MIT Center for Transportation and Logistics

For nearly 50 years, the MIT Center for Transportation and Logistics (CTL) has been a world leader in supply chain management, logistics, transportation education, and research. The center's world-renowned research programs directly involve more than 80 faculty and research staff from a wide range of academic disciplines, as well as researchers in various affiliate organizations around the world. MIT is consistently ranked first among graduate business programs in logistics and supply chain management.

Accomplishments and Awards

- The MIT Supply Chain Management master's program was ranked as the world's number one graduate business program in supply chain and logistics by Eduniversal for the fourth consecutive year.

- Chris Caplice was promoted to Senior Research Scientist.

- Bryan Reimer, research engineer at the AgeLab, received the Jack A. Kraft Innovator Award from the Human Factors Ergonomics Society.

- The team that developed the MITx MicroMasters Program in Supply Chain Management received a silver award for Best Online Program for Nurturing 21st Century Skills and a bronze for the North American region at the QS Reimagine Education Awards.

- The third class of supply chain management blended students arrived at, and graduated from, MIT.

- Twenty-one eligible supply chain MicroMasters students attended the third annual MIT SCx Supply Chain boot camp.

- CTL researchers published more than 50 articles in various mainstream and industry publications. They were also extensively interviewed and quoted on supply chain issues.

- CTL published weekly blog posts that were syndicated by other blogs and publications, as well as a monthly article based on a supply chain management master's thesis in the leading trade journal, *Supply Chain Management Review*.

- The number of corporate partners in the CTL Supply Chain Exchange membership program stands at 47.

- More than 1,200 people attended CTL Supply Chain Exchange (SC) events in FY2020, both in person and virtually when necessary.

- Due to the widespread global supply chain disruptions caused by the COVID-19 pandemic, CTL researchers were consulted by and featured in more than two dozen media publications.

Education

MIT Supply Chain Management Master's Program

Since 1998, the MIT Supply Chain Management program has attracted a diverse group of talented and motivated students from across the globe who graduate from our program as thought leaders ready to engage in an international, highly competitive marketplace. The program combines analytical, engineering-focused coursework with advanced leadership skills, and is delivered in two formats:

- The 10-month Supply Chain Management residential (SCMr) option, designed for early-career professionals who want to build skills and increase their earning potential with minimal time out of the workforce.

- The Supply Chain Management blended (SCMb) option, allows MITx MicroMasters credential holders to earn an MIT master's degree by completing spring term on campus. Launched in 2016 and the first hybrid master's at MIT, the blended program option allows us to reach students who may not have considered or had the option to pursue traditional pathways toward a master's degree.

CTL's global Supply Chain and Logistics Excellence (SCALE) Network provides SCM students with opportunities for deep, cross-cultural engagement and collaboration with fellow students and researchers around the world.

Class of 2020 Profile

The program admitted approximately 26% of SCMr applicants for AY2020, with 44 students (18 women, 26 men) from 18 countries matriculating. Students had an average age of 29, and 5.9 years of professional experience. The class included nine Supply Chain Excellence Awardees. The SCM department's Supply Chain Excellence Awards (SCExA) program provides provisional fellowships to the most outstanding seniors in undergraduate supply chain or industrial engineering programs at nine leading US universities and Tecnológico de Monterrey in Mexico. SCExA awardees must apply and be admitted to the SCM program after three to five years in the workforce to redeem their fellowships.

Thirty-nine students (13 women, 26 men) from 17 countries were selected to join the Class of 2020 in the SCMb cohort. Students entered with an average of 9.6 years of work experience (7.9 on average in the supply chain field). Their average age was 32.6.

Across both cohorts, SCM master's students completed a total of 49 capstone and thesis research projects in AY2020. Students work closely with one of CTL's corporate partners to complete these research projects as a requirement for graduation, and are advised by researchers from CTL centers and labs. A complete listing of this year's capstone projects can be found in the Capstone Projects and Research Partners section.

In response to the COVID-19 crisis, CTL researchers connected SCM student volunteers with organizations such as UNICEF and the American Logistics Aid Network to partner on projects in April and May, focusing on supply chain workforce safety guidance, US and international freight flow monitoring, and development of an oxygen supply chain design tool.

Class of 2020 Career Outcomes

Despite the severe disruptions to the spring semester caused by COVID-19, over 53 companies recruited SCMr students in AY2020, and 100% of students seeking employment received a job offer within 60 days of graduation. Of those employed students, 84% secured employment in the United States. Their mean/median base compensation was $125,600/$130,000, with a range of $94,000 to $160,000. Of the employed students, 77% secured their position through SCM/MIT-facilitated activities including, but not limited to, on-campus recruiting; faculty, staff, and alumni referrals; and career fairs.

Most blended cohort students (54%) were either sponsored by a previous employer (46%), pursuing further education (5%), or postponing their job search (3%). Of students seeking employment, 33% had accepted positions with new employers within 60 days of graduation. These new employers include Abbott Labs, Anheuser-Busch InBev, Amazon, Apple, Johnson & Johnson, JSR Micro, Novavax, and the World Food Program.

MicroMasters Credential in Supply Chain Management

During FY2020, we ran nine SCx massive open online courses (MOOCs). We revisited the contents of the five SCx courses, adding more lessons, recitations, interviews with experts, and live events to interact with the SCx online learners. We have created and developed at least 30 live events during the last year and we increased the number of live views in those events. In September 2019 and March 2020, we administered the fifth and sixth Comprehensive Final Exams (CFx) for learners who qualified by passing all five courses. The exam was proctored online and we tested a new software provider based on new, artificial intelligence technology. This was an important effort for the team, since we were pioneering the use of this technology in a major way.

We have also worked to create new materials and bring reality to the SCx courses. For this purpose:

- We added new lessons in supply chain fundamentals about transportation management.

- We conducted expert interviews with industry leaders that were included as part of the supplemental materials for SC3x: Supply Chain Dynamics, and SC4x: Supply Chain Technology and Systems.

- We created one new, virtual field trip to bring real projects to the SCx courses, in particular to SC4x: Supply Chain Technology and Systems.

- We finalized the research project funded by the MITili Learning Effectiveness Research Grant in February 2020. Thanks to this project, we proposed a framework to design, develop, and implement interventions to reduce the number of learners dropping out of MOOCs.

As of July 2020, over 365,000 learners from 196 countries across the globe have enrolled in at least one MicroMasters course. A total of 35,548 individual verified course certificates have been issued to more than 12,000 unique learners. A total of 2,243 MicroMasters credentials in supply chain management have been granted. The

MicroMasters team is currently preparing the next run of the Comprehensive Final Exam for October 2020 and is currently running three SCx courses this summer. A new intake of SCx learners began on July 29, 2020.

We participated in several conferences and academic events to share updates and results from the MicroMasters program, including Decision Sciences Institute (DSI) 50th Annual Conference, Sustainable Development Goals (SDG) Summit 2019, and other academic and industry events. We also published articles about the impact of the MicroMasters program in different journals, such as *Supply Chain 24/7* and *Supply Chain Management Review*.

Finally, the program received the Silver Winner award for the Best Distributed Program for Nurturing 21st Century Skills, granted by the QS Reimagine Education in December 2019.

MIT Global Supply Chain and Logistics Excellence Network

The MIT Global SCALE Network, conceived by MIT CTL, is an international alliance of leading research and education centers dedicated to supply chain and logistics excellence through innovation. Its mission is to create the next generation of supply chain management professionals who have a system-wide and global perspective, strong analytical problem-solving skills, a grasp of the latest and emerging technologies, and practical change leadership capabilities. Each local center contributes resources to conduct joint research, administer educational programs, and work with corporate sponsors.

In addition to the MIT Center for Transportation and Logistics, the network includes:

- Zaragoza Logistics Center (ZLC), Zaragoza, Spain

- Center for Latin American Logistics Innovation (CLI), Bogotá, Colombia

- Malaysia Institute for Supply Chain Innovation (MISI), Shah Alam, Malaysia

- Luxembourg Centre for Logistics (LCL), Luxembourg City, Luxembourg

- Ningbo China Institute for Supply Chain Innovation (NISCI), Ningbo, China

Collectively, the six SCALE centers offer 12 graduate-level and executive education programs (online, residential, and blended formats) and have in excess of 80 researchers and faculty, 150 corporate and more than 100 academic partners, nearly 50 administrative staff, and greater than 1,300 alumni working worldwide.

Education highlights

Since 2016, Paris-based Eduniversal has ranked the MIT SCALE 10-month residential SCM master's program the number one global supply chain management master's program in the world, while ZLC's master of engineering in logistics and supply chain management has been ranked number one in the logistics field in the "250 Best Masters in Spain" rankings by the newspaper *El Mundo* for nine consecutive years.

In addition to the residential master's program, MIT CTL, ZLC, and MISI offer blended or accelerated master's options to MITx MicroMasters in SCM credential holders, providing alternative pathways for nontraditional students to earn a master's degree

at lower cost and with less time out of the workforce. At NISCI, the 10-month SCM curriculum is incorporated into a two-year MBA conferred by Ningbo University. NISCI graduated its second cohort of students in 2020.

CLI offers the Graduate Certificate in Logistics and Supply Chain Management (GCLOG): an elite hybrid program combining online study with two, three-week residencies on the MIT campus, open to students pursuing graduate degrees at CLI's 30 Latin American partner universities. A cohort of 28 students completed the GCLOG program in 2020 and were awarded completion certificates on campus at MIT on January 31.

Students from all SCALE centers came together in January 2020 for SCALE Connect, three intense weeks of cross-cultural collaboration and learning through team projects, lectures, workshops, presentations, and industry site visits.

As the COVID-19 pandemic swept across the globe, NISCI was the first to close its campus and move to online instruction in early February 2020, followed by ZLC, LCL, and CTL in mid-March, and MISI later that same month. Students and researchers at several centers volunteered to assist industry partners and NGOs with supply chain-related problems arising during the global crisis.

After presenting their capstone and thesis research projects remotely to large online audiences, 168 students were awarded MIT SCALE certificates of program completion in 2020, and were the first recipients of MIT SCALE secure digital certificates delivered on blockchain.

Research and outreach highlights

ZLC continues to lead the European market in research and development (R&D) projects in the area of logistics and supply chain management, with 21 ongoing R&D projects funded by the European Union, private companies, and the government of Aragón. In AY2020, research at ZLC resulted in six articles in peer-reviewed journals, one Scopus database article, one book, and two book chapters. ZLC faculty and research staff presented their research findings in key national and international conferences.

MISI's funded research programs cover 50% of MISI's operating costs. They also have a strong National Center for Secure and Resilient Maritime Commerce (CSR) component, for example, MISI's palm oil supply chain project—with more than 20 MISI research assistants working on a daily basis with farmers to improve fertilization, collection, and supply chain practices—will improve the livelihoods of 5,000 independent, small holder farmers. MISI researchers published one book and eight papers in peer-reviewed journals in 2020.

LCL faculty and researchers presented at a number of industry conferences in AY2020, including INFORMS, Manufacturing and Service Operations Management (MSOM) Conference, International Test and Evaluation Association (ITEA) Paris Conference, Green Shipping Summit, Air Transport Research Society (ATRS) World Conference, and the Conference on Computational Management Science, the Lecture Series of the Research Institute for Supply Chain Management, and various symposia, including the International Symposium on Mathematical Programming and the Commodity and Energy Markets Annual Meeting.

CLI currently has 13 corporate partners with whom it develops a wide range of executive and collaborative research projects in seven research areas, and it has completed over 140 collaborative projects with industry.

NISCI continued its evolution as the newest center in the SCALE Network. In 2019, Jiequn "Jay" Guo was appointed director of the center, replacing Shaoxuan Liu; and NISCI opened a new building in September on Ningbo University's Meishan campus. The new building provides state-of-the-art classroom, meeting, office, and dormitory space under one roof.

Research

MIT Megacity Logistics Lab

The MIT Megacity Logistics Lab (MLL) focuses on understanding and transforming how supply chain organizations approach the provision of cities with goods and services in light of rapid global urbanization. As cities grow in size and density and are getting increasingly congested, last-mile delivery operations are becoming increasingly critical for the success of companies in reaching urban markets.

Since its founding in 2012, the MLL has grown into one of MIT CTL's most active research groups, attracting significant amounts of external funding from major private- and public-sector research partners. Among the sponsors of the lab are UPS, Walmart, Coca-Cola Femsa, Anheuser-Busch InBev, Adidas, and the World Bank Group.

The lab has engaged a large number of graduate and undergraduate students from all over the world and has started to offer the graduate course 1.263J/11.263J/SCM.293J Urban Last-Mile Logistics at MIT in spring 2019, which is cross-listed in MIT's Supply Chain Management, Civil and Environmental Engineering, and Urban Planning programs. Furthermore, the lab collaborates with a dense network of international researchers on topics of common interest.

Computational and Visual Education Lab

The MIT CTL Computational and Visual Education (CAVE) Lab is a research and education initiative started in 2017 around the use of interactive visualization to improve supply chain and logistics data visibility, advanced data analytics, and data-driven supply chain decision making. Leveraging a specifically created physical lab space at MIT CTL equipped with state-of-the-art visualization technology, the lab is working on developing interactive visual interfaces for data and analytical tools addressing complex supply chain and logistics problems.

The lab provides students, researchers, and decision makers with a more intuitive understanding of and access to quantitative methods to support strategic design, tactical planning, and operational decision problems in the supply chain and logistics domain and related fields. It provides a hands-on environment for learning about and implementing advanced analytics approaches to complex decision problems and also allows for an in-depth analysis of behavioral aspects of data-driven supply chain and logistics decision making.

MIT Humanitarian Supply Chain Lab

The mission of the Humanitarian Supply Chain Lab (HSCL) is to help meet human needs by understanding and improving the supply chain systems behind public services and private markets. The lab has a diverse portfolio of supply chain initiatives to improve emergency response during crisis and to strengthen markets in vulnerable communities.

Domestic research

Emergencies

The Humanitarian Lab continues to work directly with the Federal Emergency Management Agency (FEMA) on disaster preparedness efforts and real-time analysis during response operations. During AY2020, preparedness work was completed on Alternatives for FEMA Disaster-Related Housing Assistance, including a report exploring the role of factory-built housing, and the impact of transportation capacity in prepositioning humanitarian supplies. As a founding member of the Supply Chain Analysis Network, which guides federal leaders on effective assistance for private sector recovery, the lab was activated during multiple tropical storms (Barry, Erick, Flossie, and Dorian), an earthquake (Puerto Rico), and the COVID-19 pandemic. For COVID-19, HSCL delivered over 20 grocery sector and freight assessments in a 12-week period, each involving a weeklong research and industry peer review process before delivery to FEMA. These assessments provided FEMA with information needed to make informed decisions regarding food supply chain support on a region by region basis.

Resilience

The Humanitarian Lab was contracted by the National Academies of Science, Engineering, and Medicine to support its Post-Hurricane Supply Chain Adaptability Study sponsored by FEMA. This consensus study on supply chain resilience was released in early 2020. The HSCL developed models to facilitate identification of the most effective interventions for private sector supply chain restoration and created an application in the CAVE Lab to analyze the dynamics of Florida fuel supply.

International research

Emergencies

The United States Agency for International Development's (USAID) Bureau for Humanitarian Assistance (BHA) delivers food and nonfood items to people in need around the world. HSCL developed models and performance metrics to assess and improve BHA's nonfood item humanitarian response capacity as part of the Optimization-Based Evaluation of USAID BHA's Global Logistics Capacity project. The lab also supports BHA food aid response through the development of an Intelligent Food Tracking Dashboard. This dashboard will provide visibility into planning, procurement, shipping, storage, and last-mile delivery processes for a chosen country and capture data that can be later used to develop predictive analytics.

Development

The Humanitarian Lab conducts research on private sector supply chains that provide essential food and health products. As part of USAID Uganda: Market Systems Monitoring, we developed, in collaboration with George Washington University, the

System Pathways Toolkit for mapping and measuring complex market systems. This approach has been further applied to guide resilience programming in Karamoja, Uganda, and utilized to undertake a rapid assessment of the COVID-19 impact on Ugandan agricultural markets.

Sustainable Supply Chains

Supply chain sustainability has become a business imperative, fueled by the demands and requirements of consumers, governments, investors, and beyond. The Sustainable Supply Chains (SSC) initiative serves as a platform for MIT CTL researchers spanning a range of expertise areas to engage with students, industry, and stakeholders on topics including supply chain transparency, carbon accounting and offsetting, climate goals, local food systems, sustainable procurement, and the circular economy.

Over the last year, we advanced several meaningful research engagements. For example, we engaged with a consumer/packaged goods company to develop an e-commerce-based plastics recycling system; partnered with an industry association to gauge the state of supply chain sustainability across industry; and, supported an IT company and logistics service provider in developing their climate goals for freight transportation.

On the education side, CTL offers an on-campus course titled SCM.290 Sustainable Supply Chain Management and is developing an edX MOOC on the same topic. We collaborated with the MIT Environmental Solutions Initiative to build a sustainability training program for the mining sector. SSC coordinated an executive roundtable at Intel headquarters on the future of responsible supply chains and another on campus about circular supply chains. Our work also allowed us to speak at major venues, including the World Bank, World Economic Forum, The UN Climate Change Conference (COP25), Sustainable Purchasing Leadership Council, Renewable Energy Buyers Alliance, Council of Supply Chain Management Professionals (CSCMP) Edge, and more.

Through this and other work, we aspire to empower current and future generations of supply chain leaders to make a positive impact for people and planet.

MIT FreightLab

The MIT FreightLab was established in 2008 to advance the art, science, and practice of how shippers, carriers, and third parties design, procure, and manage freight transportation across the globe.

The management of freight transportation is becoming increasingly complex. Outsourcing of manufacturing overseas, constraints on infrastructure capacity, and a wider range of modal options are just some of the more recent trends leading to this complexity. This research initiative focuses on improving all aspects of freight transportation: design, procurement, management, systems, and execution. Recent projects have included forecasting short-term spot rates, exploring the linkage between strategic planning and operational execution, quantifying the cost of design complexity, and carrier responses to combinatorial auctions. Underlying all of these projects is the challenge of identifying and managing the uncertainty that is inherent in freight transportation networks.

In AY2020, the research was focused on PhD and master's theses and capstone project work, as well as the launch of our new website.

FreightLab projects include the following:

- The Driver Initiative

- Using machine learning to forecast short-term spot TL rates

- Measuring reciprocity between shippers and carriers under changing market conditions

- Measuring individual driver efficiency using ELD data

- Root cause analysis and impact of unplanned procurement on truckload transportation costs

- Impact of special events on the freight spot market

- Alternate pricing model for transportation contracts

AgeLab

The AgeLab is a multidisciplinary research program that works with businesses, government, and non-government organizations (NGOs) to improve the quality of life of older people and those who care for them. AgeLab enjoys sponsorship from corporations in multiple industry sectors addressing the needs of an aging society (e.g., property, casualty insurance, retail, auto, financial services, pharmaceuticals, consumer electronics, and consumer products). Sponsors include the American Association of Retired Persons (AARP), Bank of America, Google, Panasonic, The Hartford, Transamerica, Stanley Black & Decker, multiple car manufacturers, United Services Automobile Association, Humana, Florida Blue Cross Blue Shield, Travelers, Affectiva, and Lowe's Home Improvement, among others. The AgeLab conducted experiments and fieldwork that engaged 196 research participants for visits on campus, and over 14,000 research participants across in-field trials of hardware, surveys, focus groups, and in-depth interviews. AgeLab researchers authored 18 peer-reviewed journal publications, participated in numerous academic conferences, and wrote for and appeared in national media outlets, including the *Wall Street Journal* and the *Washington Post*. The AgeLab hosted two symposia of experts in the fields of caregiving and health/nutrition. With sponsor Five Star Senior Living, the AgeLab held the annual summit for its OMEGA program, an initiative designed to foster intergenerational connections between high school students and older adults. AgeLab also assembled a first-of-its-kind, 1,000-plus-participant caregiver panel, CareHive, as a new means of gathering data about the caregiver experience. On-going research and insights developed over 20 years were captured in a new graduate Department of Urban Studies and Planning course successfully offered in spring 2020, 11.S941/11.S195 Global Aging: Planning Cities for a 100-Year Society.

Following the COVID-19 outbreak in the United States, the AgeLab moved nearly all its operations and research online, including its ongoing, bimonthly focus group

of consumers age 85 and over. It continues to conduct research and collaborate remotely, including on a new, cross-generational survey series exploring life, work, and consumerism in the Covid era. It will convene two symposia remotely this coming fall: on new caregiving resources and the impact of artificial intelligence and machine learning on the life course, respectively.

The AgeLab is recognized worldwide as an innovator in understanding the demands of the evolving longevity economy and its impact on various complex systems, including transportation, health, finance, and community development. Collaborating with multiple departments, including the Media Lab (Livable Communities), Departments of Urban Studies and Planning (Future of Real Estate), Brain and Cognitive Sciences (Aging Brain Initiative), and Mechanical Engineering in conjunction with the Computer Science and Artificial Intelligence Lab (Ubiquitous Computing and Autonomous Systems), the AgeLab is laying new ground in thinking about retirement, information presentation and design, autonomous vehicle systems, and home services that offer both convenience and care across the lifespan.

MIT GeneSys: Supply Chain Management for Micro and Small Firms in Developing Countries

The MIT GeneSys project aims at contributing to the survival and growth of micro and small firms (MSEs) by improving supply chain management.

Since 2016, we have developed a comprehensive methodology, a data collection process, and a mobile app that provides a detailed assessment and recommendations to increase the survival of MSEs. We have partnered with 20 universities in nine countries in Latin America (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, and Uruguay) and worked with more than 1,000 undergraduate students who have participated in the data collection and assessment of at least 500 MSEs.

In the face of the sudden outbreak of the Coronavirus, the world has been pushed into a recession, and the economic damage is mounting across all countries, but more severely in Latin America and the Caribbean where 99% of the companies are MSEs, representing 47% of the employment in the region. As a response to this crisis, we broadcasted six webinars, with the participation of more than1,500 MSE managers from the nine partnering countries in Latin America. These webinars were focused on providing insights into the different ways to mitigate the impact, and improve MSEs survival via better supply chain management.

Consequently, our team has outlined and deployed a large-scale research project for fall 2020 organized in the following three research questions and objectives. These studies aim at helping MSEs survive the crisis of COVID-19.

Fifteen universities have joined the project (some of them with multiple campuses participating), with presence in the following countries and regions: Bolivia (La Paz and Santa Cruz); Brazil (Rio de Janeiro and Florianópolis); Colombia (Bogotá and Medellín); Ecuador (Quito); Mexico (Mexico City, Aguascalientes, State of Mexico, Puebla, Monterrey, and Torreón); Peru (Lima and Piura); and Uruguay (Montevideo).

In sum, we have in excess of 200 MSEs participating in this research project, with greater than 40 faculty members and researchers, and more than 400 undergraduate students, one master student, and two PhD students. All students will be trained in the use of a mobile app to gather data from the MSEs.

The expected outcomes of this large-scale project are as follows: First, to help MSEs in Latin America under study, mitigate the impact of the COVID-19 crisis. Second, to develop and disseminate the findings of the applied research that will be used to scale the impact with other MSEs in similar challenging conditions. Lastly, to develop supply chain management competencies in students in Latin America as a tool for the training of future professionals, and scale up the impact in the region.

Finally, in order to disseminate our findings, we are planning to conduct large-scale webinars, and a web-based simulator in which any MSE could input their data and obtain recommendations and share best practices. We will use our media connection and other sources to engage with more MSEs and key stakeholders of the region.

Measuring and Investing in Resilience

This project extends 15 years of research done on resilience here at CTL. It focuses on identifying how to make the case for investing in resilience and overall risk management for businesses. Considering the increasing frequency of disruptions that have affected supply chains over the past 19 years, companies now recognize the importance of being able to actively manage supply chain response to disruptions, and they also recognize the importance of making investments in resilience to protect the franchise and to protect the business's ability to continue serving customers despite disruptions.

Currently, there are no precise ways to answer the host of questions that managers must address in order to make investment decisions: What different investments should be considered? How effective are different methods to achieve resilience? What is the cost of resilience? And so on. A primary focus for this work starts at understanding how firms go about making risk management and resilience investment decisions, and solicits companies to participate by sharing their practices in order to identify the frontier of practice in making these kind of investments. Subsequent phases of study intend to develop methods for making the financial investment case for resilience.

Organizations have come to realize that investments in supply chain resilience are needed to protect the franchise and continue serving customers despite disruptions, with example cases like Topps Meat Company, the Ford Motor Company, and Soybean Farmers. The work to date has generated a novel approach for assessing investments in supply chain resilience by innovating in three areas: process integration, data visualization, and investment value calculation. Moving forward, the project will work with organizations to test actual data in the process, visualizations, and models with the intent of soliciting feedback to generate iterative improvements from an implementation perspective. This work has the potential to create an accepted, standardized approach that organizations can use to justify investments and supply chain resilience and ensure that the franchise is protected and can continue serving customers despite ever-increasing disruptions.

Omnichannel Distribution Strategies

While most of the existing research in this area has focused on the sales side of the omnichannel movement, our work focuses on appropriately designing the physical network of urban goods transportation that would form the backbone of any omnichannel strategy. We propose a model that helps retailers integrate both online and offline channels and design a more efficient omnichannel distribution network.

We developed a mixed integer programming model for the network design problem of a carrier specialized in online deliveries. The model incorporated customer preference for click and collect facilities and studies the impact of several relevant parameters.

We published a paper about omnichannel logistics network in *Computers and Industrial Engineering*, a top international journal in the field.

We also developed a network design model to integrate offline and online channels in the grocery business. The model shows that omnichannel can deliver improved performance and reduced costs in the grocery business. We published the results of this model in *Supply Chain Management Review*.

Food and Retail Operations Lab

Retailers play an important role to connect food production systems (i.e., consumer packaged goods manufacturers, restaurants, and farmers) to end consumers. However, end consumers are diverse and have changed their purchasing behavior in terms quantity, frequency, variety, and shopping channels; particularly, during the COVID-19 crisis. In addition, the fragmentation of farmers and retailers have increased in the world, increasing the logistics and commercial challenges to serve all population in effective and inclusive ways. The Food and Retail Operations Lab's mission is to create high-performance supply chain and route-to-market strategies to match dynamic consumption patterns to retail and so-called e-tail channels to ensure product accessibility, availability, and affordability and avoid social backwardness.

To meet that mission, the lab performs high-impact research to build data-driven decision- and policy-making strategies to improve supply chain operations to serve retailers and e-tailers, particularly, the smallest businesses (i.e., nanostores) that account for 57% of the world's market share. Our studies show that they are relevant to supply food to over 65% of the world's population that lives on less than $5 per day. Given the most vulnerable population segments purchase their goods in nanostores, we aim to understand significant factors of consumer choice and to analyze their evolution over time, so as to build high-performance supply chains to increase social inclusion and reduce disparity and food insecurity. Also, we are looking to increase the survival rate of nanostores by improving operations considering scarce storage capability, limited budget, shopkeeper's mindset, and low technology adoption rates.

To combat food malnutrition, we are assessing the use of food access models, such as ridesharing, grocery delivery models, and use of coupons; and configuring innovative distribution strategies, such as subscription-based models to reduce the number of intermediaries, food waste, and logistics costs. Furthermore, we are linking smallholder

farmers to nanostores, promoting the development of better practices among farmers, creating direct-to-consumer channels through models that promote zero waste, inclusive marketplaces, and help solving issues present in food deserts and underserved communities across the world.

Outreach

The foundation of CTL's corporate outreach is the Supply Chain Exchange: a large, active, and robust corporate membership program in the supply chain management field.

Corporate Relations

During FY2020, CTL dropped six companies from the Exchange: BASF, Fruit of the Loom, Iron Mountain, MSC Industrial Supply, Nordstrom, and Trawind Shipping Logistics. Nine were added as partners to the exchange: Amazon, Biomarin Pharmaceutical, GlobalTranz, LLamasoft, New Balance, Salesforce, Schneider National, Starbucks, and Waters Corporation.

Outreach Events

In FY2020, CTL organized 15 events. Following the closure of campus due to the COVID-19 pandemic, CTL moved all events to be conducted virtually. Unfortunately, a number of events had to be postponed or canceled.

- This year's CTL Crossroads Conference (April 28, 2020) focused on innovations that are driving revolutionary change in the supply chain world. The conference featured experts from MIT speaking about the technologies that will likely impact supply chain management in the future.

- CTL held two sessions of its major supply chain management executive education course (June 2019 and January 2020), Supply Chains: Driving Strategic Advantage. The June course was also attended by 24 executive MBA students from the Antwerp Business School and 24 from the Institute of Business Studies, Moscow.

- CTL conducted custom executive education courses at partner locations in the United States and Europe.

- On January 29, 2020, CTL held its ninth annual networking night and poster session. Over 180 students from all SCALE Network programs (CTL, ZLC, CLI, and MISI) presented in excess of 100 thesis projects to more than 80 representatives from 50 companies.

- On July 28, CTL hosted the second annual SCx Supply Chain boot camp that was attended by more than 20 students.

- CTL hosted the following events for CTL Supply Chain Exchange partners:

  - Data Management: Preparing for Machine Learning, October 15–16, 2019 (MIT), November 13, 2019 (Malaysia)

  - Toward Circularity in the Supply Chain, December 4, 2019 (MIT)

  - Virtual Exchange on Coronavirus Response, March 11, 2020 (virtual)

  - Research Fest featuring student thesis final presentations, May 15, 2020 (virtual)

- In March 2020, CTL began hosting a weekly series of research briefings for Supply Chain Exchange members. The Supply Chain Exchange Virtual Series has hosted a number of CTL researchers who have presented on a range of topics, including supply chain resilience, the impact of COVID-19, supply chain sustainability, and more.

Capstone Projects and Research Partners

In the Supply Chain Management master's program, 18 companies participated as Supply Chain Exchange capstone and thesis partners. This year's projects included the following:

- Assessing the State of Supply Chain Sustainability

- Continuous Multi-Echelon Inventory Optimization

- Building Sustainable Supply Chains in the Era of E-Commerce

- Machine Learning and Optimization-Based Modeling for Asset Management

- Designing an Efficient Supply Chain for Specialty Coffee from Caldas-Colombia

- Resource Optimization During Merger and Acquisitions Transactions

- Supply Chain Coopetition: A Simulation Model to Explore Competitive Advantages in Logistics

- Reducing Oil Well Downtime with a Machine Learning Recommender System

- Traditional Routing Guide Performance and Segmentation to Improve Compliance with Contracted Budget

- Going Awry: Understanding Transportation Budget Failures

- Predicting and Planning for the Future: North American Truckload Transportation

- Closing the Gap between Information and Payment Flows in a Digital Transformation

- Application of Linear Models, Random Forest, and Gradient Boosting Methods to Identify Key Factors and Predict Truck Dwell Time for a Global 3PL Company

- Closing the Food Access Gap in American Underserved Communities

- Scenario Planning for Offshore Wind Supply Chains 2030

- Conditions for Deep Supplier Engagement: A Cross-Case Comparison

- Optimizing Fleet Utilization by Adjusting Customer Delivery Appointment Times

- Utilization of the American Truck Driver

- An Omnichannel Distribution Model to Better Serve Online Customers

- E-Commerce Based Closed-Loop Supply Chain for Plastic Recycling

- Increasing Supply Chain Visibility by Incentivizing Stakeholders to Use Blockchain

- Development and Application of an Immunization Network Design Optimization Model for UNICEF

- Humanitarian Assistance for Markets in Conflict: A System Dynamics Approach

- Data Aggregation for Data Analytics in Medical Device Supply Chains

- Dynamic Trade Policy and Supply Chain Design within the Oil and Gas Industry

- Mirroring Payment Terms and Lead Times

- Improving the Cash Availability of Small Firms in Latin America via Better Inventory Management

- A Time Series Model for China to US Ocean Freight Pricing

- A Predictive Model for Transpacific Eastbound Ocean Freight Pricing

- Achieving Sustainable Growth at Uber Freight

- Dealing with Complexities in Digital Supply Chain

- Manufacturing Digital Transformation Strategy For FMGG

- Human-Machine Teaming in AI Driven Supply Chains

- Human-Machine Teaming for Intelligent Demand Planning

- Optimizing Satellite Locations for a Multi-Echelon Last-Mile Distribution Network to Utilize Alternative Delivery Vehicles for Last-Mile Delivery

- IoT-Based Inventory Tracking in the Pharmaceutical Industry

- CO_2 Emissions of Innovative Last-Mile Delivery Solutions

- Facility and Routing Decisions in Truck-and-Drone Distribution

- Eliminating Last-Mile Inefficiencies in the Trucking Industry

- Capacity and Inventory Optimization for Pharmaceutical Industry

- A Forecasting Face-Off for Oil and Gas Spare Parts

- Evaluating Inventory Risk Pooling Strategy for Multi-Echelon Distribution Network

- Intermittent Demand Forecasting for Inventory Control: The Impact of Temporal and Cross-Sectional Aggregation

- Inbound Logistics Optimization

- How to Plan and Schedule for Profit: An Integrated Model and Application for Complex Factory Operations

- Exploring Carbon Offset for Freight Transportation Decarbonization

- Right Sizing Safety Stock and Effectively Managing Inventory Using Forecastability

- Using Machine Learning Approaches to Improve Long-Range Demand Forecasting

- A Natural Language Processing Approach to Improve Demand Forecasting in Long Supply Chains

Personnel Changes

In FY2020, new hires and appointments at CTL included Bedriye Akson, senior program assistant; Maria Besiou, research affiliate; Bobbie Bredfeldt, research affiliate; Andrew Duncan, data software engineer; John Flannery, hardware engineer; Jan Fransoo, research affiliate; Chelsey Graham, research associate; Mary Griswold, events planning assistant II; Yifan Lu, research affiliate; Atieh Madani, postdoctoral associate; Arnold Maltz, research affiliate; Daniel McCool, communications coordinator; Alberto Morando, postdoctoral associate; Mohammad Moshref Javadi, research affiliate; Beatriz Royo Agustin, research affiliate; Heesuk Son, postdoctoral associate; Elise Tanner, technical associate I; Ozden Tozanli Yilmaz, postdoctoral associate; Michael Veatch, research affiliate; and Meng Wang, machine learning engineer.

In addition, visitors to CTL included visiting military scholars Lieutenant Colonel James Ezell; Lieutenant Colonel (Promotable) Erin Miller; Colonel Stanley Ostrem; and the following international visiting scholars and students: Mojdeh Azaddisfany, Lygia Bronneberg, Daniel Calcinaro, Fiona Guerin, Walid Klibi, Daniela Neupert, and Luis Eduardo Wilbert Albernaz Andrade.

Departures from CTL included Justin Boutilier, Bobbie Bredfeldt, Li Ding, Lex Fridman, Karla Gamez Perez, Marina Guimaraes Mattos, Sina Golara, Jason Gordon, Adam Lovett, Mohammad Moshref Javadi, Aleksandr Patsekin, Alexander Rothkopf, Luca Russo, Maria Bernarda Serrano Duenas, and Michael Windle.

With 10 years at MIT, Bruce Arntzen retired in August. After 34 years with MIT, Nancy Martin retired in April. After 41 years at MIT, Frederick Salvucci retired in January. He will still retain a 10% appointment.

Yossi Sheffi
Director