2020 SCM RESEARCH JOURNAL

Summaries of research projects by the 2020 graduates of the MIT Master of Supply Chain Management Program
Introduction

Welcome to the MIT Supply Chain Management (SCM) Research Journal.

The forty-nine master’s program research projects submitted by the SCM Class of 2020 at the Massachusetts Institute of Technology are represented here with short summaries framed for a business rather than an academic audience. These summaries are intended to give the reader a sense of the business problems being addressed, the methods used to analyze the problem, the relevant results and the insights gained.

The projects summarized cover a wide selection of interests, approaches, and industries, and address real-world business problems in areas including sustainability, urban logistics, digital transformation, supply chain strategy, machine learning, inventory management, and transportation.

Each of the projects is a joint effort between a sponsoring company, one or two students, and one or two faculty advisors. Companies who are members of CTL’s Supply Chain Exchange are eligible to submit their ideas for research projects in June and July, then present these proposals to the students in mid-August. In early September the students select which projects they will work on. From September until early May the teams conduct the research and write up the results. In late May all sponsors, faculty, and students participate in Research Fest where all the research projects are presented.

The SCM program is designed for early to mid-career professionals who want a more in-depth and focused education in supply chain management, transportation, and logistics. We welcome roughly 80 students each year from around the globe and across all industries. The research projects give students hands-on opportunities to put into practice the learnings they are receiving in their coursework.

We hope you enjoy learning about the types of projects our students completed this year. If viewing this document online, you may click on project titles to access additional information. If you would like to learn more about the SCM Master’s Program or sponsor a master’s student’s research, please contact us directly.

Happy reading!

Dr. Josué Velazquez
Executive Director, MIT SCM Program
josuevm@mit.edu

Dr. Maria Jesus Saenz
Executive Director, MIT SCM Blended Program
mjsaenz@mit.edu
Class of 2020 SCM Research Projects

**Closing the gap between information and payment flows in a digital transformation**
By Michael Smith  
Advisor: Dr. Chris Caplice  
Topic Areas: **Digital Transformation, Data Analytics, Warehouse**

Companies spend significant resources on digital transformation projects that do not always meet expectations. This thesis contends that these projects fail or fall short because organizations do not consider the three fundamental flows of a supply chain: materiel, information, and payment. To improve digital transformations results, it is recommended that work processes and performance expectations ensure the synchronous flow of materiel, information and payment.

**Dealing with complexities in digital supply chain**
By Jamica Brillante and Yoon Joo Lee  
Advisors: Dr. Maria Jesus Saenz, Dr. Ozden Tozanli Yilmaz  
Topic Areas: **Digital Transformation, Machine Learning, Supply Chain Strategy**

Using a four-dimension analysis, this capstone explores how supply chain complexities and buyer-supplier relationships as a complex adaptive system interact with an integrated and enacted external environment and drive the key supply chain performance of the company. Methodologies in this paper provide cornerstones for implementing data-driven decision making in supply chain management.

**Human-machine teaming for intelligent demand planning**
By Ye Ma  
Advisor: Dr. Maria Jesus Saenz  
Topic Areas: **Digital Transformation, Machine Learning, Demand Planning**

Today collaboration is switching from just among humans to between humans and machines. This study empirically analyzed the effects on forecast accuracy and inventory level of applying different human-machine teaming decision-making structures in a demand adjustment process. The research found that hybrid human-machine teaming models with adequate human intervention provided the optimal performance, especially for short-term forecast accuracy of low-turnover products.

**Human-machine teaming in AI driven supply chains**
By Christoph Herrmann and Libin Huang  
Advisor: Dr. Maria Jesus Saenz  
Topic Areas: **Digital Transformation, Machine Learning, Supply Chain Strategy**

Artificial Intelligence (“AI”) increasingly performs cognitive tasks and has evolved into the role of a human's teammate. However, algorithms are not designed to facilitate a teaming process. This Capstone project explores effective human-machine teaming (“HMT”) capabilities that enable successful AI implementations. The developed and empirically validated HMT framework (based on 22 case studies) provides guidelines to supply chain professionals for AI project implementations and assessments.

**Increasing supply chain visibility by incentivizing stakeholders to use blockchain**
By Vijay Krishnan Dasan Potty and Zhehao Yu  
Advisors: Dr. Inma Borrella, Dr. Maria Jesus Saenz  
Topic Areas: **Digital Transformation, Blockchain**

Applications of blockchain-based visibility technologies are a rapidly evolving field of supply chain management. Our research suggests that when stakeholders in a supply chain introduce blockchain-enabled visibility technologies, there is a significant increase in the percentage of deliveries that are on time and in full (OTIF), and a reduction in dispute management costs. Meanwhile, there are also challenges that supply chain actors need to tackle to increase blockchain adoption.
IoT-based inventory tracking in the pharmaceutical industry

By Andrew Kerr and Anthony Orr
Advisor: Dr. Matthias Winkenbach

Topic Areas: Digital Transformation, Inventory Management, Supply Chain Strategy

Inventory visibility has been a primary concern for corporate supply chains for decades. Utilizing inventory location and time data is particularly important for pharmaceutical companies and, until recently, archaic tracking processes created inaccuracies and mismanaged inventory for pharmaceutical manufacturers. However, recent Internet of Things (IoT) innovations provide potential solutions for pharmaceutical companies to manage and protect retail inventory levels while mitigating consumer risk and existing corporate financial waste streams. Through technology research, real-world experimentation, and cross-functional supply chain analyses, we propose a Bluetooth IoT network infrastructure and business approach to meet traditional pharmaceutical visibility needs.

Manufacturing digital transformation strategy for FMGG

By Sarah Gallo and Anais Ortega Camacho
Advisor: Dr. Maria Jesus Saenz, Dr. Ozden Tozanli Yilmaz

Topic Areas: Digital Transformation, Manufacturing

This project aimed to close the gap between the technological components of a digital transformation and the human factor. To accomplish this task, several methodologies were applied. On one side, a quantitative analysis based on data obtained from the ERP system of the sponsor company was performed. On the other side, to include the human factor, a survey was administered to discover the digital maturity of the company's bottling plants. Finally, both methodologies were analyzed jointly to provide a holistic analysis of the company that served as a basis for the creation of a Manufacturing Digital Transformation Strategy.

Reducing oil well downtime with a machine learning recommender system

By Jesus Madrid and Andrew Min
Advisor: Dr. Cansu Tayaksi

Topic Areas: Digital Transformation, Machine Learning, Manufacturing, Data Analytics

The price of oil has fallen in recent years and oil and gas companies are turning to advanced analytics and Big Data to reduce downtime costs. This project presents a machine learning recommender system to measure similarities among customers and make product recommendations. Results show the recommender system could lead to a significant reduction in unplanned downtime and an increase in revenues for the sponsoring company.

Using machine learning approaches to improve long-range demand forecasting

By Sohyun Jung and Katherine Nowadly
Advisor: Dr. Tugba Efendigil

Topic Areas: Digital Transformation, Machine Learning, Demand Planning

This capstone tests the feasibility of applying machine learning approaches to improve long-range demand forecasting for our sponsor company, a large pharmaceutical manufacturer. We developed machine learning models that identified key features and found the optimal time lag to use in forecasting models. We found that model performance differed greatly based on data availability, forecasting horizon, and individual product.

Development and application of an immunization network design optimization model for UNICEF

By Yuto Hashimoto and Henrique Ribeiro Carretti
Advisor: Dr. Jarrod Goentzel

Topic Areas: Humanitarian, Network Design, Healthcare

This research explored the potential benefits of applying an optimization model in the design of vaccination networks. The developed model focuses in the last-mile vaccine distribution, where one-day outreach clinics are commonly used to provide immunization to remote areas. Using the case of The Gambia, the developed modelling approach was validated to increase immunization access and generate meaningful insights.
**Humanitarian assistance for markets in conflict: a system dynamics approach**

By An Qi Hao and Sindhu Srinath  
Advisor: Dr. Jarrod Goentzel  
Topic Areas: **Humanitarian, Sustainability, Supply Chain Strategy**

The International Committee of the Red Cross (ICRC) uses a static market mapping method called Market Analysis Guidance (MAG) to arrive at a relief action for conflict-stricken markets. We collaborated with ICRC to enhance the MAG using system dynamics method to model complex interactions between market actors. These interactions can be used to simulate different scenarios of the market condition based on ICRC’s interventions.

**A forecasting face-off for oil and gas spare parts**

By: Mahmood Serry and James Vasa  
Advisor: Dr. Nima Kazemi  
Topic Areas: **Inventory, Demand Planning, Machine Learning**

Spare parts demand forecasting is an important yet challenging activity as demand is irregular in quantity and frequency. The research classifies the parts, then applies a conventional time series. Both of these, along with demand parameters and a judgmental forecast were fed into machine learning algorithms which had a substantial improvement in accuracy compared to conventional methods. This illustrates the potential benefit of formally adding human judgement.

**A natural language processing approach to improve demand forecasting in long supply chains**

By William Teo  
Advisor: Dr. Tugba Efendigil  
Topic Areas: **Inventory, Machine Learning, Demand Planning, Data Analytics**

In this thesis, a new natural language processing (NLP)-based forecasting model, known as NEMO, is proposed to forecast the demand of B2B commodities in long supply chains. NEMO uses modern NLP techniques to extract information from lengthy news articles for forecasting. NEMO’s performance compared favorably to a statistical model and a gradient boosting model. NEMO can be used alongside other forecasting models and provide invaluable information about upcoming demand volatility.

**A time series model for China to US ocean freight pricing**

By Yuchen Cao  
Advisors: Dr. Josue Velazquez, Dr. Ozden Tozanli Yilmaz  
Topic Areas: **Inventory, Transportation**

After comparing three different types of forecasting models, multiplicative seasonality exponential smoothing (with no trend) was concluded to be the best-fit model for predicting the China-to-U.S. ocean freight rates. We also concluded that the historical ocean freight rates are correlated with the oil price and some economic indicators, however adding an exogenous factor to the forecasting model does not improve the timeseries model accuracy.

**Data aggregation for data analytics in medical device supply chains**

By Gabriela Lamas and Sherif Alhalafawy  
Advisors: Jim Rice, Dr. Tugba Efendigil  
Topic Areas: **Inventory Management, Healthcare, Data Analytics**

In this capstone, we evaluated the potential of integrating the sponsoring company’s big data sets from fragmented planning systems. The goal was to enable advanced data analytics and visualization to improve inventory management. A data integration tool was developed, enhanced data analytics performed, and SKU segmentation completed. Results support the use of aggregated data sets to enhance inventory management capabilities in medical device supply chains.
Evaluating inventory risk pooling strategy for multi-echelon distribution network
By Angelica Bojorquez Aispuro and Hari Sharma
Advisor: Dr. Nima Kazemi
Topic Areas: Inventory Management, Network Design

The focus of this study is to evaluate risk pooling strategy. For that purpose, we develop a model to optimize cost by integrating both network and inventory decisions. We develop a MINLP model to solve a multiechelon Location inventory Problem using Guaranteed Service Model approach. Our research demonstrates that reconfiguring an existing network to introduce risk pooling could reduce supply chain costs of top selling products by 15%, without affecting service levels.

Improving the cash availability of small firms in Latin America via better inventory management
By Trevor Thompson and Analiz Cabrera Hernandez
Advisors: Dr. Josué C. Velázquez-Martínez, Dr. Cansu Tayaksi
Topic Areas: Inventory Management, Sustainability, Risk Management

This research contributes to furthering the understanding of how micro and small firms operate, focused on how better inventory management practices can lead to improved cash availability. We created an inventory framework that identifies, for firm owners, which inventory models best fit which demand patterns. We also introduce a business pulse dashboard that provides weekly visibility to cash management. Micro and small firms can use the tools we created for their benefit and these tools can also serve as a basis for future research.

Inbound logistics optimization
By Xuefang Hu and Eza Weisel
Advisor: Dr. Sergio Caballero
Topic Areas: Inventory Management, Machine Learning, Production Planning

This capstone project explores cost saving opportunities in inbound logistics management of a consumer goods company. An optimization model to determine the minimum production quantity for finished goods and minimum order quantity for materials is developed to reduce production frequency and return flows of remnants. Simulation results demonstrated substantial cost saving opportunities by utilizing machine learning.

Intermittent demand forecasting for inventory control: the impact of temporal and cross-sectional aggregation
By Ngan Chau
Advisor: Dr. Nima Kazemi
Topic Areas: Inventory Management, Demand Planning, Data Analytics

Managing intermittent demand is a challenging operation in many industries, since this type of demand is difficult to forecast. This challenge makes it hard to estimate inventory levels and thus affects service levels. This thesis develops a procedure that integrates lead-time and customer heterogeneity into the forecasting using temporal and cross-sectional aggregation and eventually evaluates its corresponding inventory cost-service performance.

Right sizing safety stock and effectively managing inventory using forecastability
By Ni Pan and Jamie Sweeney
Advisor: Tim Russell
Topic Areas: Inventory Management, Procurement, Supply Chain Strategy

In order to retain high value customers in the competitive consumer goods industry, businesses are incentivized to incur whatever cost necessary to meet demand. This research presents an analytical framework to help businesses effectively right size safety stock while maintaining high service levels with the integration of demand and forecast data. Businesses can identify potential inventory improvements through the lens of SKU forecastability, and quickly adapt as business needs and requirements shift.
An omnichannel distribution model to better serve online customers
By Wassim Aouad and Nikhil Ganapathi
Advisors: Dr. Eva Ponce Cueto, Dr. Sergio Caballero
Topic Areas: Supply Chain Strategy, Omnichannel, Network Design

The objective of this project is to develop an omnichannel distribution model by leveraging the existing network infrastructure of the sponsor company, a large US grocery retailer. A mixed integer linear program was formulated to determine the omnichannel network model, and multiple scenarios were simulated to highlight the robustness of the model as well as the potential savings that can be realized.

Capacity and inventory optimization for pharmaceutical industry
By Huong Dang and Brett Elgersma
Advisor: Dr. Nima Kazemi
Topic Areas: Supply Chain Strategy, Production Planning, Inventory Management

In this capstone, we developed a mixed integer linear program that allows decision makers to implement optimal production capacity and inventory strategies to combat demand uncertainty in the pharmaceutical industry. Real world simulations revealed that a mix of excess production capacity and inventory buffers is required for optimality, given the unique constraints inherent in pharmaceutical supply chains.

Conditions for deep supplier engagement: a cross-case comparison
By Gina Gerhart
Advisor: Dr. David Correll
Topic Areas: Supply Chain Strategy, Procurement

Building deep, strategic supplier relationships has come to the forefront of companies’ goals in recent years. There is a gap in identifying the reasons and motivations as to why companies develop their suppliers and how suppliers are developed in different business environments and contexts. To address this question, this study used semi-structured interviewing in support of a cross-case comparison approach. Based on the analysis, the research shows that there is no “one method fits all” when it comes to strategic sourcing; the strategy needs to be tailored to the current business needs and goals.

Continuous multi-echelon inventory optimization
By Sundeep Mathur
Advisor: Dr. Alexis H. Bateman
Topic Areas: Supply Chain Strategy, Inventory Management

In this research, we create a framework to systematically reduce Multi-Echelon Inventory Optimization (MEIO) safety stocks. We focus on improving supply lead time variability and understand primary factors that drive supply variability in our sponsor’s supply chain. We apply the framework to improve supply variability for two products and present the results and recommendations as case studies. The framework and learnings from case studies can be generalized and applied by other companies.

Dynamic trade policy and supply chain design within the oil and gas industry
By Liam Sharkey
Advisor: Jim Rice
Topic Areas: Supply Chain Strategy, Risk Management

Trade policies of the late 2010s are characterized by a unique combination of severity, shorter lifespan, and greater frequency. Supply chain leaders within the oil and gas industry are unaware of the range of responses they might take when responding to this new dynamic. This report proposes two frameworks based on semi-structured interviews and case studies to help inform decision makers within the oil and gas industry.
How to plan and schedule for profit: an integrated model and application for complex factory operations
By Allesandro Silvestro
Advisor: Dr. Sergio Caballero
Topic Areas: Strategy, Production Planning, Inventory Management, Machine Learning

Optimization of factory operations is a fundamental aspect of any manufacturing company. However, planning and scheduling is a challenging and complex task, often very demanding in resources, investment and training. The research project relies on a large-scale MILP model for accurately evaluating, simulating and/or optimizing the internal manufacturing supply chain, in order to balance competing production/SCM cost goals while maximizing profit in the (short-term) planning horizon.

Mirroring payment terms and lead times
By Matt Dale
Advisor: Jim Rice
Topic Areas: Supply Chain Strategy, Inventory Management, Procurement

“Mirroring Payment Terms and Lead Times” showed that lead times can be used to determine payment terms. If a seller prefers to provide a longer lead time to reduce costs, payment terms can be extended to have a neutral impact on the buyer. Alternatively, buyers and sellers can reference the thesis framework to quantify which party is subsidizing the other’s working capital using neutral variables.

Resource optimization during merger and acquisitions transactions
By Bilal Ahmed and Sai Pil Jung
Advisors: Dr. Cansu Tayaki
Topic Areas: Transportation

The objective of this capstone is to determine a mathematical approach that can estimate the amount of workforce required to create a stable supply chain operation during the sequential merging and separating of subsidiaries. After conducting a simulation-based optimization, this project revealed the most advantageous resource-allocation options while simultaneously providing beneficial insights into effects of uncertainties on system for future strategic decisions by the executive management.

Scenario planning for offshore wind supply chains 2030
By Haiyin Chen
Advisors: Dr. David Correll, Dr. Chris Caplice
Topic Areas: Supply Chain Strategy, Sustainability, Procurement

This study focuses on devising supply chain strategies especially toward China, to help energy companies fulfill offshore wind development goals. Scenario planning was utilized to prepare for several possible futures. Based on twelve key driving forces, three scenarios for 2030 and potential strategies were surveyed in an energy company and an industry network. Sourcing, construction, assembly and installation strategies were recommended by scenarios and markets.

Supply chain coopetition: a simulation model to explore competitive advantages in logistics
By Henrique Berbel Pedreira and Tarso Melo
Advisor: Dr. Cansu Tayakici
Topic Areas: Supply Chain Strategy, Sustainability, Transportation

Coopetition is an approach where competitor companies decide to partner on specific functions to get benefits and differentiate themselves from other companies. This project uses data from two world-renowned food manufacturing companies and a simulation model to evaluate the quantitative benefits of the coopetition. The results show that the reductions in outbound transportation costs, CO2 emissions, and lead times stay in a range of 5% to 25%, depending on the collaborative policies implemented.
Assessing the state of supply chain sustainability
By Ashley Barrington and Laura Allegue Lara
Advisors: Dr. Alexis H. Bateman, Yinjin Lee
Topic Area: Sustainability

This research focuses on understanding supply chain sustainability practices from the perspective of frontline professionals, across industries, geographies, cultures, and regulatory environments in 2019. We gathered data and insights from a survey distributed to supply chain professionals, executive interviews, and review of existing literature. Results confirm increased interest in supply chain sustainability. Findings also show that company goals are focused mainly in social sustainability.

Building sustainable supply chains in the era of e-commerce
By Christian Gatmaitan and Lisha Yangali Del Pozo
Advisors: Andres Munoz and Dr. Josué C. Velázquez-Martínez
Topic Areas: Sustainability, Demand Planning, Network Design

Consumer preferences are driving changes within the retail space. E-Commerce is growing rapidly and there are increased pressures on companies to be environmentally friendly, yet still cost-competitive. Therefore, it is more important than ever for retailers to have the desired product in the right location at the right time.

Closing the food access gap in American underserved communities
By Luiz Paulo Silva Barreto and Jamal Taylor
Advisor: Dr. Chris Mejia
Topic Areas: Sustainability, Retail Operations, Healthcare, Supply Chain Strategy

Malnutrition is a global issue that affects millions of people across the world, including in the U.S, particularly those living in “food-deserts”. This research focused on understanding the preferences of residents from low-income areas between three food supply chain models, the veggie-box, low-cost ridesharing, and low-cost delivery, and the feasibility of implementing these models. To analyze this, 388 Somerville, MA residents were surveyed and farmers, distributors/wholesalers, neighborhood markets, and ridesharing services were interviewed. Additionally, 388 residents of Somerville, MA were surveyed. The results show a preference for the veggie-box model. This model also presented a better prediction power in comparison with other two models.

E-commerce based closed-loop supply chain for plastic recycling
By Saikat Banerjee
Advisors: Dr. Eva Ponce Cueto, Dr. Suzanne Greene
Topic Areas: Sustainability, Urban Logistics, Supply Chain Strategy

The plastic in landfills are rising. We have developed a novel process to take back post-consumer plastic using e-commerce reverse logistics channels so that plastic waste doesn’t end up in the landfills. We performed optimization using a MILP-based network design model, cost analysis using a novel cost equation, and a scenario-based sensitivity analysis. From results, we conclude that an economic, social and environmentally feasible process is achievable.

Exploring carbon offset for freight transportation decarbonization
By Catherine Dame and Abdelrahman Hefny
Advisors: Dr. Suzanne Greene, Dr. Alexis H. Bateman
Topic Areas: Sustainability, Transportation

Carbon offsets present a mechanism to leverage corporate sustainability commitments to accelerate investment in green transport systems through projects like fleet renewal programs. This study evaluates the feasibility of this approach from a financial and logistical perspective, analyzing the potential market size and emissions avoidance, quantifying the costs, and synthesizing best practices in fleet renewal programs. The analytical frameworks developed can be utilized to support the design and implementation of such a program that has the potential to drive significant impact in global carbon emissions reduction.
A predictive model for transpacific eastbound ocean freight pricing
By Yan Huang
Advisor: Dr. Josue Velazquez, Dr. Ozden Tozanli Yilmaz
Topic Area: Transportation, Procurement, Optimization

The containerized ocean freight market has been very volatile due to overcapacity and several disruptive changes. This research aims to explore the economic indicators affecting the ocean market dynamics and predict the spot freight rates for Transpacific Eastbound lanes, which carry the largest trade volumes in the global ocean market. Via correlation analysis and multiple linear regressions modeling, we identified six economic indicators influencing the spot rates and predicted the rates at 69.0% accuracy for China – US East Coast and 55.4% accuracy for China – US West Coast.

Achieving sustainable growth at Uber Freight
By Elizabeth Raman and Sadia Rahman Shathi
Advisors: Dr. Josué C. Velázquez-Martínez, Dr. Suzanne Greene
Topic Area: Transportation, Sustainability, Data Analytics

In this capstone, we calculated and forecasted emissions at an aggregate level for Uber Freight, a third-party freight logistics company. The Global Logistics Emissions Council Framework served as the basis for the study. We compared industry average emissions data to data reported by carriers to assess the accuracy of results. We analyzed key areas to determine the factors causing higher emissions, quantifying how utilization through freight consolidation can significantly decrease Uber Freight's total emissions. We also determined the Science-Based Target for Uber Freight to mitigate growth in emissions through 2050 in accordance with global climate goals.

Application of linear models, random forest, and gradient boosting methods to identify key factors and predict truck dwell time for a global 3PL company
By Sireethorn Benjatanont and Dylan Tantuico
Advisors: Dr. Chris Mejia, Dr. David Correll
Topic Area: Transportation, Data Analytics, Machine Learning

This research is focused on understanding how dwell time can be reduced within our sponsoring company's network, a third-party logistics provider in the U.S freight transportation industry. It uses descriptive analytics to evaluate the key drivers of dwell time, and statistical modelling techniques to predict it. The analysis reveals that practices in shipper facilities heavily influence the dwell time of a load. Moreover, a random forest classification model with one-hour bins outperforms other models based on multiple predictive performance metrics.

CO2 Emissions of innovative last mile delivery solutions
By Fedor Egorov
Advisor: Michelle Simoni
Topic Area: Transportation, Sustainability, Urban Logistics

This work studies the impact of truck and drone delivery solutions on the amount of produced CO2 emissions. To meet this task the model that combines simulation and optimization approaches was developed. The computational experiments show that the truck and drone tandem can significantly (more than twice) shorten the delivery time in congested urban areas. The sensitivity analysis reveals that drone speed does not considerably affect delivery time or the amount of produced CO2 emissions.

Designing an efficient supply chain for specialty coffee from Caldas-Colombia
By Santiago Botero Lopez and Muhammad Salman Chaudhry
Advisor: Dr. Cansu Tayaksi
Topic Area: Transportation, Sustainability, Urban Logistics

In this research, we developed a Network Design model to minimize the total Supply Chain cost of a new sales channel for a Colombian specialty coffee company. The model considers the transportation and production operations starting at the farms in Caldas, Colombia, and finishing at multiple distributor's facilities in the Northeastern region of the United States. The results were a total supply chain cost saving between 51% and 78%.
Eliminating last-mile inefficiencies in the trucking industry
By Kristian From and Katharina Mangan
Advisor: Milena Janjevic
Topic Areas: Transportation, Machine Learning, Data Analytics

The performance of last-mile delivery operations is improved through higher visibility and elimination of efficiencies. A performance metric framework is defined and used to establish a performance assessment tool for visual performance assessment. Machine learning analysis is used to identify the parameters volume, population density, and number of pieces delivered as most relevant for predicting route stop times. Route drive time appear closely correlated to mileage.

Facility and routing decisions in truck-drone distribution
By: Vu Bich Nga Doan and Amr Taiyeb
Advisor: Michele Simoni
Topic Areas: Transportation, Network Design, Urban Logistics

This research project focuses on the Location-Routing Problem with Ancillary Modes (LRPAM), which involves identifying the most strategic locations for distribution facilities and the optimal trucks and drones delivery routes. Following a metaheuristic approach, the developed model was validated and found comparable with the exact solution. The model shows that adding drones can reduce the total distribution cost by a quarter, while sharply cutting the truck traveling distances.

Going awry: understanding transportation budget failures
By Venkateswararao Bandaru and Emilio Dolci
Advisor: Dr. Chris Caplice
Topic Areas: Transportation, Demand Planning, Procurement

The US truckload transportation industry cycle goes through phases of oversupply and undersupply of capacity, causing a dramatic impact on freight rates and transportation budgets. External factors like macroeconomic conditions, unexpected market forces, and changing regulatory policies tend to influence the velocity of these phases. The results of our research suggest that prevailing truckload market conditions impact shippers’ transportation budget accuracy. The volume variation of a lane, and the origin or destination states, also have an impact, to a lesser degree. Higher awareness of the conditions that influence transportation budget accuracy will allow shippers to be more effective in their planning processes.

Optimizing fleet utilization by adjusting customer delivery appointment times
By Colleen Copley and Lu Lu
Advisor: Dr. David Correll
Topic Areas: Transportation, Network Design, Supply Chain Strategy

A heuristic algorithm is created to maximize trucking fleet utilization by modifying delivery appointment windows so that multiple scenarios can be compared based on fleet utilization and cost savings metrics for the sponsor company. This paper will further articulate the methodology and assumptions used to generate these scenarios and provide context to the recommendations for utilization improvement on its logistics network.

Predicting and planning for the future: North American truckload transportation
By David Sokoloff and Gaohui Zhang
Advisor: Dr. Chris Caplice
Topic Areas: Transportation

In our research project we developed a machine learning model to predict the US truckload dry van spot rate and a Tactical Playbook of contingent actions associated with market fluctuations. Tested across 6 years of data, the model achieves a MAPE of below 7% and a mean error below 0.05 for predicting 12 months in the future. The significant forecast accuracy allows companies to employ our playbook’s strategic and tactical measures to mitigate risk and unplanned costs stemming from the volatility in the US trucking market.
Machine learning and optimization-based modeling for asset management
By Justin Casey and Carlos Rafavy
Advisor: Andres Muñoz
Topic Areas: Transportation, Machine Learning, Network Design, Inventory Management

Our sponsoring company is a global water technology company, and this capstone project covers its industrial pump rental business across the United States. With millions of dollars spent every year for asset mobilization, the company looks for ways to improve overall utilization rate. In response, we propose an improvement for the company's asset management practice by modeling an integrated decision tool that involves the evaluation of several machine learning algorithms for demand prediction and mathematical optimization for centrally-planned asset allocation. We find that a feed-forward neural network (FNN) model with a single hidden layer is the best performing predictor for the company's intermittent product demand, and the optimization model is proven to prescribe the most efficient asset allocation given the prediction.

Optimizing satellite locations for a multi-echelon last mile distribution network to utilize alternative delivery vehicles for last mile delivery
By Abhinav Goyal
Advisor: Dr. Matthias Winkenbach
Topic Areas: Transportation, Urban Logistics, Network Design

This project proposes a mathematical model to determine the optimal count and locations of urban cross-docking facilities, called satellites, in a two-echelon last mile distribution network of a large parcel distribution company, integrating a vehicle routing problem with a facility location problem to determine the optimal distribution network design. The model optimizes the cost of operating satellites against the costs of transit. The research also incorporates road traffic considerations and calculates distances along the actual road network, thus closely replicating the reality of last mile network operations.

Traditional routing guide performance and segmentation to improve compliance with contracted budget
By Tala Alnajdawi and Israel Lopez Jimenez
Advisors: Dr. Chris Caplice, Angi Acocella
Topic Areas: Transportation

This research examines the performance of routing guides to segment freight to help shippers identify and characterize where and how budget overruns occur. A strong seller's market in 2017 and 2018 led to dramatically increased costs in transportation due to demand surpassing supply. As a result, the carrier rejection rates by primary carriers in the routing guide increased significantly. The research found that frozen truck loads contribute to higher budget deviations, while dry truck loads tend to contribute to lower budget deviations on average. Origin states tend to deviate above total budget as compared to destination states. Finally, volume deviations contribute more to budget overruns than price deviations. "mile cost and the overall cost of distribution. The introduction of CDPs effectively reduces these costs by aggregating the demand.

Utilization of the American truck driver
By Adam Buttgenbach and Mei Qing Zhang
Advisor: Dr. David Correll
Topic Areas: Transportation, Data Analytics, Machine Learning

As of 2018, the American Trucking Association reported there is a shortage of 61,000 truck drivers. In this capstone, we used six months of trucking Electronic Logging Device data from a regional Over the Road truck carrier to understand truck driver's daily stop activity at each truck locations. Using data analysis techniques, our team saw the start time of the delivery, the stop location factor, and frequency of freight points all significantly affected the delivery time the truck drivers will experience.
## Topic Index

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blockchain</td>
<td>4</td>
</tr>
<tr>
<td>Data Analytics</td>
<td>4, 5, 6, 7, 11, 12, 13</td>
</tr>
<tr>
<td>Demand Planning</td>
<td>4, 6, 7, 10</td>
</tr>
<tr>
<td>Digital Transformation</td>
<td>4, 5</td>
</tr>
<tr>
<td>Healthcare</td>
<td>5, 6, 10</td>
</tr>
<tr>
<td>Humanitarian</td>
<td>4, 5</td>
</tr>
<tr>
<td>Inventory Management</td>
<td>5, 6, 7, 8, 9, 13</td>
</tr>
<tr>
<td>Machine Learning</td>
<td>4, 5, 6, 7, 11, 12, 13</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>5</td>
</tr>
<tr>
<td>Network Design</td>
<td>5, 7, 8, 10, 12, 13</td>
</tr>
<tr>
<td>Omnichannel</td>
<td>8</td>
</tr>
<tr>
<td>Procurement</td>
<td>7, 8, 9, 11, 12</td>
</tr>
<tr>
<td>Production Planning</td>
<td>7, 8, 9</td>
</tr>
<tr>
<td>Retail Operations</td>
<td>10</td>
</tr>
<tr>
<td>Risk Management</td>
<td>8</td>
</tr>
<tr>
<td>Supply Chain Strategy</td>
<td>4, 5, 6, 7, 8, 9, 10, 12</td>
</tr>
<tr>
<td>Sustainability</td>
<td>6, 7, 9, 10, 11</td>
</tr>
<tr>
<td>Transportation</td>
<td>6, 9, 10, 11, 12, 13</td>
</tr>
<tr>
<td>Urban Logistics</td>
<td>10, 11, 12, 13</td>
</tr>
<tr>
<td>Warehouse</td>
<td>4</td>
</tr>
</tbody>
</table>