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SPECIAL SESSIONS

Tecnológico de Monterrey
Escuela de Ingeniería y Ciencias

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PREFACE

We are pleased to present this volume of extended abstracts associated with the Special Sessions on "The Future of Artificial Intelligence in Logistics," held during the International Conference in Computational Logistics 2024 (ICCL 2024). This year's conference is hosted in the dynamic city of Monterrey, Mexico, from September 8th to 10th, a region renowned for its industrial prowess and innovation. The special sessions aim to foster insightful discussions and share experiences that address the current logistical challenges while driving forward innovation in the field. Participants have been encouraged to present case studies, applied projects, and practical solutions that enhance the efficiency, sustainability, and competitiveness of supply chains. Through these contributions, we aim to explore the transformative potential of artificial intelligence in reshaping the logistics landscape.

The topics covered in these sessions span a broad spectrum of interest areas, including AI-Robotics & Logistics, AI-Driven Supply Chains, Freight & Transport Planning, Maritime Logistics, Retail Logistics & Nearshoring, and Sustainability. These themes reflect the diverse and interdisciplinary nature of computational logistics and its critical role in advancing global supply chains. In this book, we have compiled 27 extended abstracts that exemplify the latest research, innovations, and practical applications in the field. The authors, through their oral presentations and written submissions, have provided a wealth of scientific findings, specific examples, and practical outcomes that contribute to enriching the ongoing dialogue and fostering knowledge exchange within our community.

We would like to express our gratitude to all the contributors for their valuable insights and to the participants for engaging in these important discussions, particularly to the academic staff of Tecnológico de Monterrey. We are confident that the ideas and solutions presented during these special sessions will inspire further research and development, paving the way for a more efficient, sustainable, and AI-driven future in logistics.

We hope this collection serves as a valuable resource for researchers, practitioners, and anyone interested in the future of logistics.

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Carlos D. Paternina-Arboleda
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ICCL 2024 (Eds.)

TRACK
AI-Robotics & Logistics

ROUTING OPTIMIZATION CONSIDERING ADVANCED CONSTRAINTS AND 3D LOAD BUILDING

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ABSTRACT

In the contemporary global economy, effective supply chain management is a business requirement to remain competitive and resilient. In the last 5 years, organizations have had to adapt to a difficult and ever-changing landscape that goes from geopolitical tension, climate change, material and resource scarcity to exponential technological advancement and evolving expectations from consumers. In addition to the growth of planning complexities, companies are exposed to face "black swan events" – extreme outliers that have a major effect on business operations. A factory total burndown represents one of the most severe disruptions a manufacturing company can face. The disruption to the company's supply chain affects everything from raw material procurement to product delivery. To address such catastrophic events, businesses must adopt a strategic approach to resilience by using technology that enables an agile recovery. This abstract delves into the transformative impact of technology to recover, adapt and overcome from unlikely and large-scale disasters. By taking advantage of Digital Twin Simulation's capabilities a Brazilian snack company was able to respond adequately from the burndown of a factory that manufactured over 37% of the country's sales volume. Digital Twins are virtual replicas of a supply chain network's requirements and capabilities: demand, production facilities and resources, warehouse restrictions, transportation networks, inventory policies, among other relevant parameters that describe the business context. Hence, they provide a modeling and optimization environment capable of representing the appropriate breadth and depth of the supply chain to simulate different scenarios and evaluate the financial and operational impact of various mitigation strategies. Within the disaster context, Scenario-based analysis enabled the capability of testing different recovery strategies in a virtual replica to understand the most efficient solutions. It allowed the reallocation of production resources, and the rapid identification of alternative suppliers and logistics options to maintain business continuity. Each of the scenarios provided insights into the performance of the company under different parameters, and their relative value was compared from a cost and profit perspective. The digital twin also served as a platform to integrate adjusted Demand and Supply data that was collected from customers and suppliers. Several scenarios were also tested to create the optimal tactical plan considering the new production, storage and fulfillment restrictions. Dashboards with relevant information on Projected Inventory Levels, Unmet Demand, Expected Production Capacity and Resource Utilization were especially useful to understand how to negotiate and align the customer's expectations. These reports also ensured the internal alignment of the company towards a common objective in a coordinated manner.

BRANCH CUT AND PRICE WITH DUAL OPTIMAL INEQUALITIES FOR THE COLORING PROBLEM

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ABSTRACT

Logistic problems are inherently complex and multifaceted, often requiring sophisticated mathematical modeling to effectively address the challenges they present. Among the various methods available, graph theory has emerged as a powerful tool for representing and solving a range of logistical issues, particularly through the lens of graph coloring problems. This presentation focuses on the application of graph coloring models to logistics, where the nodes and edges of a graph can represent various logistical entities and constraints, and the coloring of these graphs corresponds to making optimal logistical decisions. In the context of logistics, graph coloring problems are particularly relevant for scenarios where certain constraints must be satisfied, such as the allocation of heterogeneous vehicle fleets or the management of incompatible goods. For instance, in vehicle routing problems, each color in the graph can represent a different type of vehicle in a fleet, where each type may have different capacities, costs, or suitability for specific goods. Similarly, in the transportation of hazardous materials, colors may be used to ensure that incompatible goods, which cannot be safely transported together, are assigned to different vehicles, thereby minimizing risk and ensuring compliance with safety regulations. We present a novel approach to generating valid inequalities for logistic problems modeled as graph coloring problems. Our approach involves analyzing the structure of the graph and the nature of the logistical constraints to identify patterns and relationships that can be captured by additional constraints. These valid inequalities are then incorporated into the decomposition methodology, further enhancing its effectiveness and efficiency. To validate our methodology, we apply it to a set of benchmark logistic problems, including vehicle routing and scheduling scenarios. Our results demonstrate the effectiveness of the decomposition approach in reducing computational complexity and improving solution quality. The incorporation of valid inequalities significantly accelerates the convergence of the solution process, allowing for the efficient handling of larger and more complex problems than would otherwise be possible. In conclusion, the combination of graph coloring models, decomposition methodology, and valid inequalities presents a robust and flexible approach to solving logistic problems. This integrated approach not only simplifies the modeling process but also enhances the solvability of complex logistical challenges, making it a valuable tool for researchers and practitioners in the field. Future work will focus on extending this methodology to other types of logistic problems and exploring the potential for further optimization through advanced algorithmic techniques.

ARTIFICIAL INTELLIGENCE APPLICATIONS IN DRONE NAVIGATION FOR LOGISTIC PROCESSES - A MINI-REVIEW

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ABSTRACT

The integration of Artificial Intelligence (AI) into drone navigation has revolutionized logistics, introducing unprecedented levels of efficiency, precision, and adaptability. This mini-review delves into the transformative impact of AI on enhancing the capabilities of unmanned aerial vehicles (UAVs) in logistical operations, marking a significant leap forward in how goods are transported and delivered. AI algorithms empower drones with the ability to navigate autonomously, a critical advancement that allows them to maneuver through complex and dynamic environments with ease. Unlike traditional navigation systems, AI-driven drones can interpret and respond to their surroundings in real-time, avoiding obstacles, recalculating routes, and optimizing flight paths to ensure the most efficient delivery of goods. This dynamic adaptability is particularly crucial in logistics, where timely and accurate delivery is paramount. One of the standout features of AI-enhanced drones is their ability to respond to unforeseen variables, such as sudden changes in weather conditions, unexpected air traffic, or last-minute alterations in delivery destinations. These intelligent systems are equipped with machine learning models that enable them to learn from past experiences and adjust their operations, accordingly, ensuring that the delivery process remains smooth and uninterrupted despite any external disruptions. Moreover, AI-driven drones utilize advanced sensor data analytics to perform critical logistics functions with a high degree of accuracy. These functions include object recognition, which allows drones to identify and interact with specific items or landmarks during flight; package sorting, which automates the organization and distribution of goods; and quality inspection, ensuring that packages are intact and meet required standards before delivery. This multi-faceted capability not only streamlines logistical workflows but also significantly reduces the likelihood of errors, enhancing overall operational efficiency. The synergy between AI and drone technology extends beyond mere operational improvements; it redefines customer service by offering faster, more reliable, and cost-effective delivery solutions. Customers benefit from shorter wait times and the assurance that their packages will arrive safely and on time, contributing to higher levels of satisfaction and trust in the service provided. The cumulative benefits of employing AI in drone navigation for logistics are profound. These include operational autonomy, which reduces the need for human intervention and thus lowers costs; responsive route management, which enhances delivery speed and accuracy; instantaneous sensor data interpretation, which supports real-time decision-making; and, ultimately, heightened delivery performance, which ensures that logistics companies can meet the growing demands of an increasingly fast-paced and globalized market. As AI technology continues to evolve, its integration into drone navigation will likely unlock even greater potential in the logistics sector, paving the way for innovations that further enhance the speed, efficiency, and reliability of goods delivery on a global scale.

USING CLOUDERA AND OPEN-SOURCE TECHNOLOGIES FOR PROCESSING SENSOR DATA

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ABSTRACT

The exponential growth in data generated each year shows no signs of slowing down and is matched only by the significant increase in the number of systems needed to ingest, process and store that data across a complex network of middleware and routers that traverse various Public Clouds and on-premises environments, each having their own particular set of characteristics and nuances. Cloudera Data Flow, together with open-source technologies like Apache NiFi, can transform the way supply chain and logistics companies manage and leverage sensor data, enabling data integration and management in the Internet of Things (IoT) ecosystem. The data lifecycle begins with the collection of data from multiple sensor sources distributed throughout the supply chain. These sensors can be located in vehicles, warehouses, distribution centers, and more. Efficient collection of this data is crucial to obtain real-time information and make informed decisions. NiFi acts as an essential tool to efficiently collect, process and move data between various sources. The flexibility of NiFi allows different types of sensors and devices to be easily connected, regardless of the data format or any communication protocol used. Once collected, sensor data is processed in real time, allowing raw data to be transformed into valuable information, identifying patterns, anomalies and trends that can influence operational decision-making by the business side. The ability to integrate multiple data sources is one of the key strengths of Apache NiFi, where the seamless integration of this data allows for a unified and coherent view of the entire operation, improving coordination and efficiency at each link in the chain. Apache NiFi stands out for its ease of use, scalability, and secure data handling. Its visual interface and low-code processors, allows users to design complex data flows without the need for advanced programming, making it easy to adopt and maintain. In addition, NiFi provides robust tools for data security and lineage, allowing the user to monitor in a friendly way how each data (flow file) that is integrated into NiFi is transformed inside the flows that are built, until it is brought to an optimized and friendly format to meet business needs. This talk will offer a clear and accessible understanding of how Cloudera Data Flow and Apache NiFi can help improve the collection, processing and integration of data from various sources in the supply chain and logistics industry. We will explore a practical case with a simple live demo of how these technologies allow informed decision making in real time, thus optimizing daily operations. By the end of the session, participants will have a broader view of the capabilities and benefits of using these open-source tools in their own organizations.

HOW DIGITAL TWINS ENABLE SUPPLY CHAIN RESILIENCY WITHIN DISRUPTIONS: A CASE STUDY

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ABSTRACT

In the contemporary global economy, effective supply chain management is a business requirement to remain competitive and resilient. In the last 5 years, organizations have had to adapt to a difficult and ever-changing landscape that goes from geopolitical tension, climate change, material and resource scarcity to exponential technological advancement and evolving expectations from consumers. In addition to the growth of planning complexities, companies are exposed to face "black swan events" – extreme outliers that have a major effect on business operations. A factory total burndown represents one of the most severe disruptions a manufacturing company can face. The disruption to the company's supply chain affects everything from raw material procurement to product delivery. To address such catastrophic events, businesses must adopt a strategic approach to resilience by using technology that enables an agile recovery. This abstract delves into the transformative impact of technology to recover, adapt and overcome from unlikely and large-scale disasters. By taking advantage of Digital Twin Simulation's capabilities a Brazilian snack company was able to respond adequately from the burndown of a factory that manufactured over 37% of the country's sales volume. Digital Twins are virtual replicas of a supply chain network's requirements and capabilities: demand, production facilities and resources, warehouse restrictions, transportation networks, inventory policies, among other relevant parameters that describe the business context. Hence, they provide a modeling and optimization environment capable of representing the appropriate breadth and depth of the supply chain to simulate different scenarios and evaluate the financial and operational impact of various mitigation strategies. Within the disaster context, Scenario-based analysis enabled the capability of testing different recovery strategies in a virtual replica to understand the most efficient solutions. It allowed the reallocation of production resources, and the rapid identification of alternative suppliers and logistics options to maintain business continuity. Each of the scenarios provided insights into the performance of the company under different parameters, and their relative value was compared from a cost and profit perspective. The digital twin also served as a platform to integrate adjusted Demand and Supply data that was collected from customers and suppliers. Several scenarios were also tested to create the optimal tactical plan considering the new production, storage and fulfillment restrictions. Dashboards with relevant information on Projected Inventory Levels, Unmet Demand, Expected Production Capacity and Resource Utilization were especially useful to understand how to negotiate and align the customer's expectations. These reports also ensured the internal alignment of the company towards a common objective in a coordinated manner.

ENHANCING LOGISTICS IN THE PICKING PROCESS WITHIN A WAREHOUSE WITH ARTIFICIAL INTELLIGENCE TECHNIQUES

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ABSTRACT

Technology in some warehouses allows locations with different products and products located in different locations. These changes have impacted the picking practices since we need to decide which locations should be visited to fulfill orders. If the locations to pick are correctly chosen, the distances traveled within the warehouse can be reduced, thus positively affecting the picking process. These new scenarios in warehouses motivate the formulation of the capacitated family traveling salesperson (CFTSP), a variant of the family traveling salesperson problem. Consider a graph where nodes are partitioned into disjoint families: The CFTSP consists of finding the subset of nodes that must be visited by the capacitated agents for each family to minimize the total distance traveled. This research incorporates a demand for each family on the graph and a set of capacitated agents and weights for each node family. To solve the CFTSP, we propose a Biased Random-Key Genetic Algorithm (BRKGA) with four new and efficient decoder algorithms tailored for large instances. The first decoder is exclusively designed for a more restricted CFTSP version called the Homogeneous CFTSP (H-CFTSP), where all families have the same weight, agents have equal capacities, and they must all be assigned to complete a picking tour. The last three decoders apply for CFTSP and the more restricted H-CFTSP. These three methods are the penalty, eject-and-insert, and compact decoders. The first one uses a penalization such that the worst feasible solution has better fitness than the best unfeasible solution, so the solutions' fitness can appropriately guide the BRKGA. The second decoder includes a mechanism to repair those unfeasible solutions. Finally, the compact decoder's main advantage is to have a more compact chromosome, which makes it easier to handle. This BRKGA exemplifies how artificial intelligence techniques can be applied within logistics to improve efficiency, reduce costs, and enhance the overall performance of logistics systems. Our experiments demonstrate the effectiveness of this method. Key words: BRKGA, IA, warehouses, logistics.

TRACK

AI-Driven Supply Chains

OPTIMIZATION AND DISCRETE-EVENT SIMULATION MODEL FOR PRICING AND INVENTORY MANAGEMENT OF PERISHABLE PRODUCTS

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ABSTRACT

The economic prosperity of wholesalers, who buy products from manufacturers, store and sell them to retailers, depends on two factors: minimizing costs by controlling inventory and determining the selling price to retailers. Using a hybrid optimization and discrete-event simulation approach, this study aims to manage the inventory of perishable products within a wholesaler, and to determine the critical selling price per unit in which costs equal revenues. The model considers multi-perishable products, multi-periods, heterogeneous suppliers, and stochastic operations in the wholesaler. The inventory costs are minimized with the optimization part of the model, and the stochastic elements in the wholesaler are addressed with the discrete simulation. With and without operating costs, the paper presents expressions to calculate the critical selling price per unit. The model is exemplified by a drug/medicine wholesaler, utilizing a database from the United Nations Office for Project Services (UNOPS). The hybrid model results are compared with two empirical operational decisions: Lowest Acquisition Cost Approach and Earliest Product Acquisition Approach. The hybrid model decreased the average critical selling price by up to 18% compared to the empirical scenarios, and the average total costs by up to 20%.

ENHANCING SUPPLY CHAIN MANAGEMENT WITH ARTIFICIAL INTELLIGENCE: INNOVATIONS AND APPLICATIONS

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ABSTRACT

Artificial intelligence (AI) is revolutionizing supply chain management by enhancing efficiency, quality, and resilience. By leveraging AI technologies, businesses can streamline operations, reduce costs, and improve product quality. This contribution explores various applications of AI in supply chain management. By integrating quality information from raw material suppliers, AI enables real-time monitoring and improvement of product quality. Additionally, AI facilitates concurrent updates of engineering changes and quality data, ensuring that all stakeholders are informed of the latest developments. Furthermore, continuous monitoring of genealogy data provides traceability, production-process optimization, and better supplier management. Business process mining is one of the AI methods that enables companies to discover and monitor processes based on event data. As a result, processes can be improved, fostering communication and collaboration between departments, and accelerating product development and deployment. This ensures that all parts of the supply chain are aligned and working towards common goals, enhancing overall efficiency and responsiveness. AI can also be used to define and solve optimization problems, recommending the best course of action for supply chain management. By combining simulation and machine learning, surrogate-based optimization and reinforcement learning can provide solutions to supply chain design and operation by incorporating stochastic considerations and dynamic models. Recent developments in AI optimization show that solutions can be obtained in less time, allowing companies to evaluate different scenarios, and simulating the impact of various decisions. AI-powered CMS can monitor and diagnose problems within the supply chain, in both vehicles and facilities. By analyzing data from sensors and other sources, AI can predict failures and recommend maintenance actions, preventing mechanical breakdowns and minimizing downtime. This proactive approach to maintenance not only saves costs but also extends the lifespan of equipment and machinery. AI can also help build resilient supply chains by collecting and analyzing data on external factors, such as market trends and geopolitical events, to better predict risks. By dynamically updating planning constraints and input parameters, such as sales intelligence, AI improves forecast reliability and adaptability. This enhanced resilience enables businesses to respond swiftly to disruptions and maintain continuity. In summary, AI is transforming supply chain management by enhancing quality, efficiency, and resilience. From automating business functions to optimizing production processes and logistics, AI offers a multitude of benefits that help businesses stay competitive in a rapidly evolving market. As AI technology continues to advance, its applications in supply chain management will expand, driving further innovation and improvement across the industry.

SUPPLY CHAIN PRESCRIPTIONS: LEVERAGE THE POWER OF AI TO UNLOCK HIDDEN SAVINGS

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ABSTRACT

The evolving complexity of supply chains has vastly increased the number of possibilities an executive has to consider while making supply chain decisions. They then have to communicate these decisions across functional teams within organizations, often with minimal lead time, in order to operationalize these decisions and fulfill objectives, such as saving costs, improving resilience, and so on. In addition to this complexity, the modelers and analysts running scenarios often have limited bandwidth. As a consequence, supply chain executives have to limit the supply chain design initiatives they undertake, often leaving money on the table. Supply Chain Prescriptions is the AI assistant for the supply chain, it prescribes opportunities in the supply chain, such as node skipping, mode switching, and volume consolidation opportunities (within business constraints), so these companies can gain insight into cost drivers and proactively identify potential cost savings in the supply chain. Through Supply Chain Prescriptions, managers can get insight into a prioritized set of potential scenarios they can run to enhance their existing supply chains further. There are millions of combinations possible for adding lanes, changing modes or consolidating volumes - each change is a possible scenario. Supply Chain Prescriptions auto-recommends opportunities in a prioritized order based on identified savings value and estimates transportation costs for any new transportation flows based on heuristics and historical data coming from Network Optimization and Cost to Serve. For many companies, this provides managers and business stakeholders with key diagnostic analytics outputs in order to perform root cause analysis and validate the business feasibility of the prescriptions. The top network factors for each type of prescription based on decreasing or increasing transportation costs are identified. The summary of the network's characteristics such as costs, customer service, average touchpoints within the model, cost by mode, service by mode, and site-level insights are provided for the network. At the end the most important is to validate the feasibility of supply chain prescriptions with tradeoffs in the digital twin, from warehouse to factory and everything in between, to be sure changes made to the supply chain are truly optimized from end to end.

OBSERVABILITY AND DIGITAL RESILIENCY FOR PROACTIVE STRATEGY

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ABSTRACT

In today's digital age, the business logistics industry faces unique challenges in maintaining operational continuity and swiftly responding to disruptions. Splunk, a leader in operational intelligence, offers robust solutions for resiliency and disaster response management tailored to the logistics sector. This conference will showcase how Splunk's observability and real-time data analytics capabilities can help logistics companies proactively manage and mitigate risks. Digital resiliency is crucial for logistics companies to ensure the smooth flow of goods and services. Observability provides comprehensive visibility into the entire supply chain, from warehouse management systems to transportation networks. Splunk's tools, including Splunk Infrastructure Monitoring, Splunk APM, and Splunk On-Call, enable effective monitoring and incident response, ensuring minimal disruption to operations. Splunk's real-time data analytics support informed decision-making, while its machine learning capabilities predict and address potential issues before they escalate. Automation reduces the mean time to resolution (MTTR), enhancing operational efficiency and ensuring timely deliveries. Real-world applications demonstrate Splunk's effectiveness in logistics: a major shipping company improved its disaster recovery plans and reduced downtime, a large retailer maintained continuous operation of its supply chain, and a global courier service protected customer data and ensured compliance during system outages. Best practices include comprehensive monitoring across the logistics network, efficient incident management using Splunk's alerting features, and continuous improvement based on past incidents. A proactive approach to resiliency and disaster response is essential for the logistics industry. Splunk's tools provide visibility, automation, and insights to ensure continuity and swift recovery. This session will provide attendees with strategies to leverage Splunk for robust resiliency, preparing their organizations for any eventuality. Join this session to discover how Splunk can transform your resiliency and disaster response management in the logistics industry, offering practical insights and actionable strategies for safeguarding your operations and ensuring timely delivery of goods and services.

IMPROVING SMART STOCK IN RETAIL WITH ADVANCE ANALYTICS

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ABSTRACT

In today's competitive retail landscape, optimizing inventory management through advanced analytics is paramount for reducing costs and improving customer satisfaction. This conference will explore innovative approaches to smart stock management, highlighting two real-world use cases that demonstrate the practical application of advanced analytics in retail settings. Use Case 1: Smart Stock Management for Car Spare Parts In the automotive industry, maintaining the right inventory levels for spare parts is crucial. Our first case study involves a car company that sought to determine the optimal inventory levels for various car parts. The goal was to balance having sufficient stock to meet demand while minimizing inventory costs associated with warehousing and obsolescence. By leveraging predictive analytics and demand forecasting, we developed a robust inventory management system that dynamically adjusts stock levels based on real-time data, resulting in reduced costs and improved service levels. Use Case 2: Optimizing Cash Supply for ATMs Our second case study addresses the challenge of efficiently supplying cash to ATMs. The company faced significant costs each time money was transported to an ATM. The objective was to supply cash precisely when needed, avoiding both the inefficiencies of premature restocking and the risk of cash shortages. Using advanced analytics, we created a predictive model that forecasts cash demand for each ATM, allowing for just-in-time cash deliveries. This approach minimized transportation costs and ensured optimal cash availability for customers. Join us as we delve into these use cases, showcasing how advanced analytics can transform inventory management practices in retail. Attendees will gain insights into the methodologies, tools, and strategies used to achieve smart stock optimization, providing valuable takeaways for their own operations.

VISIBILITY AND AGILE DECISION MAKING IN TRANSPORTATION EXECUTION IMPROVING SMART STOCK IN RETAIL WITH ADVANCE ANALYTICS

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ABSTRACT

The transportation and logistics sector is characterized by its complexity and the necessity for real-time coordination across multiple stakeholders. Limited visibility into transportation operations presents significant challenges, leading to inefficiencies, increased costs, and diminished customer satisfaction. To navigate these challenges effectively, businesses must adopt advanced technologies that provide comprehensive visibility and support agile decision-making. Control Tower solutions address these needs by providing a holistic view of an organization's supply chain with intelligent response recommendations to optimize supply and demand matching as disruptions occur. These solutions connect customer and partner operations to provide extended visibility of a user's supply chain with informed situation planning and adaptive execution capabilities. End-to-end visibility enables real-time monitoring of transportation activities and warehouse requirements, allowing businesses to track shipments, oversee delivery schedules and monitor inventory levels. This real-time data helps in identifying issues as they arise and in taking immediate corrective actions. Artificial Intelligence and Machine Learning algorithms within these solutions enable prescriptive capabilities. New supply chain plans are offered when customizable alerts are prompted. These alerts trigger new decisions with updated logistic routes and delivery times and provide insights to understand the effects of these new decisions. New data inputs from other supply chain partners inform the downstream situation and predict ETAs, potential shortages and inventory numbers. These powerful insights allow organizations and their partners to discover, interpret, and act on disruptions from the entire digital ecosystem, and bridges the gap between planning and execution. Collaboration rooms with scenario analysis specific to the different types of exception are available to test solutions within the relevant parties. In this presentation we will provide actionable insights and best practices for leveraging end-to-end visibility and intelligent decision-making to achieve operational excellence in transportation execution.

A PROCESS-BASED SIMULATION AND DATA ANALYTICS MODEL FOR IMPROVING DECISION MAKING IN AUTOMOTIVE SUPPLY CHAINS

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ABSTRACT

In the era of Industry 4.0, the automotive industry is increasingly turning to data and simulation models to optimize its operations and enhance decision-making. This study presents a case study of a prominent German automotive company situated in Mexico to illustrate the practical application of data-driven strategies. The company faced challenges related to storage, procurement, and the imperative to reduce invested capital, as dictated by economic policies. To address these challenges comprehensively, a four-phase project was initiated. The initial phase involved an exhaustive review and mapping of key processes within the organization, including inbound logistics, outbound logistics, spare parts dispatch, and warehouse operations. This phase provided a profound understanding of existing processes and identified areas ripe for improvement. Subsequently, simulation models were developed using Business Process Model and Notation (BPMN) in conjunction with SAP Signavio software. These models were grounded in real-world operational data, providing a pragmatic representation of processes. In a subsequent phase, an extensive analysis of the company's operational databases was conducted. This analysis aligned the simulation models with key performance indicators (KPIs), using descriptive, predictive, and prescriptive statistics to evaluate performance. The final phase introduced real-time data-driven dashboards to provide insights into ongoing operations, which, in turn, facilitated more efficient and informed decision-making. The results revealed a substantial reduction in decision-making times, the formulation of ongoing improvement plans based on specific area needs and highlighted the transformative potential of integrating simulation models and data science for supply chain optimization within the automotive industry. This research underscores the significant value of data and model-based strategies in enhancing operational efficiency and supporting strategic decision-making in supply chain management.

TRACK

Freight & Transport Planning

A TRI-OBJECTIVE OPTIMIZATION MODEL FOR THE ELECTRIFICATION OF PUBLIC TRANSPORTATION FLEETS

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ABSTRACT

In many cities around the world, the public transportation system relies mainly on diesel buses, which can have a negative impact on the environment and public health. In order to move towards carbon neutrality, transportation operators are considering replacing their diesel bus fleets with electric vehicles. This study presents a tri-objective model for bus fleet replacement, determining the timing and quantity of electric vehicles to purchase, the type of technology, and their allocation to bus lines. We considering constraints such as electrical capacity, depot space limitations, a budget, and not exceeding the maximum average vehicle age. The objectives of this model are to minimize the costs associated with the procurement of vehicles across different technologies, including expenses related to charging infrastructure, maintenance, fuel, and battery replacements. By reducing these costs, the transition to electric vehicles becomes more economically viable for transportation operators. Furthermore, the model aims to maximize fleet electrification, thereby reducing greenhouse gas emissions and enhancing air quality, which in turn benefits public health. Additionally, the model seeks to promote equity in the allocation of electric fleets across different regions within a city, ensuring that all communities benefit from improved air quality and reduced noise pollution. To address this model, we propose using an epsilon constraint algorithm to approximate the Pareto front and highlight the conflict between the proposed objectives. This algorithm allows us to obtain a set of non-dominated optimal solutions, reflecting the different trade-offs between the objectives. This work aims to provide a valuable tool for public transportation operators and governments, offering a comprehensive framework that balances economic feasibility, environmental impact, and social equity. By addressing these three objectives, the model presents holistic solutions to the complex challenge of transitioning to sustainable urban transportation.

ENHANCING LAST-MILE DELIVERY EFFICIENCY: ENVIRONMENTAL AND TRAFFIC BENEFITS OF DEDICATED LOADING-UNLOADING ZONES IN MEXICO

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ABSTRACT

Last-mile distribution is the most expensive and time-consuming aspect of logistics. A significant challenge is a lack of parking spaces, which forces freight drivers to cruise or park illegally, degrading company performance and worsening traffic congestion and pollution. Inadequate freight vehicle parking causes inefficiencies in last-mile logistics and has negative environmental and societal consequences. Cruising for parking increases fuel consumption, time, cost, and emissions. Double parking clogs streets, causing congestion, noise, accidents, and fines, exhibiting the importance of parking availability in logistics efficiency and urban living conditions. These issues are expected to worsen in developing cities due to rapid urbanization and market fragmentation. This investigation looks at the impact of dedicated loading and unloading zones in emerging markets. We conducted two field experiments in the downtown areas of two major Mexican cities, Zapopan and Guadalajara, to assess the environmental impact and traffic congestion effects of loading-unloading zones. For our quasi-experimental designs, we created a technology-based system that combined infrastructure, a mobile App, and promoters. We created dedicated parking spaces for freight vehicles in collaboration with local authorities, marked with yellow paint, traffic signs, and QR codes for registration and usage tracking via the mobile App. The first field experiment took place from August 10 to September 11, 2021. The intervention went live on August 29, 2021. We trained samplers to collect noise and air pollution data every two hours, from 7 a.m. to 5 p.m., before and after the intervention, using high-precision equipment. The second field experiment, which ran from November 14 to December 31, 2022, used data from TomTom's traffic service. We measured the hourly average speed of each street segment in the study areas before and after the introduction of loading-unloading zones (December 11, 2022). The results showed significant benefits, including a 2.73% reduction in CO2 emissions, a 5.94% reduction in noise pollution, and an average vehicle speed increase of up to 4.66% during rush hours. Dedicated loading-unloading zones effectively reduce pollution and improve traffic flow, albeit with some complexities. Traffic improved in segments without bays but worsened in segments with bays, highlighting the nuanced nature of the intervention.

HOW TO SOLVE ROUTING PROBLEMS WITH GRAPH ANALYTICS

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ABSTRACT

The world is rapidly evolving in how we generate and utilize data. The explosion in both the volume and variety of data has transformed the quest for real-time information into a complex challenge. This complexity is further amplified as the relationships between data points grow increasingly intricate. In this context, the ability to effectively manage and interpret these relationships becomes crucial. Leading consulting firms predict that within the next three years, 80% of analytics challenges will require the implementation of graph technology. Graphs, by their very nature, excel at modeling complex relationships, making them indispensable in addressing these emerging challenges. This shift underscores the importance of understanding and solving routing problems, which fundamentally revolve around understanding and optimizing relationships. The integration of advanced technology into solving these problems offers significant benefits: increased efficiency, reduced operational costs, and the creation of a vastly improved client experience. By leveraging cutting-edge tools and methodologies, we can navigate the complexities of modern data relationships, transforming them into actionable insights that drive innovation and growth. In this conference, we will delve into how we can tackle these challenges from an analytical perspective. We will explore how to harness the power of existing and emerging technologies to enhance our industry's capabilities, paving the way for a more efficient, cost-effective, and transformative approach to data analytics. Join us as we discuss the future of analytics, and the pivotal role technology will play in evolving our industry.

EXPLORING THE OPTIMIZATION OF ITINERARIES WITH A TIME-DEPENDENT COMPONENT THROUGH THE STUDY OF THE TOURIST TRIP DESIGN PROBLEM IN PUEBLA

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ABSTRACT

It is estimated that by 2024, tourism in Mexico will contribute with over 30 billion dollars in revenue, making its development as an industry highly important for our country. A key experience for any tourist revolves around properly planning their itineraries, as to ensure that all points of interest are visited within a daily time window set by the tourist, aiming to provide them with the most satisfactory experience possible at their destination. Our proposal consists of a mixed-integer programming model that addresses the tourism trip design problem (TTDP) based on user preferences, with an approach similar to a CVRP with time windows (due to the operating hours of tourist attractions), maximizing user satisfaction based on the level of site attendance per hour. Due to the complexity and scalability of the problem, we first attempted to solve a relaxed version using relevant optimization-focused Python libraries (GAMSPy and pymoo), as to find the optimal solution to a simpler approach for it to serve as a guide for evaluating metaheuristic methods both in their efficiency and accuracy to reach a valid solution. For this, we proposed two solution methods. The first involves using priority queues to order visits according to a weighted rate between expected satisfaction and distance, progressively improving the satisfaction of the presented plan. The second approach uses genetic algorithms that seek to maximize satisfaction in different cases: a basic model which only focuses on maximizing satisfaction, a second one that allows the random inclusion of rest periods and a final one that chooses the next destination from the nearby unvisited locations for maximal satisfaction. Throughout the different iterations made for each algorithm, acceptable solutions were obtained within a reasonable computation time for all models. Our work stands out by its comprehensive address of a highly relevant issue for Mexico: improving the experience offered to tourists. Starting from a “simple” case, it can be extended to more complex and extensive itineraries, ensuring that any generated plan meets time, cost, and day constraints according to the tourist’s preferences and needs, whether as constraints or an optimization function. Furthermore, this approach can be later implemented to other industries and interests beyond tourism, where optimal route planning involves a time requirement besides other user-specific factors.

ENABLING DIGITAL TRANSFORMATION THROUGH AUTONOMOUS SUPPLY CHAIN

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ABSTRACT

In today's rapidly evolving digital landscape, businesses must embrace digital transformation to stay competitive and meet the increasing demands of the global market. Delayed decision making, data inconsistency and inefficient resource utilization are among the most frequent challenges organizations face due to traditional siloed planning. Siloed planning refers to the fragmented approach where different departments or functions within an organization operate independently without adequate coordination or communication. This method of planning typically shows high forecast error, stockouts in relevant finished goods, excess inventory in slow moving products, and low levels of service as each department works in isolation without considering the overall supply chain objectives. Conversely, Integrated Business Planning is the process of integrating all planning activities across an organization into a cohesive and collaborative framework. This approach ensures that all departments work together towards common goals, leveraging shared data and insights to make informed decisions. IBP is essential for overcoming the challenges of siloed planning and is a critical step toward achieving an autonomous supply chain. This presentation explores the digital transformation journey toward an autonomous supply chain, from siloed planning to agile, predictive and integrated business processes through AI and Machine Learning capabilities. Real-time data gathering through a single platform facilitates intelligent analysis with algorithms to simulate and predict outcomes for what-if scenarios, resulting in more accurate, more precise decision making. This self-orchestration is known as the autonomous supply chain. Join us as we delve into the steps needed to intelligently orchestrate resources across and outside organizations and discuss its significant benefits.

TRACK

Retail, Logistics & Nearshoring

RESILIENCE CONSIDERATIONS IN SUPPLY CHAINS

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ABSTRACT

Due to supply chain vulnerability to unplanned disruptions, companies need to analyze how to increase their resilience satisfactorily, which can benefit those involved in the supply chain network. Decision-makers should be able to monitor possible disruptions to minimize response time and know how much and where to invest in restoring a supply chain network after a disruptive event. Our analysis delves into the impact of a disruptive event, the imperative for swift supply chain recovery, and the necessity of a comprehensive understanding of supply chain resilience. Since supply chain resilience covers both a pre-disaster and a post-disaster phase, there will be an example for each. In the pre-disaster phase, the work presented here will be a visualization framework capable of identifying possible product disruptions via social media as a quick detection tool for the pre-disaster phase. The visualization framework merges text-mining techniques with Statistical Process Control (SPC) to help companies monitor their social media for possible product disruptions. For the post-disaster phase, the example is a mathematical model that focuses on understanding supply chain vulnerability and returning the supply chain to its desirable performance levels by reconfiguring the supply chain network.

RECENT NEARSHORING OPPORTUNITIES AND SUSTAINABILITY CONCERNS IN NORTH AMERICA

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ABSTRACT

The session delves into the economic benefits of nearshoring, especially in North America, and recent trends. However, these opportunities come with significant sustainability concerns. Attendees will gain insights into how businesses can leverage nearshoring to achieve both economic growth and environmental responsibility, positioning themselves competitively in a rapidly evolving global market. Through real-world examples and statistics, this panel provides a comprehensive overview of the current trends, challenges, and best practices in nearshoring and sustainability in North America.

EFFICIENCY AND ENVIRONMENTAL IMPACT: A BI-LEVEL OPTIMIZATION OF CUSTOMER PREFERENCES DELIVERY IN NEARSHORING SUPPLY CHAINS

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ABSTRACT

The growing environmental concerns and the expansion of global trade have intensified the need for sustainable supply chain practices. Nearshoring, the practice of transferring a business operation closer to its end market, has become an attractive strategy for companies aiming to reduce their logistical costs and carbon footprint. This study explores how different delivery modes—door-to-door and door-to-hub—can be optimized within a nearshoring context to achieve better sustainability and economic outcomes. Previous research highlighted the benefits of nearshoring in reducing transportation costs and enhancing service levels. Studies like those by Huang et al. (2019) and Pahwa and Jaller (2022) have established the impact of delivery choices on carbon emissions and operational costs. This study proposes a novel bi-level, bi-objective optimization model that incorporates: Decision-making at two levels: a distribution company (leader) and a manufacturing company (follower). Two delivery modes: door-to-door (direct delivery to customers) and door-to-hub (delivery to centralized hubs). Objectives of minimizing carbon emissions and maximizing profits. The model's complexity required the development of the NISL algorithm to find optimal solutions efficiently. This algorithm helps navigate the trade-offs between environmental impact and profitability by adjusting delivery routes and manufacturing decisions based on dynamic customer demands and delivery preferences. Simulation results, based on benchmark instances reflecting various operational scenarios, demonstrate that strategic selection of delivery modes can significantly influence both carbon emissions and profitability. The findings indicate that door-to-hub delivery generally results in lower carbon emissions due to centralized logistics but may reduce customer satisfaction due to decreased convenience. Conversely, door-to-door delivery, while increasing customer satisfaction and potentially boosting profitability, results in higher carbon emissions. Practical implications derived from the study suggest that companies can leverage these insights to design their supply chain strategies more effectively, balancing cost, customer satisfaction, and environmental impact according to their specific operational contexts and strategic goals. Integrating strategic delivery options in nearshoring supply chains offers substantial opportunities for sustainability and profit enhancements. The proposed bi-objective bi-level optimization framework provides a systematic approach to evaluate and implement effective supply chain strategies that align with both environmental goals and business profitability. References: Huang, Z., Huang, W., and Guo, F. (2019). Integrated sustainable planning of self-pickup and door-to-door delivery service with multi-type stations, https://doi.org/10.1016/j.cie.2019.06.022; Pahwa, A. and Jaller, M. (2022). A cost-based comparative analysis of different last-mile strategies for e-commerce delivery, https://doi.org/10.1016/j.tre.2022.102783

DEVELOPMENT OF A GAME THEORY COURNOT MODEL WITH INCOMPLETE INFORMATION TO MEASURE THE LEVEL OF COOPERATION AMONG OIL COMPANIES IN A PIPELINE SUPPLY CHAIN

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ABSTRACT

Carmona-Benítez and Cruz (2023) develop a multiproduct gasoline supply chain with product standardization and postponement strategies. Their supply chain strategy minimizes the costs of multiple oil companies that share pipelines and storage terminals to simultaneously distribute different types of gasoline. Their strategy is based on three supply chain management principles: postponement, product standardization, and cooperation. They developed a Mixed-Integer Nonlinear Programming Problem (MINLP) to simulate their proposed gasoline supply chain. Their proposed MINLP minimizes transportation costs, environmental impact costs, inventory costs, and transmit refining process costs of the gasoline supply chain for one or more oil companies that share pipelines and storage facilities to simultaneously distribute different types of gasolines. They apply their new strategy to model a small part of the Mexican oil pipeline network with real data. Their results demonstrate the feasibility of their gasoline supply chain because it achieves beneficial impacts on gasoline distribution costs. Their supply chain reduces the costs associated with transportation, storage, and refining of mid-grade gasoline, costs that would increase when multiple oil companies use the same pipelines and storage terminals to distribute different types of gasolines. Hence, they demonstrate that distributing one type of gasoline, "standard gasoline," from the midstream to the upstream of the gasoline supply chain and postponing the additivities process to the downstream of the supply chain to differentiate final products at the end of the supply chain, is highly beneficial for all the oil companies that use the same pipelines and storage terminals to distribute different types of gasoline. However, the explained gasoline supply chain is also based on the supply chain strategy of cooperation, which implies that oil companies are willing to cooperate by distributing one type of gasoline through shared pipelines and storage terminals, and additivity their gasolines at the end of the supply chain. But they did not probe whether oil companies are willing to cooperate; it is only an assumption in their study. In this research, a Cournot game theory model is developed to calculate the level of willingness to cooperate among different oil companies that use the same pipelines and storage terminals to distribute different types of gasolines, as proposed by Carmona-Benítez and Cruz (2023). The oil industry is an oligopoly where oil companies do not have complete information about the other oil company's behavior, then, a Cournot-Nash game theory model allows us to study oligopolies where cooperative behaviors can reach cooperative equilibriums without previous agreements. Therefore, developing the Cournot game theory model to the same Mexican oil pipeline network case study studied by Carmona-Benítez and Cruz (2023), the results indicate that oil companies are willing to cooperate.

ENHANCING COVERAGE AND ACCESSIBILITY IN HEALTHCARE: A MOBILE UNIT APPROACH TO THE MAXIMAL COVERING LOCATION PROBLEM WITH ACCESSIBILITY INDICATORS

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ABSTRACT

We investigate the maximal covering location problem by integrating accessibility indicators and deploying mobile units to significantly enhance facility coverage, zone accessibility, and the spatial distribution of resources. Our approach is distinguished by its ability to leverage mobile units, which extend the reach and effectiveness of open facilities, thereby providing critical benefits to residents across various zones. To address this problem, we develop a mixed-integer linear programming (MILP) model and introduce a novel metaheuristic approach that synergizes exact and heuristic optimization techniques. We rigorously validate our method using several instances created from official databases in Mexico, ensuring its practical applicability. A key focus of our study is on improving coverage in low-income areas particularly affected by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Our results demonstrate substantial enhancements in both coverage and accessibility when mobile units are incorporated, compared to scenarios where such units are absent, highlighting the potential for this approach to make a meaningful impact in public health and resource distribution.

NET REVENUE MANAGEMENT AT SCALE: CHALLENGES AND SOLUTIONS AT PEPSICO

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ABSTRACT

The concept of Net Revenue Management is the data-driven decision making that organizations take to maximize their net revenue, throughout the use of pricing, promotion, and revenue generation optimization. In the context of Consumer-Packaged Goods (CPG), NRM helps to answer the question of selling the right product at the right time and place, with the right price. Rather than increasing volume mindlessly, NRM allows for bold strategies of pricing and promotions to drive net revenue up. As a global market leader in the CPG industry, PepsiCo Inc. has innovated with its NRM efforts, working jointly with retailers across the world to maximize profits for all parties involved. Using artificial intelligence to optimize promotion and pricing planning, PepsiCo has developed a robust and disciplined NRM approach that uses Data Science, Forecasting and Mathematical Optimization, to provide optimal strategies for its partners. The NRM project is the culmination of the joint work of data cleaning and engineering of data from retail partners, simulating and forecasting the demands of products and brands, changing factors such as base pricing and promotional mechanics, considering economical and marketing concepts such as market cannibalization and competition with other brands and modelling the business rules of each retail partner and PepsiCo as mathematical models. This effort has not come without its challenges, at different stages of the NRM process. In this talk, we will see how the optimization stage has faced severe challenges regarding ease of use, time and resources costs, interpretability, and the evolution of the mathematical models as well as the implementation of these in computational tools.

ARTIFICIAL INTELLIGENCE IN PROCUREMENT: BUZZWORD OR REAL REVOLUTION?

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ABSTRACT

Artificial Intelligence (AI) has become a ubiquitous term in today's discourse. News channels and prominent newspapers worldwide continuously showcase the latest advances and applications of this transformative technology. Frequently, we are inundated with headlines about AI's radical impact on established paradigms across various domains, including the labor market, medicine, transportation, and the entertainment industry. In the realm of logistics and supply chain management (LSCM), AI has catalyzed the adoption of innovative technologies and practices, positioning itself as a potential game-changer. However, the practicality of AI in procurement management remains a topic of significant interest and debate. This presentation aims to discern whether the current AI tools represent merely another buzzword inflated by media and academia, or if they indeed signify a revolutionary shift for professionals in procurement within LSCM. To explore this, we examine AI from a general perspective, with a particular focus on the critical needs of the procurement sector. We leverage Warren Powell's theoretical framework, which categorizes AI behaviors into simple (rule-based logic), machine learning (basic machine learning, pattern recognition, and large language models), optimization (static optimization and sequential decision problems), and unstructured problems (knowledge, creativity, and judgment). Our preliminary findings suggest three key insights: first, existing AI tools are not entirely adequate for addressing the complex challenges faced in procurement; second, the related field of data science appears more promising in delivering effective solutions; and third, procurement analysts must be proficient in identifying suitable machine learning models, conducting preliminary evaluations of project ideas, and implementing these projects using the Cross-Industry Standard Process for Data Mining (CRISP-DM) methodology.

TRACK
Sustaintability

AN EOQ MODEL FOR GROWING ITEMS IN A THREE-ECHELON SUPPLY CHAIN CONSIDERING MORTALITY, PLANNED SHORTAGES, IMPERFECT QUALITY, AND CARBON TAX POLICY

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ABSTRACT

Carmona-Benítez and Cruz (2023) develop a multiproduct gasoline supply chain with product standardization and postponement strategies. Their supply chain strategy minimizes the costs of multiple oil companies that share pipelines and storage terminals to simultaneously distribute different types of gasoline. Their strategy is based on three supply chain management principles: postponement, product standardization, and cooperation. They developed a Mixed-Integer Nonlinear Programming Problem (MINLP) to simulate their proposed gasoline supply chain. Their proposed MINLP minimizes transportation costs, environmental impact costs, inventory costs, and transmit refining process costs of the gasoline supply chain for one or more oil companies that share pipelines and storage facilities to simultaneously distribute different types of gasolines. They apply their new strategy to model a small part of the Mexican oil pipeline network with real data. Their results demonstrate the feasibility of their gasoline supply chain because it achieves beneficial impacts on gasoline distribution costs. Their supply chain reduces the costs associated with transportation, storage, and refining of mid-grade gasoline, costs that would increase when multiple oil companies use the same pipelines and storage terminals to distribute different types of gasolines. Hence, they demonstrate that distributing one type of gasoline, "standard gasoline," from the midstream to the upstream of the gasoline supply chain and postponing the additivities process to the downstream of the supply chain to differentiate final products at the end of the supply chain, is highly beneficial for all the oil companies that use the same pipelines and storage terminals to distribute different types of gasoline. However, the explained gasoline supply chain is also based on the supply chain strategy of cooperation, which implies that oil companies are willing to cooperate by distributing one type of gasoline through shared pipelines and storage terminals, and additivity their gasolines at the end of the supply chain. But they did not probe whether oil companies are willing to cooperate; it is only an assumption in their study. In this research, a Cournot game theory model is developed to calculate the level of willingness to cooperate among different oil companies that use the same pipelines and storage terminals to distribute different types of gasolines, as proposed by Carmona-Benítez and Cruz (2023). The oil industry is an oligopoly where oil companies do not have complete information about the other oil company's behavior, then, a Cournot-Nash game theory model allows us to study oligopolies where cooperative behaviors can reach cooperative equilibriums without previous agreements. Therefore, developing the Cournot game theory model to the same Mexican oil pipeline network case study studied by Carmona-Benítez and Cruz (2023), the results indicate that oil companies are willing to cooperate.

EFFICIENCY AND ENVIRONMENTAL IMPACT: A BI-LEVEL OPTIMIZATION OF CUSTOMER PREFERENCES DELIVERY IN NEARSHORING SUPPLY CHAINS

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ABSTRACT

The growing environmental concerns and the expansion of global trade have intensified the need for sustainable supply chain practices. Nearshoring, the practice of transferring a business operation closer to its end market, has become an attractive strategy for companies aiming to reduce their logistical costs and carbon footprint. This study explores how different delivery modes—door-to-door and door-to-hub—can be optimized within a nearshoring context to achieve better sustainability and economic outcomes. Previous research highlighted the benefits of nearshoring in reducing transportation costs and enhancing service levels. Studies like those by Huang et al. (2019) and Pahwa and Jaller (2022) have established the impact of delivery choices on carbon emissions and operational costs. This study proposes a novel bi-level, bi-objective optimization model that incorporates: Decision-making at two levels: a distribution company (leader) and a manufacturing company (follower). Two delivery modes: door-to-door (direct delivery to customers) and door-to-hub (delivery to centralized hubs). Objectives of minimizing carbon emissions and maximizing profits. The model's complexity required the development of the NISL algorithm to find optimal solutions efficiently. This algorithm helps navigate the trade-offs between environmental impact and profitability by adjusting delivery routes and manufacturing decisions based on dynamic customer demands and delivery preferences. Simulation results, based on benchmark instances reflecting various operational scenarios, demonstrate that strategic selection of delivery modes can significantly influence both carbon emissions and profitability. The findings indicate that door-to-hub delivery generally results in lower carbon emissions due to centralized logistics but may reduce customer satisfaction due to decreased convenience. Conversely, door-to-door delivery, while increasing customer satisfaction and potentially boosting profitability, results in higher carbon emissions. Practical implications derived from the study suggest that companies can leverage these insights to design their supply chain strategies more effectively, balancing cost, customer satisfaction, and environmental impact according to their specific operational contexts and strategic goals. Integrating strategic delivery options in nearshoring supply chains offers substantial opportunities for sustainability and profit enhancements. The proposed bi-objective bi-level optimization framework provides a systematic approach to evaluate and implement effective supply chain strategies that align with both environmental goals and business profitability. References: Huang, Z., Huang, W., and Guo, F. (2019). Integrated sustainable planning of self-pickup and door-to-door delivery service with multi-type stations, https://doi.org/10.1016/j.cie.2019.06.022; Pahwa, A. and Jaller, M. (2022). A cost-based comparative analysis of different last-mile strategies for e-commerce delivery, https://doi.org/10.1016/j.tre.2022.102783

TRUCKING TOMORROW: A COMPREHENSIVE ANALYSIS OF INDUSTRY VARIABLES

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ABSTRACT

Trucks are vital for transporting goods between companies and distributors. According to the 2022 Transportation Statistics Annual Report, the trucking industry moved 73% of the cargo in the U.S., with a value of around 13 U.S. billion dollars. The trucking industry faces many challenges, including the shortage of drivers, the environmental impact of equipment, a high incidence of accidents involving heavy trucks, and a rise in fuel prices, all of which negatively influence trucking companies' economies. This research aims to identify the industry's main drivers and where they are headed; with this information, changes and proactive action towards the industry's future are sought. The research is divided into four phases: First, a systematic review using the PRISMA methodology was conducted to identify the current literature in the industry, the main trends on which the research is focused, and the most significant challenges addressed. Second, the information is grouped through the PESTLE model, which helps classify the factors involved according to the model, whether political, environmental, social, technological, legal, or economic, and determine which factors impact the industry the most. Third, identify the key variables that were found in the literature. And fourth, perform a prospective analysis of the key variables using the MICMAC methodology. Determine the relationship between the variables and their impact, which will help determine each variable's influence in the present and its evolution into the future. The results of the review using the PRISMA methodology show that about 80% of the research focuses on technological, social, and environmental factors. We identified 13 key variables, including autonomous trucks, infrastructure, emission reduction, artificial intelligence, connected vehicles, social acceptance, digitalization, safety, traffic, alternative energies, energy efficiency, trucking company economics, and policies. The final phase is currently focusing on determining the relationships between these variables. This phase is still in development, and we plan to present the completed work at the upcoming conference.

QUANTIFYING THE IMPACT ON GHG EMISSIONS AND MOBILITY OF MASS EVENTS USING CELL PHONE LOCATION

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ABSTRACT

Mass events in urban centers, such as sports games and concerts, can contribute substantially to greenhouse gas emissions. These emissions are mainly represented by the trips made by those attending the event and the synergistic effect of the congestion generated in the city. As a first step before identifying and/or implementing mitigation actions, it is necessary to quantify these emissions. The biggest challenge in the pursuit of this objective is to identify the routes followed by the attendees with the express purpose of attending the event and subsequently identify the selected mode of transportation. This information can be fed into existing models to predict emissions, such as MOVES, COOPERT, and IVE. Under the assumption that a cell phone is associated with a user, this paper proposes the use of historical cell phone location data to identify the trajectories followed by a representative sample of the attendees of the massive event. The first step is to define the mass event in terms of geographic location and time window. The next step is to identify all those users who arrive at the defined place within the defined time window. To do this, the cell phone location database must be cleaned to eliminate repeated data from users who authorize their tracking in more than one application simultaneously. It should be noted that the location data required corresponds to the geographic location obtained by GPS of the cell phone, as opposed to the antenna of the telephone network to which the cell phone is connected. The next step is to determine for each user the path they followed during the day of the event before and after arriving at the event venue. Dijkstra's algorithm determines the most likely trajectory followed by the user between two consecutive recorded location points within the city's network or roads, which can be consulted in tools such as Open Street Map. As a result, the total distance traveled by each user is obtained. However, it is likely that part of this trajectory was carried out as part of their daily routine and therefore they would perform these segments of trajectory with or without the presence of the event. The first alternative is to compare the trajectory that each attendee takes days before and days after the event. However, it is unlikely to have records for the same user that satisfies this condition. As an alternative, it is proposed to carry out this evaluation in global terms. That is, to compare the trajectories of the entire population on days similar to the event against the day of the event at two levels of scale: metropolitan scale and scale in a region close to the event. This comparison is made in terms of mobility metrics such as average distance traveled per user, origin destination matrices, and average hourly speed per street and frequency of use. This comparison quantifies the impact of the event on traffic congestion in the city and in particular in the region near the event.

INTEGRATED TIMETABLING AND VEHICLE SCHEDULING AND ELECTRIC FLEET PROCUREMENT FOR A SUSTAINABLE TRANSIT SYSTEM

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ABSTRACT

In rapidly growing urban centers, there exists a significant opportunity to enhance efficiency in transportation planning and operations. This research aims to support decision-making processes that deliver high-quality transportation services which are environmentally sustainable and economically viable. Efficient urban transportation is tackled through a comprehensive planning process involving various subproblems at different decision levels: network line design, frequency setting, timetable design, vehicle/driver scheduling, and driver rostering. Our work focuses on addressing strategic, tactical, and operational decisions of the transportation system by optimizing social, economic, and ecological objectives. We integrate three optimization problems into a multi-objective approach: timetabling to enhance service regularity (social objective), vehicle scheduling to reduce operational costs (economic objective), and procurement of electric vehicles to maximize electrified kilometers (ecological objective). To model our problem, we employ concepts of mixed-integer linear programming and conduct preliminary experiments using randomly generated instances. We optimize objectives independently to analyze the impact of each objective function on the overall system.

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