example.

Measuring Sustainability in Agri-Food Supply Chains: The Role of Key Performance Indicators

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Abstract:

This work discusses the need for a shared and homogeneous method of measuring sustainable supply chain performance in the agri-food sector. Given the complexity and heterogeneity of agri-food supply chains (AFSC), pursuing sustainable management is challenging for the multiple intermediaries who must ensure food quality, safety and security while promoting sustainable management practices aligned with the SDGs. This work collects and characterizes a set of sustainability-related indicators specific to AFSC, paying attention to their characterization according to ISO 22400. A multimethodology approach is used. First, a content-based literature review is undertaken to identify the KPIs. This step builds on previous frameworks published on the topic. Afterwards, a multiple-case study method was chosen to validate the KPIs involving seven cases representing the AFSC. The results show that companies have different ways of measuring and defining the same indicator, which does not allow a reliable comparison. The low level of automation in data collection, the lack of reliable data and the lack of trust and transparency among practitioners are barriers to the assessment. The indicators proposed to provide AFSC stakeholders with a standard and knowledge-based view to pursue sustainability across the supply chain. Also, it is highlighted the importance of continuously improving and the expiation of the indicators set to capture dynamic, relevant aspects of sustainable supply chain performance in AFSC.

Sustainable Supply Chains in the Construction Industry: A Material Flow Analysis in the Ruhr Region

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Abstract:

The Ruhr region in Germany has undergone a significant urban transformation in recent decades, shifting from a dependence on mining and the steel industry to services, technology and knowledge. As a result, buildings and infrastructures have to be adapted to the changing needs of industry and society. The construction and demolition waste (CDW) generated by these changes can be recycled and used to produce new construction materials in the form of recycled aggregates e.g. for civil engineering or in order to produce RC-concrete for building construction. Especially in areas with short distances between demolition, recycling and construction sites, the use of recycled materials not only saves natural resources but also CO2 emissions by reducing transport emissions. Against this background, the potentials for promoting sustainability in the construction sector of the Ruhr area are investigated in this research by conducting material flow analyses. First, the supply chains are presented. Secondly, the study uses a bottom-up approach analyzing statistical data, technical and legal standards to determine the amount of CDW available in the Ruhr area and the demand for recycled materials. The aim is to assess material flows and quantify the impact of implementing sustainable value networks in the construction sector, taking into account factors such as energy consumption and CO2 emissions. Thirdly, different scenarios are considered. The scientific value of this research lies in its potential to support the transition to sustainable construction practices by using sustainable supply chains to implement circular economy approaches, thus contributing to climate change mitigation.

IoT-Based Temperature Monitoring in Fresh Fruit and Vegetable Supply Chains: Stakeholders' Perspectives and Requirements

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Abstract:

Food waste is a major problem, with losses being particularly high in fresh fruit and vegetables (F&V) [1,2]. These highly perishable products are strongly influenced by the supply chain conditions, especially by the ambient temperature [3]. Currently, temperature monitoring in F&V supply chains mostly relies on non-connected technologies [3], but recent developments in Internet-of-things (IoT)- based temperature monitoring show great potential to enhance cross-chain transparency [4]. This can lead to higher process control, optimized product qualities and facilitation of shelf-life based distribution planning [5], resulting in less rejections and thus, less food waste. However, technical challenges, but also the complexity and heterogeneity of international, multi-actor supply chains in the F&V sector hinder large-scale implementation. Therefore, the aim of this study was to investigate how current challenges and changes in the F&V sector influence the implementation of IoT-enabled temperature monitoring for less food waste and more sustainability. Guideline based expert interviews with 17 actors from different F&V supply chain stages were conducted. All actors are facing multiple challenges that impede their daily business. Among them, the need to save costs because of rising (energy) prices and the compensation for lacking personnel were the main drivers for automatization and digitalization. Although most actors were familiar with IoT-based temperature monitoring technology, the level of experience and interest was very different. Interestingly, the requirements on a cross-chain temperature monitoring and corresponding data exchange were quite similar across different supply chain stages. Particularly, the potential for supporting objective decision-making was emphasized, to reduce product rejections and optimize distribution planning, enhancing the sustainability of fresh F&V supply chains.

How Can Repairers Improve their Service? Consumer Perspective on Operational Aspects of Repair Services

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Abstract:

Repairing broken products is not yet preferred to replacing them with new ones. A major problem is that repair is typically perceived as too expensive, time-consuming and inconvenient. In order to change consumer behaviour and thus increase repair rates, repair must be an attractive option compared to buying new products. To achieve this, repair shops need to offer convenient services and continuously improve their processes. Our study aims to identify the most important operational aspects for (potential) consumers of repair services. First, operational aspects were compiled based on an extensive literature review, complemented by expert interviews. Then, the importance of these aspects from a consumer perspective was determined through a survey of more than 600 participants. We find that the most important items are related to information and economic aspects, as well as confidence-building measures and communication skills. Comparing the importance of the items in relation to different product options shows that the results are a general representation of the importance of operational aspects, independent of the specific product. The results of this study will help repairers to optimise their services and policy makers to identify promising entry points for effective policy measures to promote repair. As this is an ongoing research, we will also present ideas on how to improve the study through further approaches such as data-driven methods (e.g. exploratory factory analysis or cluster analysis) or analytical hierarchy process

Intelligent Assembly Methods: A Model to Support Decision-Makers towards more Sustainable Manufacturing

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Abstract:

High-technological products consist of several components, each with varying feature values that are critical to the quality of the assembly. Traditional manufacturing involves random selection of components, so strict tolerance ranges are set to contain their feature variability. Unfortunately, this increases scrap rates and inhibits circular manufacturing. By smartly combining components based on their measured features, selective and hybrid assembly allow for more relaxed tolerances without aecting the nal product's quality. However, these intelligent manufacturing methods involve additional costs due to inspection and sorting operations, which makes the choice for the best method not trivial. This study presents a decision-making model for choosing between traditional, selective, and hybrid assembly. After the denition of the corresponding cost functions, the model is formulated by analytically determining the optimal choice boundaries between the three methods based on the involved parameters. Estimation methods for the instance-specic process parameters are then discussed before validating the model with a fully elaborated case study. The results conrm the need for a quantitative framework to support an informed choice as this strongly depends on the involved parameter values. Overall, hybrid assembly showed superior resiliency towards parameter uctuations, making it a safer option when high levels of uncertainty aect operational parameters. This study aims to pave the way towards more sustainable manufacturing by supporting practitioners to identify the conditions whereby intelligent assembly methods, in addition to allowing for scrap reduction and circularity, also represent the most cost-eective choice.

Queuing Joining Strategies to Control Air Pollution

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Abstract:

A central measure of interest in queueing theory is waiting time. We introduce two additional performance measures related to the co-exposure of customers to each other while waiting in the system. Specifically we study the negative network effects that increase with the number of customers using the system or with the time spent with these customers. To the best of our knowledge, such negative effects and the disutility caused due to co-exposure have not been studied, even though such negative effects are common in reallife, for example damage caused due to air pollution. The implications of our model are of interest to queue managers who can set the optimal capacity of the system in order to reduce the rate of pollution.

Bi-Objective Optimization of Biomass-to-Biofuel Supply Chains with Mobile Processing Facilities

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Abstract:

The design of modern bioenergy supply chains is a multifaceted task requiring simultaneous consideration of productivity, profitability, and sustainability aspects. Biomass is characterized by uncertainty, seasonality, and geographical dispersion impeding strategic and tactical decision-making. Such multiparametric systems become even more challenging when sustainability is promoted as the conditio sine qua non for the effective planning and operation of a biomass-to-biofuel value chain. To facilitate decisions in such a complicated system, the present study introduces a bi-objective mixed integer linear programming model to optimize both the economic and environmental performance of a biomass-to-biofuel supply chain. A single-feedstock option is considered, while pyrolysis is chosen as the core conversion technology. The interesting feature about pyrolysis is that both large-scale stationary facilities which take advantage of economies of scale, and mobile units which provide a flexible and adaptable way of biomass conversion, can be used conjunctively in the production process. The ε-constraint method is used to solve this bi-objective optimization problem and investigate the trade-offs between the conflicting goals of economic performance and environmental sustainability, expressed as CO2eq emissions. The model's outcomes provide decision support on biomass harvesting plans, storage usage, material flows, facility siting, and mobile pyrolysis units' routing. The findings show that in some cases, the reduction of environmental impact can be accomplished by favoring the use of mobile facilities, because of reducing the amount of transportation necessary to transfer the material.

An Integrative and Prospective Approach to Material Flow Analysis: The Transformation to Hydrogen-Based Direct Reduction of the North Rhine-Westphalian Steel Industry

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Abstract:

The production of primary steel is characterized by a high emission intensity. Due to its coal consumption, the steel industry is responsible for around 30 % of industrial greenhouse gas emissions and thus for 5 % of total German emissions. In North Rhine-Westphalia, steel production accounts for up to 30 million tonnes or even more than 10 % of the state's total emissions. The enormous coal consumption is not only due to the high energy demand, but also to the process-related coal dependency of the classic blast furnace process. For a far-reaching decarbonisation of the North Rhine-Westphalian industry, the introduction and rapid diffusion of new technologies and processes in steel production is essential. Herein, direct reduction has emerged as a promising Carbon Direct Avoidance technique in the steel industry. All major German steel producers have announced specific steps to substitute coalbased feedstocks by switching to hydrogen-based direct reduction processes. If the hydrogen production and utilization of the steel producers are supplied by renewable energy sources, emissions can be largely avoided. However, this path is associated with far-reaching technical and procedural changes as well as a substantially increased demand for renewable electricity. Hence, this study presents a case study from Western Germany via quantifying the changes in the regional material and energy flows in the state of North Rhine-Westphalia until the planned decarbonisation in 2045. The quantitative analysis firstly presents a detailed material and energy flow model that depicts the existing supply chain of the regional industry and intersectoral relations. Thereafter, a detailed process simulation model of hydrogen-based steel production is developed according to the industry's detailed technological plans to track the regional impacts of such a transformation to achieve zero-emission steel. In combination with different assumptions on the availability of green hydrogen and complementary climate reduction measures, the results of the process simulation are integrated into the material and energy flow model to map possible stepwise transformation paths until 2045. Here, the analyses show that with a maximum focus on hydrogen, more than 47 TWh of electricity from renewable energies could be required per year for these structural changes. Consequently, our work quantifies different approaches by which the decarbonization of the steel industry can be achieved with lower amounts of renewable electricity. For example, partial reliance on natural gas as a reducing agent in combination with the use of CCUS technologies can significantly reduce electricity demand for the transformation, especially in the medium term.

Analyzing Different Implementations of a Funding Scheme for Encouraging Repair

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Abstract:

In April 2022 Austria introduced a country-wide repair funding scheme for electric and electronic equipment. In Graz, it replaced a scheme that had been used since 2017. The two schemes are structurally similar, with only a few differences. The key difference is that under the replaced system consumers had to pay the regular repair price to the repair company and claim the refund from the funding body aNerwards. Conversely, under the new system consumers only pay the reduced price to the repair company, which then must claim the funding from the funding body. Results from consumer focus groups indicated that the percep1on of these differences may influence repair demand as well as repair company decision making, thus affec1ng the effec1veness and efficiency of the scheme. In this project, a stylized analy1cal model is used to compare the two schemes in terms of several key performance figures like repair demand, repair company profits, and overall welfare. Key insights include that both schemes do increase demand, even though – as suspected by consumers – repair prices increase rela1ve to a situa1on without funding. Comparing the two systems, it turns out that for a fixed funding rate the new system always leads to higher prices but may s1ll induce more demand and consequently benefit both consumers and repair firms. Yet, the welfare op1mizing funding rate is (almost) always lower under the new system.

Determining the Influencing Factors for Operational Disposition Decisions in Closed-Loop Supply Chains

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Abstract:

Environmental considerations, corporate social responsibility and legislation drive companies to embrace reverse activities in the context of closed-loop supply chains. Decisions about further handling of returned used products have to be made, so-called disposition decisions. Remanufacturing, refurbishment, harvesting of spare parts or recycling are potential, though interdependent disposition alternatives. While strategic disposition is comprehensively researched, it is unknown how operational decisions about individual products are made as they are affected by uncertainties regarding quality, quantity and arrival times of returned products. We explore how these decisions are made in practice and want to know (1) which influencing factors are considered by decision makers, (2) which differences exist when comparing different product types and (3) to what extent different hierarchical levels evaluate the importance of influencing factors for operational disposition decisions differently. For this purpose, we conduct semi-structured interviews with decision makers from various industries to identify the disposition decision process and the considered influencing factors. Built on these results a survey study facilitates to explore the perceived importance of influencing factors depending on hierarchical levels. The expected results can be applied in further research, for example for the consideration of input factors in disposition decision models. Further, they have practical implications as companies can use them to consider their effectiveness of their disposition decisions. They can include identified factors, contemplate excluding others or use the results for better alignment of strategic and operational views. Since this is work in progress, we will present preliminary results

Sustainability of the Archimedean Drum Screen Clean-Up Technology in Aquatic Ecosystems: A Comparative Supply Chain Analysis

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Abstract:

The study analyzes the sustainability performance of the Archimedean Drum Screen (ADS) clean-up technology used in biomass and plastic waste cleaning in aquatic ecosystems. A specifically tailored theoretical framework is developed and a deductive research approach relying on a mix of qualitative and quantitative data collection methods is embraced. Followed by a systemic literature review, the study sets up comprehensive criteria of 12 key performance indicators aimed to collectively encompass supply chain sustainability. Next, to ensure a sufficient scope of the analysis, three different supply chain scenarios for handling the biomass and plastic waste collected by the ADS are constructed. These scenarios are based on separation, palletization, and liquefaction of collected plastic waste and biomass. The scenarios are evaluated by input-output modelling and comparative sustainability indicators are assessed. Findings show that the most promising scenario for the company is waste palletization, characterized by comparatively lower CO2 emissions, complete (100%) waste reuse, significant expected increase in annual demand of finished products, and a strong commercial competitiveness on the economic front. A common finding between all scenarios is that implementation of industrial symbiosis between the power plant processing the collected waste and the ADS is the most suitable technology integration strategy. This study finds that the post-collection handling of the waste plays only a marginal role in the achieved level of sustainability and further technological improvements are needed to ensure high ADS sustainability performance.

Closed-Loop Production Planning Incorporating Eco-Efficiency Using the Example of Circular Battery Production in Europe

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Abstract:

Resource scarcity and sustainability concerns lead to new challenges for supply chains worldwide. Closing the loop is a critical action to face these issues. It allows for reusing spent products and cycling the materials limiting needed production and mining. Therefore, researchers and managers tackled problems regarding supply chain design, technology selection, and capacity planning of closed-loop supply chains. These efforts result in the successful implementation of closed loops for many products. Consequently, the question arises of how these closed-loop supply chains can be utilized best regarding economic performance, e.g., costs, and environmental performance, e.g., greenhouse gas emissions. We tackle this question by developing novel optimization models for closed-loop production planning incorporating eco-efficiency. First, a multi-objective optimization model is used to analyze the economic and environmental potential in operational planning. Second, we adjust the model by integrating carbon caps and taxes, enabling a practical trade-off between economic and environmental performance. The models are applied to a comprehensive case study for different circular battery productions in Europe to validate our models and derive recommendations. While strategic decisions highly influence economic and environmental performance, the results indicate that potentials can be materialized in the closed-loop production planning and trade-offs between economic and environmental performance exist.

Green Hydrogen Supply Chain Network Design for Sustainable Aviation

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Abstract:

Hydrogen-based propulsion concepts for aircraft are considered a promising technology towards the decarbonization of aviation. While the development of respective aircraft models is still in progress, questions regarding the sustainable supply of green hydrogen are arising. The supply chain starts with the generation of renewable electricity, which is used for the electrolysis of water. The gaseous hydrogen obtained from this process needs to be liquefied (by cooling it down to below -253 °C) before it can be used to refuel the aircraft. Moreover, various transportation and storage processes for gaseous and liquid hydrogen are involved between the electrolyzers and the airports. Due to the spatially dispersed availability of renewable electricity, the techno-economic characteristics of hydrogen production, liquefaction and transportation (e.g., pronounced economies of scale), as well as the specific requirements of hydrogen handling (e.g., losses during transportation and storage), the optimal design of hydrogen supply networks is an interesting problem. We present a mixed-integer linear programming model that minimizes the total cost of hydrogen supply by deciding on locations, capacities, and hydrogen flows. Its application is illustrated for the case of Germany. We analyze the optimal network structures for different demand scenarios for 2050 and discuss potential model extensions that would be required to study international hydrogen supply chains and optimal transition pathways.

Mobile Deconsolidation Points: A Lever for Sustainable Distribution of Perishable Goods

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Abstract:

In this contribution, we study the economics of Mobile Deconsolidation Points (MDPs) in the distribution of perishable goods. The research is motivated by the need to mitigate environmental (e.g., greenhouse gas emissions) and social issues (e.g., congestion and noise) associated with transport in distribution logistics. An additional objective for perishable goods is to reduce waste while maintaining high service levels. In this context, we model MDPs as semi-trailers that are shipped from central warehouses to urban areas. They hold goods that are consolidated into full truckloads to serve demand clusters, thereby allowing for inventory pooling. From the MDPs, the goods are transhipped in small quantities to their destination using environmentally friendly vehicles. This structure is derived from established parcel service concepts with an added focus on inventory pooling to reduce waste of resources and out-of-stock risk. To minimize holding and shipping costs in such a distribution network, we develop a closed-form solution that combines a newsvendor model for optimal inventory decisions with a continuous approximation approach for estimating the resulting shipping costs. After validating that the approximation yields results within 10 % of the optimal solution, we analyze different network structures to identify conditions under which MDPs allow for reduced operating costs compared to traditional milk-run deliveries from a central warehouse. According to the analysis, MDPs offer an economically viable way to counteract the waste of resources especially for high-value goods with highly volatile demand and very high service level requirements, e.g., medical products such as blood units and vaccines.

Optimising the Reverse Supply Network Design of End-of Life Wind Turbine Blades under various Policy Scenarios

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Abstract:

Wind energy is key to supply low-carbon energy; however, the increasing number of wind turbines poses significant challenges in terms of their end-of-life management, as landfilling remains the most widespread option. Circular economy pathways are being established, however the designed reverse supply chains proposed so far do not consider existing regulatory aspects, such as waste shipment and landfilling constraints, which can hinder the development and scalable implementation of reverse supply networks. A Mixed-Integer Linear Programming method was developed to investigate the optimal reverse supply chain network design for end-of-life wind blades under different policy scenarios, based on EU-directives. Three scenarios were explored: 'as-is', 'EU Proposal 2021/0367', which removes transboundary restrictions on waste material shipments, and 'Landfilling Ban', which enforces an EU-wide ban on landfilling composite materials. The reverse supply networks with minimum costs were identified for each scenario, contextually determining location and sizing of recycling facilities and calculating landfilling quota and GHG emissions associated to each network configuration. This work contributes to the circular economy literature by analysing the impact of policy initiatives on the shaping of optimised reverse supply networks at the EU-level, focusing on the key industrial context of renewable energy.

Symbiotic Supply Chains Planning

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Abstract:

Industrial Symbiosis (IS) is a collaborative approach between traditionally separate industries aimed at optimizing material and energy consumption (Chertow, 2000). Recently, the concept of IS has gained increasing relevance and popularity, leading to exponential growth in examples of its usage and studies conducted on this topic (Neves et al., 2020). However, there remains a gap in addressing IS in the context of the supply chain (SC) (Herczeg et al., 2018; Turken & Geda, 2020). Adding symbiotic objectives to the SC requires adequate planning, and companies need to adapt their SC structure and operations (Turken & Geda, 2020). We address this challenge and propose a multi-objective linear programming model to support SC planning where symbiotic supply chains are targeted. The model is solved through the augmented **ε**-constraint method, allowing the calculation of the optimal quantities of raw materials and by-products exchanged between different entities that maximize the symbiotic flow (i.e., the difference between the quantity of final product produced from virgin raw materials and the quantity obtained from by-products) while minimizing the environmental impact and maximizing the economic profit. The model is validated through a case study. Results suggest that IS can benefit SCs by increasing profitability and reducing environmental impact. However, it is essential to carefully study and identify which symbiotic flows are optimal in different SC operating conditions, as prioritizing symbiotic exchanges may result in increased costs and environmental impacts. The developed model serves as a valuable tool for SCs to identify and adopt the most beneficial symbiotic flows. It highlights the need for a case-by-case analysis to determine the optimal planning of symbiotic exchanges within SCs. Keywords: industrial symbiosis, symbiotic supply chains, multi-objective optimization, tactical and operational planning.

5 Participants

We are welcoming 54 participants from 14 different countries.