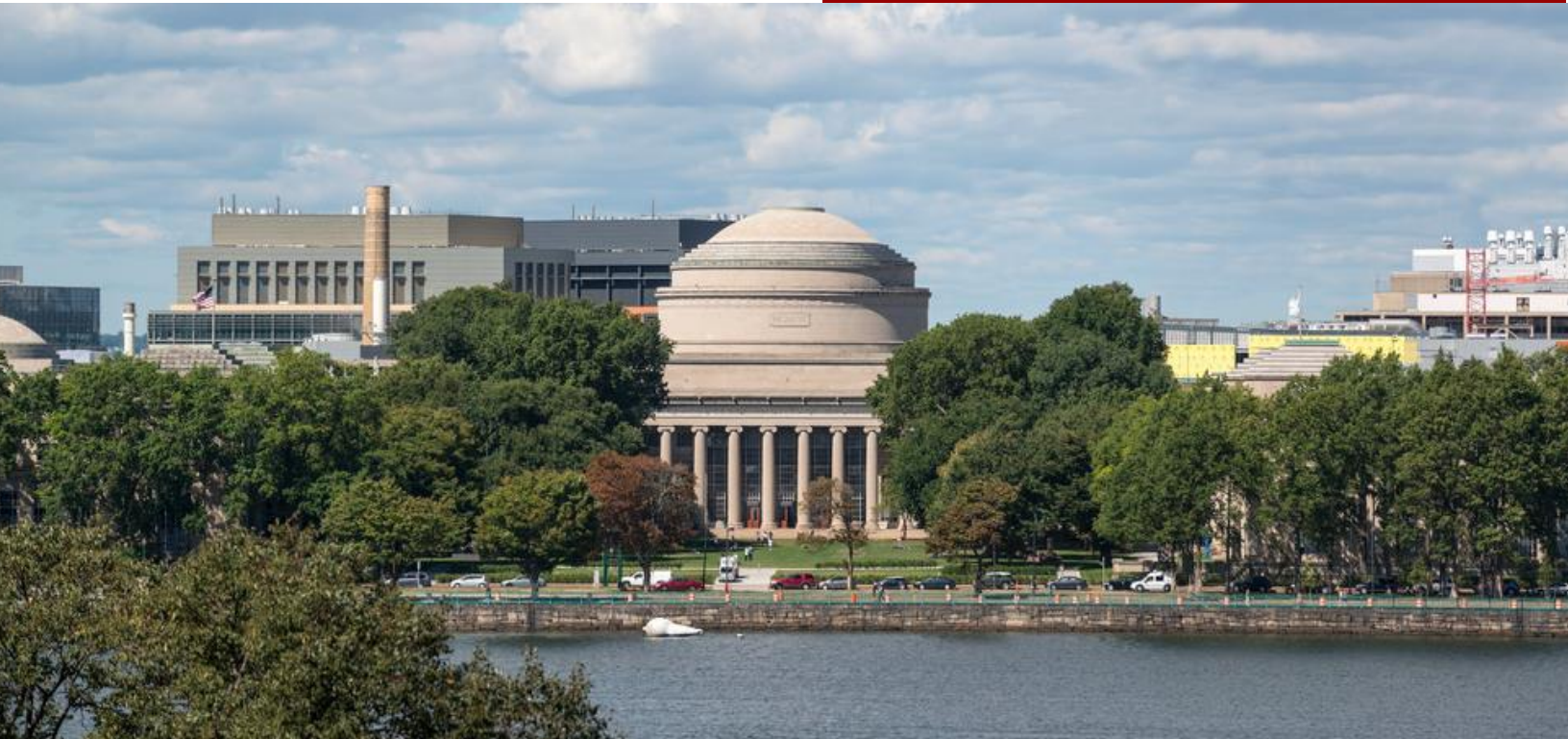




# 2018 MIT SCALE Latin America Conference Proceedings



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# 2018 MIT SCALE Latin America Conference

## Event Summary

In 2008, the MIT Center for Transportation & Logistics (CTL) and GS1 firm LOGYCA, signed a multi-year agreement to create the Center for Latin-American Logistics Innovation (CLI) as part of the MIT Global Supply Chain and Logistics Excellence (SCALE) Network. This partnership currently brings together over 20 Latin-American top universities (i.e., academic partners) to perform cutting-edge research in the region, build an educational agenda that fits the needs and responds to the challenges of the region. The vision of the MIT SCALE Latin America network is to lead innovative research and educational initiatives, with the purpose of creating, applying and transferring knowledge for the betterment of Latin America and the world.

As a key initiative of this regional alliance, the MIT SCALE Latin America network and the MIT SCALE Latin America center (i.e., CLI) organize every two years an academic conference with researchers, students and practitioners from supply chain management (SCM) and logistics fields, coming from all over Latin America. This conference is a unique forum designed for sharing emerging and applied multi-disciplinary research in all aspects related to logistics and SCM relevant to Latin America.

In this document, we present the conference proceedings from the 2018 MIT SCALE Latin America conference held at the MIT campus in April 15<sup>th</sup> – 16<sup>th</sup>, 2018. The event hosted more than 170 attendees coming from 14 different countries (mainly from Latin America). The conference accounted for 85% academics (professors, researchers and students), 14% practitioners and 1% public authorities. In the event 99 research articles were presented in 15 sessions with key nine topics for the region. These tracks comprise 1) Data-driven and emerging technologies in supply chain management (SCM), 2) Agro-logistics, mining and livestock in supply chains, 3) SCM for small firms and retailing operations for nanostores, 4) Urban logistics and last-mile operations, 6) Resilience and risk in supply chains, 7) Humanitarian logistics and relief operations, 8) Innovations in education-related to SCM and 9) Logistics public policy-making and infrastructure. We also had a special track for (graduate and undergraduate) student paper competition.

For the reader, we have grouped the abstracts according to the aforementioned nine topics. We hope that at least one of these areas will pick your interest and motivate your learning. We sincerely hope you enjoy the abstracts as much as we did.

Dr. Christopher Mejia  
Director, MIT SCALE Latin America Network

Isabel Agudelo  
Director, Center for Latin-American Logistics Innovation

# 1. Data-driven and emerging technologies in supply chain management (SCM)



### Demand planning: Case study in a fashion and accessories Latin-American company

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Aranda-Portocarrero, C.<sup>1</sup>

1. School of Engineering, Universidad del Pacifico, Peru

Demand forecasting plays a key role in a company's supply chain, as this is the basis for all future planning. In the fashion industry, three characteristics increase the complexity of the forecast: single-period product life cycles, long replenishment lead-times and large product variety. This study develops a methodology based on the combination of two independent approaches for demand forecasting: the first is a qualitative approach, which uses historical analogies, and the second is an extrapolative approach based on the characteristics of new products. Both approaches were applied in a Latin-American fashion and accessories company. The results show a consistent reduction in the three categories of the business unit, as well as an increase of the operating profit associated with the reduction of inventory costs and obsolescence.

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### Material Requirement Planning (MRP) systems for department of maintenance in production: Implementation proposal.

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Zuluaga A.<sup>1</sup>; Ruiz C.<sup>2</sup> and Conti D.<sup>3</sup>

1. Master of Industrial Engineering, Colombian School of Engineering Julio Garavito, Colombia

2. Department of Industrial Engineering, Colombian School of Engineering Julio Garavito, Colombia

3. Department of Applied Mathematics, University of Campinas, Brazil

According to Duffuaa et al. (2010), most of the materials stored in a company are related to maintenance and production. The constant need to improve the performance of companies to become more efficient has led them to advance the control of their inventory complex processes. Thus, the implementation of Material Requirement Planning systems (MRP) is considered a good practice. If the existing literature is evaluated, most of the inventory of material is concentrated in the processes related to maintenance and likewise systems such as the MRP. Therefore, the analysis and modelling of MRP systems applied to the management of inventories in

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maintenance operations presents a great research opportunity. This type of model determines and facilitates the planning of the requirements of materials for maintenance operation. Final results were obtained by evaluating existing models, determining variables and constraints and by testing the model used for this research against different scenarios with hypothetical data. This project is in work in process (WIP), so in this paper we show an implementation proposal for MRP in the maintenance process.

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### An Expansion on the KM<sup>2</sup> Methodology: A Clustering Algorithm Comparison for the Case of Lima

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Regal, A<sup>1</sup>

1. School of Engineering, Universidad del Pacifico, Peru

The current methodology is applied in last-mile logistics research at a km<sup>2</sup> level. This methodology involves the characterization of a city to generate logistic profiles. These profiles are based on secondary sources of data, mainly road network infrastructure, socio-economic data and population density. The final profiles are built using a K-Means algorithm, which uses principal component analysis (PCA) for correlation analysis. Previous research has shown that PCA is sensitive to outliers and high dimensionality, which might limit the conclusions of this research. Different clustering algorithms were developed to deal with the data and the outliers and to improve the performance of the model. This paper presents a comparison of clustering algorithms to evaluate their performance when determining Lima's logistics profile.

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### Evaluation of artificial intelligence to increase trust and drive ecommerce sales in the Peruvian rental market

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Helfer, S.<sup>1</sup>

1. School of Engineering, Universidad del Pacifico, Peru

This study seeks to evaluate the benefits of leveraging artificial intelligence (AI) to increase trust and drive e-commerce sales for an established retailer in the Peruvian market, where only 16% of internet users engage in online shopping. Benefits are measured by the profits generated from

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additional revenue of new customers who would try online shopping for the first time and cost savings gained from operational efficiencies. It is estimated that an additional 5% of customers would trust the e-commerce platform, based on other retailers, which have undertaken similar initiatives; on the other hand, costs savings are calculated by comparing operating call center cost estimates against consumption of AI services to hold conversational interactions with customers. This evaluation indicates that sharing trust through AI technologies holds over US\$500,000 of benefit for the retailer, when compared to relying solely on human interaction. This application of AI might help establish retailers to remain competitive amid a challenging and disruptive environment.

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### Measuring promotions performance with financial KPIs from the manufacturer, retailer and supply chain perspective: a case study.

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García Castillo, J.<sup>1</sup>; Castañeda, A.<sup>1</sup> and Cárdenas, A.<sup>1</sup>

1. Center for Latin-American Logistics Innovation (CLI), Bogota, Colombia.

During the last two years, traditional retailers in Colombia have struggled against a new business concept: Hard discounter stores. This distribution channel offers basic shopping basket products with relatively low prices. To remain competitive and preserve their market position, traditional retailers must improve their processes and their pricing decisions. Promotions and discounts have been considered as an effective alternative to compete. Most companies base their promotions planning on intuition, disregarding other supply chain echelons and ignoring the effect of supplementary products. This study aims to measure the net performance of promotions in a supply chain, which does not adopt any collaborative strategy using financial KPIs. The study involves one CPG manufacturer and two retailers in Colombia, whose total market share is over 66%. Authors calculate the effect over individual and global financial KPIs, considering different products categories and country regions. Results highlight that benefits are unequally distributed along the different echelons, and the supply chain performance is affected when pricing decisions are made independently.

## 2. Agro- logistics, mining and livestock in supply chains





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### Daily Train Scheduling in Seaport Terminal: a MILP approach

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Guedes, L. S. M.<sup>1</sup>; Bretas, A. M. C.<sup>2</sup>; Faria, C. H. F.<sup>2</sup>; Medeiros, B. T.<sup>1</sup> and Moreira, B. D.<sup>1</sup>

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2. Department of Production Engineering, Federal University of Minas Gerais, Brazil

This work proposes a mixed-integer linear programming (MILP) model for the daily train-scheduling problem. All trains operate by Valor da Logística Integrada (VLI) in the São Luis port, Brazil, are scheduled to minimize the departure times. This is because an important efficiency indicator for a railway operator in seaport terminals is the railcar dwell time. The railroad system in the port consists of two classification yards and five terminals with a double-track railway for circulation. Different products are transported (e.g. grains, minerals products, cellulose and fuel). The model also incorporates different operations at the terminals, railroad and terminal occupation restrictions due to maintenance and third-party flow in the system. These special features are modelled through a pre-processing step. In this phase, a series of auxiliary sets are defined in order to simplify constraints and circulation options are mapped using operational rules. In addition, the double-track is divided into segments based on the transit-time with the objective to control line occupation. This pre-process step also reduces the model complexity, and consequently, the computational time as shown in the numerical tests using real-world operational data.

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### A hybrid method combining exact and heuristics approaches for the integrated supply chain planning: a Brazilian grain export logistic case

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Bretas, A.M.C.<sup>1</sup>; Faria, C.H.F.<sup>1</sup>; Guedes, L.S.M.<sup>2</sup>; Moreira, B. D.<sup>2</sup>; Tazoniero, A.<sup>3</sup> and Gonçalves, R. A.<sup>3</sup>

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3. Nitryx Consulting, Brazil

This work presents a practical implementation of a three-phase optimization model applied in the scheduling of terminal, railway and port operations of a grain-export flow and fertilizer-import flow in Brazil. A multi-commodity network flow model for empty and loaded cars, a

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discrete event model to build a detailed solution considering all operational constraints and a local search model to improve the solution compose the algorithm. The objective function is to maximize the total loaded weight of products. Some practical results are presented and the importance of end-user tests phase highlights the evolution of the number of loaded wagons. Comparisons between the scheduling process using worksheets and the mathematical model show a result 7% better. The developed system has been used daily by VLI (Valor da Logística Integrada S.A.) and new improvements are planned to be performed soon.

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### Demand management to optimize the supply chain of an agribusiness company

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Perez-Franco, R.<sup>1</sup>; Pérez, A.<sup>2</sup>; Villamonte, C.<sup>2</sup>; López, C.<sup>2</sup>. and Chong, M.<sup>2</sup>

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2. Master of Supply Chain Management, Pacifico University, Peru

The growing consumption in the world of the so-called super food, such as quinoa (*Chenopodium quinoa*), establishes new challenges for a small business that is active on the transformation and marketing of the product. This allows them for taking advantage of the positive conditions of the market in a rapid and flexible way.

The current research proposes the optimization of the supply chain for the company called BANSAC, using strategic diagnosis methodologies like CSAR methodology (Pérez-Franco, 2016) and operational analysis such as value stream mapping – VSM (Martin and Osterling, 2014). CSAR methodology made possible to carry out an analysis in multiple dimensions and build a logical bridge between the company's strategy and the activities performed. This provided the company the capacity to adjust its strategy before any changes in the market.

As a result, the strategic flexibility of an efficient supply chain gives priority to operational activities, which enhances growth objectives to be achieved. For that reason, an adjustment in the supply chain sourcing strategies to promote a pull-push strategy must be performed to allow an increase in sales of US\$ 239,475 per year.

### Determining port hinterlands: The case of agricultural products in South American ports

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Mac Cawley, A.F<sup>1</sup>; Florez, L.<sup>2</sup>; Maturana, S<sup>1</sup>. and Giesen, R<sup>2</sup>.

1. Department of Industrial Engineering, Pontifical Catholic University of Chile, Santiago, Chile.
2. Department of Transportation and Logistics, Pontifical Catholic University of Chile, Santiago, Chile.

This paper builds a model to determine the hinterlands for South America's main ports, considering Euclidean distances as well as the actual routes existing in the region. Further, differences between these two methods were analyzed and the impact of the main cost variables on the port hinterland was quantified. This is a new approach to hinterland modeling, since it considers the actual routes used to transport goods in the region. The paper is based on the idea that port election is mainly based on the objective of minimizing the total cost of intermodal freight transport. The methodology can be used to determine the ports' captive hinterlands and analyze which variables can significantly affect the size and the shape of these hinterlands. The methodology was applied to six ports in South America and four destinations. Results show that the differences between the hinterlands modelled by the two methods are considerable, reaching 280 billion dollars in GDP captured for some ports.

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### Enhancement of the supply management of materials and goods in an agribusiness company

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Ochoa, J.<sup>1</sup>; Ríos, F.<sup>1</sup>; Sakihara, L.<sup>1</sup>; Chong, M<sup>1</sup>. and Perez-Franco, R.<sup>2</sup>

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2. Centre for Supply Chain and Logistics, Deakin University, Australia

Agribusiness companies in Peru are known particularly for being created as family businesses during their early stages. Therefore, their growth has been disorganized, informal and empirical. During the last decade, the growth of international demand for high-quality agricultural products, supported by the signature of free-trade agreements, has benefited agroindustry with

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private foreign investment. Such situation has prompted Peruvian agribusiness companies to standardize and automatize their processes to be more competitive. El Pedregal is a Peruvian agribusiness company dedicated to cultivating, harvesting, packaging and exporting fresh fruits. It owns three farms in the coastal area of Peru that makes the supply chain more complex. This scenario can cause additional, undesired expenses, overtime and low quality of working hours. This research paper focuses on enhancing the supply process of this agribusiness company. To develop this study, we use the supply chain strategy methodology detailed in Perez-Franco (2016), the Lean Supply philosophy and the big data tool QlikView. This set of techniques allowed us to identify the root problem of El Pedregal's logistics area and to organize a new procurement process.

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### Integration of Strategic and Tactical Planning in Agro industrial Supply Chains

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Gutierrez, E<sup>1,2</sup>; Sarmiento, A.<sup>3</sup> and Rabelo, L.<sup>2</sup>

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2. Department of Industrial Engineering and Management Systems, University of Central Florida, USA
3. University of La Sabana, Colombia.

This paper aims to propose a framework that supports decision making in supply chains. A case study in the biofuel industry in Colombia is described to illustrate the mathematical modeling design when strategic and tactical decisions are involved. The emphasis is on the formulation and linking of models representing levels of decision-making. First, deterministic models of linear programming were developed and analyzed, and secondly, the approach of a two-stage stochastic linear programming model was implemented to consider uncertainty in a set of scenarios with associated probabilities for the biodiesel demand. The results support strategic and tactical decisions such as harvesting, production plans, distribution, capacity expansion, allocation and production mixture percentages. The optimization models formulated in this study represent a flexible tool that allows a central planner to define actions according to the conditions of the supply network. Therefore, the proposed models might be used to evaluate the

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inclusion of new raw materials, define the increase of capacities in the production plants and, in general, make tactical and strategic decisions for distribution and production.

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### Using discrete-event simulation in capacity planning for grain storage terminal with loop track

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Medeiros, B. T.<sup>1</sup>; Faria, C. H. F.<sup>2</sup>; Guedes, L. S. M.<sup>1</sup> and Moreira, B. D.<sup>1</sup>

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2. Department of Long-term planning, Valor da Logística Integrada (VLI S.A.), Brazil

This work presents a capacity planning for a Brazilian storage terminal integrated with a loop track using discrete-event simulation. In multimodal flows, it is increasingly common to use logistical terminals for integration. However, in a large-scale supply chain, a strategic capacity planning for terminals is important to analysis and avoid impacts on the railroad operation and the grain stock balance. The proposed simulation model can be replicated to other storage terminal with a loop track.

### **3. SCM for small firms and retailing operations for nanostores**



### Supply Chain Description of SMEs in Ecuadorian's Flowers Industries. Case Study: "Canton Pedro Moncayo"

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2. Department of IT in Production and Logistics, Technische Universität Dortmund, Germany

Ecuador is one of the main exporters of flowers in the world. In average, Ecuadorian flower industry employs 11.8 workers per hectare, creating thousands of direct and indirect jobs. However, the industry has many performance gaps along the supply chain. By identifying these problems, the industry may solve them and increase their competitiveness in the world market.

Canton Pedro Moncayo was selected because of the high density of flower industry. In the province of Pichincha, there is 66% of the Ecuadorian flower production. The distribution of flower production in Pichincha is 39.4% in Pedro Moncayo, 30% in Cayambe, 25.4% in Quito and 5.2% in the rest of the countryside. The data collection was performed in 12 flower producers with a maximum size of 10 hectares. Growers are located in Cayambe and Pedro Moncayo and were selected using sampling by convenience. The main objective of this study is to characterize the supply chain of flower firms by using a guideline manual about micro and small firms from MIT Center for Transportation & Logistics. The data collection process is conducted iteratively until a proper validation of the data is performed. This study found many problems in the supply chain related with a low adoption with the practices of the SCOR model.

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### Implementation of Management Science Techniques in 47 Companies Settled in a Latin American Country

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Sánchez-Partida, D.<sup>1</sup>; Martínez-Flores, J.L.<sup>1</sup>; Caballero-Morales, S.O.<sup>1</sup> and Cano-Olivos, P.<sup>1</sup>

1. Department of Logistics and Supply Chain Management, Universidad Popular Autónoma del Estado de Puebla, México

This study presents the common logistics problems when the companies make empirical decisions and the proposed solution in accordance to the context analyzed. Throughout the

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years 2013, 2014, 2015, 2016, and 2017, forty-seven companies settled in Mexico were analyzed. These companies are Small and Medium Enterprises (SMEs) and belong mainly to manufacturing, automotive, pharmaceutical, and service sectors. All these companies have increased their logistics costs by not having skillful employees with knowledge in Management Science (MS) techniques. For example, the forecasting, order planning and inventory levels are elaborated empirically resulting in elevated logistics redundancies and undesired costs. In the present paper, Production and Inventory Planning and Control Systems were implemented. The benefits obtained include a reduction of the variability in the demand, cost reductions by using lean manufacturing processes, appropriate inventory levels, and adequate customer service levels. In addition, around US\$1.2 million were obtained in annual savings registered after the implementation of the proposal in 10 participating companies. Furthermore, four companies are in the evaluation stage and the potential annual savings of implementation are estimated to in US\$5.9 million.

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### **A collaborative logistic cost-reduction strategy (S-CJRP) for non-competitive small and medium sized enterprises.**

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This paper introduces a collaborative strategy suitable for non-competitive small and medium sized enterprises (SMEs). It aims to reduce the logistics cost for these firms by using a joint replenishment of multiple items. The proposed approach is an extension of the classical joint replenishment problem (JRP), called Stochastic Collaborative Joint Replenishment problem (S-CJRP) since it considers stochastic demand, but also contemplates real world constraints such as finite warehouse and transport capacities and multiple buyers and vendors. This research addresses three main problems: (I) determines the frequency in which each buyer should replenish her products, (II) allocates investment and benefits between partnering buyers and (III) decides whether to internally coordinate the supply chain or outsource. The S-CJRP is solved through a heuristic approach that deals with (I); S-CJRP incorporates the use of the Shapley Value Function in order to deliver solution for (II). In addition, (III) was examined by using several scenarios that consider unexpected variations in the parameters. All scenarios showed prospective cost reductions in inventory levels. Yet, both holding and ordering costs could be



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increased when coordination underperforms. Preliminary results show that third-party logistics companies could be a valuable resource in coordinating a variety of collaborating with SMEs in the supply chain.

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### SCM for small firms and retailing operations for nanostores

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1. Department of Industrial Engineering, Monterrey Tech, Campus Toluca, Mexico

Small firms have an impressive importance for the world economy. They contribute to the production and stimulate the economic growth by providing employment opportunities. However, only a fraction of these small firms survives, due to many factors as the low productivity, especially in Latin America. Therefore, we have the challenge to learn more about them because their features and productivity change depending on the country, location and other circumstances. Moreover, the challenge to adapt our knowledge in large firms to these smaller firms is not trivial to increase their production and survival rate, decreasing their rate of disappearance and solving their problems.

Working on this challenge, we used the methodology from MIT Micro Supply Chain Management and the JICA methodology. The methods were applied to a small firm (i.e., a carpentry) located in Toluca, Mexico, by having an immersion there, asking to the employees and the owner about the company and watching how they worked during a set of days. We found the root problems, identified the key activities and helped owner giving a structured working plan to improve their performance and activities.

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### The survivors of the stores business development

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Carrillo A.; Romero D.<sup>1</sup> and Álvarez M.,<sup>1</sup>

1. Monterrey Tech, Campus Ciudad de Mexico

This article explores the expectations of stakeholders upon nanostores and their consumer preferences to improve on their competitiveness in the retail landscape of a metropolitan area. This study was done by making a descriptive statistical analysis of over 300 surveys collected in

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Mexico City over 2017. This work highlights, from the viewpoint of shopkeepers, that nanostores mainly seek surviving rather than growing or competing against convenience stores or supermarkets. In contrast, customers look for nanostores to provide more services such as telephone recharges, home delivery, or products variety of assortment. As a result, this work proposes business model alternatives to increase the competitiveness of nanostores beyond their survival.

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### Adoption of Best Business and Supply Chain Practices and Micro/Small Firms Performance. Evidence from Northern Peru

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1. Universidad de Piura, Perú

2. MIT Center for Transportation and Logistics, Cambridge, MA, USA.

Micro and small enterprises represent 99.3% of Peruvian firms, contribute with 42% of Peru's Domestic Gross Product (GDP), and employ half of the country labor force. Despite their relevance for the Peruvian economy, they mostly operate in the informal sector, have extremely low survival rates and are characterized by low productivity and many inefficiencies. This paper explores if the adoption of better business practices in SCM influences micro and small firms performance. We use data from 50 small and micro enterprises in the trade, service and manufacturing sectors from the Piura Region, in North of Peru. The MIT SCALE Data Collection Guidelines were used to measure the firms' adoption of the best practices. Our basic results, based on simple mean comparisons, indicate that firms with higher total sales are more likely to adopt practices related to financial planning, supply chain planning, supplier relationship management, marketing, procurement and stock control. We performed an in-depth analysis using multiple regression, which allow us to identify potential significant factors such as owner experience, gender, education and the firm sector. Our regression findings indicate that best practices do matter for firm performance (measured in total sales per worker), and that different practices complement each other. For example, the effect of better management practices is higher if the firm also adopts supply chain practices. Finally, our findings also suggest that firms with better performance have managers that diversify their time between strategic and operational activities and a better planning of them, have a proactive attitude towards suppliers and empower their workforce.

### Study about the key differences and similarities in Mexican SMEs. Finding a solutions for Mexico City SMEs

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In Mexico, Small Medium Enterprises (SMEs) account for 98.8% of the total number of enterprises, contribute with 52% of the national Gross Domestic Product (GDP) and 72% of the employment rate. However, less than half of them will survive beyond five years and a few will evolve into a large enterprise. One of the main challenges faced by SMEs in Mexico is the adoption of better supply chain practices to improve their productivity, which in the case of Mexican SMEs, is one of the lowest in the OECD. Thus, a study was conducted in a sample of four SMEs located in Mexico City by using the methodology and instruments provided by the MIT Center for Transportation and Logistics and the Supply Chain Operations Reference (SCOR) model, to diagnose current practices, identify areas of opportunity and provide recommendations.

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### Socio technical systems in supply chain resilience of SMEs: case study of small Peruvian firms

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González Alvarez, D.<sup>1</sup>; Vargas Florez, J.<sup>1</sup>; Rocca Espinoza, E.<sup>1</sup> and Miranda, H.<sup>2</sup>

1. Department of Engineering, Pontifical Catholic University of Peru, Peru

2. Catholic University of Trujillo, Peru

This research investigates supply chain resilience in small and medium business (SMEs), based on a socio-technical approach, which allows to explain social elements that take part in the development of resilience in SMEs. The research is qualitative and exploratory, employing multiple case studies from three small businesses affected by the Coastal meteorological phenomenon "El Niño". The firms are located in La Libertad region, in the North of Peru. Results indicate that resilience in each firm has close relationship to sectorial differences. On the other hand, the social system finds that the inter-organizational approach contributes to greater resilience in these companies. These findings are relevant to support SMEs Latin America, where

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there is a large number of small businesses permanently exposed to disruptive events of great impact that might disturb their performance or hinder their growth and development.

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### Shaping commercial and supply chain strategies to address traditional channel

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2. Department of Industrial Engineering, Monterrey Tech Campus Toluca, Mexico
3. Department of Industrial Engineering, Universidade Federal de São Carlos, Brazil

In-store sandal purchasing processes were studied considering shopper profiles and their interaction with both traditional and modern channels in Brazil. We collected data using surveys and video/audio camera analytics. Coupling those two data sources with sales data sets from the leading company of this segment, we performed our analysis with the aim to adjust company's commercial and supply chain strategies respect to consumer preferences. Our approach provided a holistic understanding of the company's current strategy, its shopper profile and behavior built from internal and external data sets, as well as analyzing the main competitor's influence on the current success of the company on the traditional channel (i.e., nanostores, mom and/or pop stores). We found that this channel is an attractive market opportunity that may increase company's sales by leveraging the estimated one million existing points of sale in this country with smarter assortment, segmentation and logistics strategies. This might be possible by implementing direct deliveries, as well as a differentiated commercial approach relying on company's strong image and not only on low-price policies. By having more focus on the traditional channel, the company might shape the future of the market and the retail landscape.

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### Increasing the Nanostores' Competitiveness in Different Socioeconomic Levels

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In this document, the importance of nanostores in the Mexican economy is presented, and their loss of competitiveness is explained because of the aggressive growth of convenience stores and big retailers. Customer preferences were identified to vary across different socioeconomic level. We identified they have special requirements that make nanostores an attractive alternative option when compared to other retailers and convenience stores. Three causal loop diagrams were built to describe the complexity of the referred situation, based on the socioeconomic level. This let us identify opportunities and ways to improve nanostore current business models to guarantee their survival and increasing their performance.

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### Supply Chain Management evaluation framework and Key Performance Indicators for Latin-American SMEs

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Today's low barriers of entry have brought benefits from people and organizations around the world by sharing knowledge, capabilities and the collaboration. However, some inequalities are exhibited when productivity is measured since the gap among large and smaller enterprises from developing countries is higher than the gap observed in developed nations. To understand the causes, we have to understand the way in which smaller firms work, what they do to enhance performance and what their biggest constraints are. This paper reviews academic literature on the topic of small firm productivity and supply chain management focusing on the models developed to measure and improve supply chain performance. This focus is founded in the fact that an efficient and accessible logistics system is a key element for organizations to successfully compete in today's competitive market (IDB, 2011). Findings show how a few key metrics structured among attributes and operational levels, give a better path for the assessment of the performance in these companies.

### Types and characteristics of small firms in Latin America: A micro supply chain perspective

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Small firms serve as the building blocks of the economic structure in Latin America. This study develops a characterization of the profiles of small firms and their managers based on demographic, environmental and intrinsic variables. The research studies 48 small companies from the manufacturing and service sector in Bolivia, Colombia, Peru and Uruguay. The cluster analysis generated seven different groups: four service providers and three manufacturers. Among the four small service providers, the youngest and highly educated profile, the “Young financiers”, have higher supply chain practices scores than the “Experienced record-keepers”. In the case of the small manufacturers, the “One-show-man” managers, whose low headcount contravenes with the years of existence of the firm, have lower scores than the “Experienced delegators”. In comparison to the service sector, where the most educated have the highest levels of adoption, in manufacturing, the firms with higher number of employees and older managers, have the highest scores.

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### How does the efficiency of the nanostores’ supply chain influence the consumption of fruits and vegetables in Lima, Peru?

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The following study analyzes the operation and cost of the nanostore supply chain in Lima, Peru. The main variables that affect the total cost of the supply chain in each phase are identified and analyzed. We propose a model that adapts the most common methods of supplying Peruvian nanostores. The model considers how the shopkeepers move from their points of sale to the wholesalers to perform their supply, transferring all the cost to the final customer, and, consequently, increasing the price of the products. The parameters of the model used were

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defined by data collected through a survey of more than 140 nanostores in the Metropolitan area of Lima.

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### Demand planning and management for Costeño Alimentos S.A.C

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1. Department of Business Engineering, Universidad del Pacifico, Lima-Peru

Costeño Alimentos S.A.C started operating in Peru in 1996 and today it is consolidated as a leader in the market of bagged rice and beans. Currently, Costeño presents problems in the volumes of products that are returned by its distribution process. It has been identified that the main reason of the returns is the lack of cash of the shopkeepers when the delivery is performed. In Peru, the purchasing orders are usually prepared on Mondays and most companies have the ability to make their distribution within the first 24 hours after placing the sales order. Costeño, Due to tax-related issues, Costeño can only distribute their products after the first 24 hours. Therefore, when the truck arrives to the nanostore with the corresponding order and the shopkeeper does not have enough cash anymore, the order will be cancelled. This creates losses to the company because the carriers need to handle returns and due to the undesired effect to perform visits that will not convert into successful sales. We build a smartphone application that functions as a new way to place purchasing orders and as a reminder for shopkeepers about the amount of products bought and the amount of money they have committed. This app will reduce the returns and the money lost in the process.

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### In-Store Logistics: Merchandiser's Role

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Attempts to maintain high service levels are often affected by in-store employee execution, which causes the supply chain to fail at the final stage, the point of sale, where the product availability has its greatest impact on consumer behavior and sales performance. We present an exploratory and descriptive study of the merchandiser's time spent in the execution of her activities and we characterize the main drivers of the workload using daily in-store observations from 10 different

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retail stores, taken in six-day periods per retail store. The in-store observations included the time spent and frequency combined with data obtained from the manufacturer on sales volume and market share data. The study focuses on non-alcoholic ready-to-drink beverages of the highest market share brand in Peru. Results indicate that the merchandiser spends more time in the replacement function, specifically in the main shelves, obtaining higher percentages of brand visibility in this area. However, by spending a lot of the time on the main shelves, the cold areas and its adjacent areas were not sufficiently covered by lowering the brand visibility percentages at these points.

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### **A distribution model to reduce the logistics costs in the last-mile delivery to nanostores in emerging cities.**

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This project emphasizes the impact in the logistics costs for a social company that serves as a broker in Mexico City Metropolitan area to distribute consumer packaged goods from big and mid-sized manufacturers to nanostores. By considering the birth and death of these smaller shopkeepers, we analyze the changes in the routing and several variables linked to the transportation and handling costs of the last-mile delivery. For a better understanding, the analysis is presented using a cost-to-serve analysis and we characterize the most important variables in a system dynamics model. We improve the last-mile delivery operations by using continuous approximation models and perform a trade-off analysis comparing the distribution using owned vehicles with outsourced vehicles. The project aims to have a win-win collaboration between big suppliers, the broker and the nanostores, which account for almost 50% of the market share in Mexico.



### Managers' knowledge of Key Performance Indicators in Small and Medium Enterprises

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In a sample of 21 small and medium enterprises taken from the wood and timber-manufacturing sector, the knowledge and usage of key performance indicators (KPIs) was assessed. The results of a survey show a high variability in the knowledge of KPI-related concepts as well as an average low level of attainment. The importance attributed to KPIs was seen as a necessary but not sufficient condition for attaining higher levels of KPI usage.

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### Nanostore-based supply chains to deal with food insecurity in Mexico City

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In this research, socioeconomic and dietary factors were used to understand food insecurity and undernourishment problems with the use of statistical tools: cross-variable validation and chi-square hypothesis testing, regression analysis and systems dynamics modelling. From these methods, we obtained that the food assortment and its availability in the nanostores have a huge impact in the food insecurity of low-income populations. We find that 19% of 536 surveyed people in Mexico City Metropolitan Area (MCMA) are undernourished due their poor shopping/eating habits and the assortment at nanostores that depends on inefficient food supply chains serving these vulnerable population segments. Therefore, logistics strategies and policies are proposed to reduce food insecurity as consequence of this study.

### Innovation using 3D printing: how much can SMEs take advantage of it?

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Traditionally, the Small and Medium Enterprises (SMEs) make limited usage of technology in their production processes and in other operations, but this is changing depending on which market (developed or developing) the firm is located. While in the European countries the advance of new technologies does not stop, the introduction and adaptation of these technologies in Latin American countries is rather slow, jeopardizing the region's economic growth related to technology use. One example is the 3D-printing technology, a disruptive production technique that can provide mass customization alternatives and other design and printing products tailored to meet each individual user needs. In this research, the introduction of this technology to Latin-American SMEs is presented and compared to the innovation carried out with two European case studies from the INSPIRE project.

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### Operations and logistics for food security in vulnerable neighborhoods of Latin American countries

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This study addresses one of the main problems in emerging countries related to guarantee accessibility to fresh produce to vulnerable populations. The objective is to understand the most important factors that motivate the commercialization of fresh fruits and vegetables in low-income areas, often known as food deserts, through nanostore-based supply chains. This study investigates a number of logistics and commercial strategies to mitigate the effects of such food deserts. For the study, we conducted around 300 surveys in the cities of Lima (Peru) and Valparaiso (Chile). The findings show that despite the differences in size and cultural aspects (Valparaiso has approximately 300 thousand inhabitants located in 401.6 km<sup>2</sup> and Lima has 9.75 million inhabitants located in 2672 km<sup>2</sup>), shopkeepers follow strategies that foster cooperation to

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gain bargaining power and direct negotiations with farmers. However, transportation pooling which was chosen as a good alternative in Lima was not used at all in Valparaiso. The longer distances and lower transport access in Lima can explain this preference. The strategy of mobile markets was considered a threat to their business in both cities. In conclusion, there is no one-size-fits-all strategy to perform these logistics operations.

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### Operating nanostores according to socioeconomic levels

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This work is based on 240 interviews and 487 surveys applied to the stakeholders of the nanostore-related environments in Mexico City Metropolitan area. Nanostores are family-owned businesses that look for earning enough income to keep operating in the market. The lack of automated processes, limited access to technology and poor performance represent a challenge for them because they need to compete with high-performance retailers. Therefore, the objective is to determine the influence of socioeconomic variables on inventory levels, layout and nanostore business model. The impact of the socioeconomic characteristics of a community on the nanostores were analyzed through combinations of socioeconomic variables to determine their relationship and the needs and/or consumer preferences. Recommendations and logistics strategies are proposed according to both the socioeconomic status of the community in which the nanostores are located and to the different consumer profiles. Finally, the main contribution of the work approximates how to make nanostores competitive in the retail landscape by improving their operations according to their geographic location.

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### Improving Small Firms' Survival Rate in LATAM

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Micro and small firms account for 99% of the businesses operated in Latin America that show higher employability rates and higher Gross Domestic Product growth rate. However, nearly one

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out of four companies fail to develop into a high-growth firm every year, mainly due to lack of supply chain expertise. The focus of this project is to identify the critical supply chain elements and business practices that have a high impact on improving the survival rate of micro and small firms. For this purpose, we analyzed the existing datasets and additional data that was collected via a workshop in Aguascalientes, Mexico to further understand and engage the small firms. As a result, from this workshop, 70% of the firms engaged on further studies and company analysis. Also, we successfully performed interviews with small firms in different sectors and identified main challenges for most of the companies as (i) Business Practices: Costing and Record-Keeping Practices, Financial Planning Practices, and (ii) Supply Chain Practices: Demand Forecast, Order Management.

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### The \$100 dollar question: Finding quick wins for micro companies

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Recent studies discuss the importance of micro and small firms for the competitiveness and economic growth of developing countries. However, due to lack of productivity, only a fraction of these firms survives and develops into larger enterprises. While some studies have discussed potential avenues to improve productivity and survival via investments in infrastructure (e.g. ERP systems, equipment, etc.), and in business operations (e.g. inventory management, production, procurement, demand planning, distribution, etc.), providing feasible and impactful recommendations is a critical challenge due to the limited resources (i.e. money and time) that micro and small firms have. In this article, we present a framework of best business and supply chain practices for micro and small firms that includes a roadmap describing the sequence in which the practices (i.e. quick wins) are to be implemented to achieve maximum impact (i.e. higher productivity and survival) with minimum effort (i.e. lowest money and time). We also present an illustration of our framework for the context of Mexico City.

### Analysis of the supply chain of SMEs in the context of a landlocked country

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This paper summarizes an analysis of 18 Small and Medium Enterprises (SMEs) of Bolivia considering their supply chain performance. The methodology adopted to carry out the study is based on the diagnostic methodology proposed in the framework of the Micro SCM project of the MIT SCALE team, which ranges from a general analysis of the company, specific analysis of the supply chain drivers and identification of tools to improve the logistics performance. The study was able to establish aspects of the general problem of Bolivian SMEs. We identify that the supply of raw materials, the differentiation of their treatment and the inventory policies were major opportunities.

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### Inclusive distribution networks for vulnerable population segments

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Inclusive distribution networks have emerged as an alternative implemented by private organizations to create meaningful synergies with poor communities and promote inclusive growth. Previous studies have pointed out the benefits obtained by the implementation of inclusive distribution networks, but these strategies have not discussed in detail the challenges that arise with them. This study aims to address this gap by analyzing implementation of an inclusive distribution network developed by DANONE in Brazilian low-income neighborhoods. The case reveals the challenges in the implementation of this type of initiatives in the food sector and efficient strategies to overcome them.

### Data analysis for finding practices to increase the survival rate of Micro and Small firms from Latin America

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This article identifies different supply chain practices that can be easily implemented in micro and small firms to help them increase their survival rate and efficiency. We select and adapt common benchmark practices from the literature for the context of small firms. Our study presents a conceptual model that ranks and prioritizes the implementation of these practices based on their impact and applicability. We conclude that the highest ranked practices according to the proposed model are: (1) Manage Plan Data Collection, (2) Manage Planning Configuration, (3) Align Supply Chain Unit Plan with Financial Plan, (4) Maintain Source Data, (5) Manage Incoming Product and (6) Manage Finished Goods Inventory.

# 4. Urban logistics and last-mile operations



### Last-mile delivery in slums: An exploratory study with Brazilian companies

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In urban logistics, home delivery has become more challenging with the continuous growth of urbanization, particularly when addressing the logistical difficulties of distributing products in low-income population areas. This research presents an empirical approach about how companies face last-mile distribution in Brazilian slums, known as “Favelas”. Delivering products in these locations is not an easy task: there is a high concentration of households without formal urbanization and there is a huge amount of cargo that might be stolen. To overcome such barriers, companies devise distribution strategies per product type and slum type. We build a novel model that helps understand last-mile delivery process in which risk is a inhibitor between last-mile logistics and logistics performance. The proposed slum-logistics assessment brings out the specific requirements to suggest companies the best distribution strategy to be used. Companies need to invest in relationships with local partners, absorbing their knowledge, to design better last-mile operations and to gather more data to improve the decision-making process.

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### City Government Perspectives for Multi-Objective Urban Goods Movement

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Current trends of urbanization and growing economies bring with them rising levels of city logistics challenges. In this context, city governments should consider new strategies to deal with such problems. Already-known strategies employed by providers, such as distribution schemes of products with classic approaches should include more holistic perspectives. For example, lack of



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coordination among providers executing their individual schedules may cause further problems in a city as well as in providers operations (e.g. traffic congestion, pollution, distribution time or even costs) mainly if they consider only single-level distribution schemes. Several key decisions that governments should perform to implement holistic approaches for last-mile operations in city logistics based on multi-objective and multi-level distribution solutions are summarized in this work. This includes experiences and approaches on related projects in Latin America. These decisions include data collection, criteria analyses, selection of constraints and suitable resolution techniques; as well as of other administrative or legal issues.

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### Cargo Theft Weighted Vehicle Routing Problem: modelling and application to the pharmaceutical distribution sector

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Cargo theft is a major problem in South and Central America. The consequences of cargo theft go beyond the cargo value losses as they cause huge losses in the supply chain. Despite the great variety of decision tools based on operation research theories, particularly vehicle routing algorithms, there is no research that is directly related to theft issues. We present a variant of the weighted vehicle routing problem to design distribution routes in high-risk areas for theft. The model aims to minimize transportation and cargo theft costs. It uses a set of flow decision variables to calculate cargo value in each arc. Theft probability is calculated according to the historical frequency of theft occurrences reported in each customer location. The inclusion of theft costs derives in non-trivial routing solutions, as it might be less costly to drive longer distances or use more vehicles in order to minimize the value of cargo arriving to risky areas and therefore cargo theft losses. We adopt a Simulated Annealing metaheuristic as a solution method. The model is tested in a Brazilian pharmaceutical distribution company using data from Rio de Janeiro. We highlight the benefits of preventive routing in relation to theft occurrences.

### Generation of Solutions to Improve Commercial Logistical Activities in the City of Quito

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Urban population is growing year after year in the world. Ecuador is facing the same challenge, given that more than half of its population lives in urban areas. The expansion of population density leads to increase the demand for goods and services and, consequently, businesses are struggling with more complex logistics activities. The city of Quito is facing logistics challenges due to the lack of proper infrastructure, growing urbanization rates and the lack of public policies and incentives. The objective of this paper is to improve commercial logistics activities related to the deliveries in the critical zones of Quito such as La Mariscal, the Historic Center and the main business/corporate district. An optimization model is used to calculate the location of transfer points considering the most concentrated type of shops within each zone. The goal is to propose a location for transportation companies to handle their resources in an efficient way. This investigation is part of a bigger project lead by the MIT Mega Logistics Lab (MIT MLL). The methodology is the Urban Logistics Atlas developed by MIT MLL. Solving an urban logistics problem can help making better cities for mobility, reducing greenhouse gas emissions and reaching a balance between the public and private sectors in the commercial logistics activities.

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### Urban logistics and last mile operations for E-Business (B2C)

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In the last five years, Peru has grown its sales in the e-commerce sector. In consequence, while last-mile operation startups have grown exponentially too. These startups have taken advantage of the characteristics that consumers seek to have via e-commerce markets like flexibility, availability, traceability and accessibility. Furthermore, these startups now offer competitive pricing and express deliveries every day. These characteristics have increased the preference of consumers by these e-commerce-based businesses, which look for more affordable deliveries

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within the densely populated city of Lima. These startups are now growing to other densely populated cities like Buenos Aires, Mexico City, Bogota, Santiago, among others. This business model is attractive and replicable in other cities that expect high growth rates in their ecommerce markets. In this paper, we analyze the impact of these urban logistics and last-mile operations services compared with traditional services within a local e-commerce startup

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### Private collective transportation system in Santa Fe, Mexico City, Mexico

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As a response to the dense traffic in Mexico City, a business model for a private collective transportation system in Santa Fe, one of the city's financial and educational centers, is presented. This approach focuses in first instance on students of Tecnológico de Monterrey Campus Santa Fe. The idea has the potential to reduce the amount of cars in the streets during the day and to reduce pollution in Mexico City. After conducting a survey among students and academics, the potential demand and possible pick-up/drop-off points were determined. By getting the optimal routes to these points, obtained with Zeemaps, a simulation model in Arena software was developed and the optimal capacity of the buses to fulfill the potential demand, was found. We modelled some constraints such as having a minimum service level. Using the optimization tool of Arena software, we were able to reach 75% of service level with vehicles with diverse capacity.

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### Optimizing the Joint Newspaper Last Mile Distribution Network for two Major Competitors in São Paulo, Brazil

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In this paper, we address the real-world problem of optimizing the joint newspaper last mile distribution network for SPDL, a dedicated logistics provider established by the two major nationwide newspaper publishers in São Paulo, Brazil. Such collaborative logistics delivery of two major competitors, which comprises servicing a huge number of customers in the urban setting of a large metropolitan area, is something unprecedented in this sector. More specifically, the problem comprises servicing 4,200 newsstands and 216,000 subscribers in the metropolitan region of São Paulo. A fleet of 630 light vehicles (i.e., vans and motorcycles) that are used in the last mile distribution are subject to tight time constraints. In the current configuration, the newspapers, which are delivered seven days in a week, can originate from four distribution centers, which are fed from two different sourcing locations, with very limited time to deliver. We developed a comprehensive optimization-based network design analysis with the aim to simulate, design and implement a new distribution operation in a more cost-efficient manner while ensuring the current service level to be maintained without any service disruptions. The new proposed configuration has allowed cost savings reduction of nearly 18%.

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### On the Use of Freight Brokering Information Services to Evaluate the Reduction of Greenhouse Gases in the Operation of Road Freight Transport In Colombia

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One of the most important logistics activities in Colombia is urban and inter-urban freight transport, because it directly affects the competitiveness of the country and its regions. The government continuously engages in projects related to freight transport activities. One of the most recent projects was related to the development of a pilot to use information services of freight brokers to evaluate the reduction of greenhouse gases in the operation of the freight road transport in Colombia. The study was defined in three stages. First, a socio-economic analysis of at least 500 drivers was performed to collect information on both vehicles and drivers. Second, the implementation of an on-board device on the vehicle computer to measure some control variables related to logistics. Last, the data analysis of potential reduction on empty trips.

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The statistics showed that empty trips are 45% of total trips in the country and that compensated trips are only 6% of total trips. This latter fact is causing the greatest challenges of the sector. In the next stages, a total reduction of empty trips (more than 28%) was got and second, an augmented number of trips per month to get more return on investment to drivers/vehicles and to the carrier.

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### Freight trip generation modeling and data collection processes in Latin American cities: Modeling framework for Quito and generalization issues

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This paper proposes a freight trip-generation analysis in Quito based on an establishment survey, which complements a data collection process that follows the MIT km<sup>2</sup> methodology. More precisely, a procedure combining observation-based and declarative data collection processes is proposed. First, the opportunities of combining both observed and declared data to characterize freight trip generation are addressed on the basis of a literature review. Then, the methodological framework is proposed. After that, results on a set of establishments in Quito are presented. The resulting models are compared with those of French and US cities. Main issues of combining establishment surveys and observations are addressed to generalize the proposed framework. Finally, implications to transfer the proposed framework to other Latin American countries are addressed.

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### One policy does not necessarily fit all: A comparison of logistics critical areas in Quito, Ecuador – Part II

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This paper presents a key study that will help the city of Quito to develop appropriate and relevant urban freight plans and policies, which should be tailored for different areas of the city. Using the *Better Cities for Logistics Toolkit* methodology, developed by the MIT-Megacity Logistics Lab (MLL), additional data through an establishment-based freight survey to retailers and other analytical methods were collected. This paper builds on previous research work done by the authors and presents a detailed descriptive analysis of three square kilometers of the city. The analysis performed allows comparing and contrasting the logistics profile and requirements of each zone. Then, after analyzing the current state of the urban freight policy in the city, this works presents a preliminary set of policy recommendations for improved urban freight. The policies are better suited for each zone given its characteristics and needs. The overall objective is to provide potential and realistic solutions based on actual data that aim to improve the development of urban freight policies for the municipality as well as good logistics practices for companies to enable the reduction of externalities that affect the quality of life of the city citizens.

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### The OD mobility survey approach for freight road transport environmental and energy analysis in São Paulo, Brazil

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3. University of São Paulo, Rua do Matão

This paper summarizes the results of an urban mobility road freight sample survey carried out in 2016 on light and heavy-duty vehicles in São Paulo, Brazil. In particular, this work reviews some of the key indicators that measure the efficiency and the operational performance of the freight road transport in the Municipality of São Paulo. The indicators of transport are coming directly and indirectly from the origin (O) and destination (D) from company vehicle surveys. The survey is based on a stratified random sampling and represents an audit of the performance of 12,424 company vehicles in a yearly basis. Although the study shows wide variation in absolute values among company vehicles, energy and environment efficiencies could improve in the future considerably. Nevertheless, assumptions and analyses of freight road transport in São Paulo find significant new points of view to the problems in order to assess vehicle utilization, fuel efficiency, and pollutant and CO<sub>2</sub> emissions.

### Logistics profile of Lima in the last mile based on MIT km2 Methodology applied in three districts

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A framework to analyze the last mile logistics practice in Lima, Peru is suggested. For this purpose, consumer behavior has been studied in three districts, each with a different socioeconomic level. The analysis carried out matches with five indicators: i) shop inventory, ii) traffic count, iii), street data (roads and regulations), iv) delivery tracking and v) disruptions. This study suggests how to identify logistics practices in each of the three districts, allows to create a logistics profile, let users identify disruption causes and, finally, to suggest some solutions based on this research that can be used in Lima and other cities. This paper aims to contribute with a general understanding of the city of Lima regarding the way logistics practices are developed. This approach is the basis to suggest policies that could make companies more efficient and to improve the logistical costs in the city, which will bring benefits for the inhabitants.

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### Characterization of homogeneous zones and identification of underlying factors in the configuration of the Urban Logistics in the Last Mile of the city of Córdoba, Argentina.

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Cities have different characteristics; in consequence, they use distinct policy measures that bring different associated impacts (Alho, 2015). The purpose of this paper is to apply a data-driven methodology to identify clusters to build Cordoba's urban logistics policy and best practice decisions. This work constitutes a first experience of classification of homogeneous areas with these methodologies and it is limited to a square kilometer, in the neuralgic center of the city, completely inside the restriction zone for heavy-duty vehicles. The methodology uses relevant

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variables for urban logistics - number of establishments, traffic lights, buildings, parcels and location inside the km<sup>2</sup> area - to perform two statistical analysis: Factor and Analysis of Variance (ANOVA). Preliminary results suggest a clear relationship between the different commercial activities and the location inside the area, as a basis for further urban logistic analyses and implementation of best practices.

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### The nanostores distribution problem under time dependent demand

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This work introduces a new logistics problem: The nanostore distribution problem under time-dependent demand (ND-TDD). This problem is inspired by real delivery operations of emerging countries, where the quantity of products sold to nanostores depends on the arrival time of the supplier. Frequently, the relation between the demand and the arrival time is a non-linear function. In this problem, the objective function aims to maximize the total sales. To solve this problem, a mixed-integer linear programming (MILP) formulation is proposed, which is able to model any shape of the demand function. This formulation is tested using a five-instance testbed based on a delivery operation of a food company in the Aburra Valley, Colombia. The results show that the MILP formulation is able to find the optimal solution for an instance and is able to find integer solution for the remaining instances with an average optimality gap of 24.67%.

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### Modelling and analyzing the economic and environmental impacts of pick-up points on ecommerce's last mile distribution: the case of São Paulo

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In this paper, we address the problem of e-commerce's last mile distribution. We aim to investigate in which conditions pick-up points (PP) in stores and automated lockers (APS) are more efficient than home deliveries, from both economic and environmental aspects, particularly in the context of megacities in developing countries. In order to accomplish this, we propose a framework that includes relevant criteria and we apply it to the context of the megacity of São Paulo, Brazil, using real data from a major online shopping retailer.

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### Vehicle Routing Decisions with Steep Roads

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Most routing decisions assume that the world is flat. However, there are many cities where this assumption does not hold. In this paper, we first formulate a Vehicle Routing Problem in regions with steep roads (VRP-sr), since the proposed model cannot be solved in a reasonable computational time for real-sized instances; we implemented a heuristic solution method. We use this model to study the impacts of not taking into account steep road grades when vehicles are visiting customers that have important differences in altitude for their locations. Several instances were created using data from the city of Valparaíso, Chile. Our initial results, in a case study with a homogeneous fleet show average cost reductions from 3% to 6%. Moreover, there are instances in which cost reduction greater than 14% can be achieved.

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### Variable Neighborhood Search for the Bin Packing Problem with Compatible Categories

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Bin Packing with Conflicts (BPC) are problems in which items with compatibility constraints must be packed in the least number of bins possible, not exceeding the capacity of the bins and ensuring that non-conflicting items are packed in each bin. In this work, we introduce the Bin Packing Problem with Compatible Categories (BPCC), a variant of the BPC in which items belong to conflicting or compatible categories, in opposition to the item-by-item incompatibility found in previous literature. It is a common problem in the context of last-mile distribution to nanostores located in densely populated areas. To solve efficiently real-life sized instances of the problem, we propose a Variable Neighborhood Search (VNS) metaheuristic algorithm. Computational experiments suggest that the algorithm gets good solutions in shorter time while compared to exact methods run on a high-performance computing environment.

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### Incorporating compatibility constraints in the vehicle routing problem for urban freight operations

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Cunha, C.B.<sup>1</sup>; Gámez-Albán, H.M.<sup>2</sup>; Mejía-Argueta, C.<sup>3</sup> and Silva, M.R.<sup>1</sup>

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This research aims to present a new variant of the vehicle routing problem considering the compatibility between vehicles and cargo type, as well as among multiple types of product categories. We build a modified version of the column generation method as the exact approach and a metaheuristic that combines tabu search, GRASP, Clarke-and-Wright savings algorithm and Variable Neighborhood search (VNS). VNS is applied to the best solution found based on three distinct neighborhoods that are selected randomly: a reallocation of delivery, swap of two deliveries in distinct vehicles, and removal of a given percentage of deliveries that are reinserted into other vehicles. We test our approach in standardized instances from Augerat et al. (2009). In addition, we use real-life delivery data from a pair of districts located in Bogota, Colombia and Sao Paulo, Brazil. Data were gathered from companies that serve retailers in those areas and from the square-kilometer data collection instrument that takes into account commercial density, traffic flow, delivery procedures and interruptions. We show that lower costs can be reached using our solution approaches and they offer complementary advantages. In addition, we show that results are influenced by load factor, city morphology and density.

### Introducing Bike-sharing Systems (BSS) to Improve Urban transportation in a Large Mexican City

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The growing urbanization in developing countries is increasing the advance of more environmentally friendly urban transportation systems. From the logistics perspective, it is expected that in the next decades non-motorized mobility will become a significant mode of transportation. Because bike-sharing systems (BSS) has emerged as an alternative to improve non-motorized transportation, this research includes a demand study that identifies the target population segment for BSS in Mexico. We build a bi-criteria model formulated and solved it to facilitate the decision-making process regarding the design and the maximum acceptable cost of the BSS. Finally, a system dynamics model is used to analyze external factors that affect usability of the BSS and the air quality of the city because of an increased use of bicycles as a regular mode of urban transportation.

# 5. Resilience and risk in supply chains



### Investment Decision in an After-sale Service Project: Modeling Risks under the Real Options Approach

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After-sales operations play a strategic role in the relationship with customers and affect the configuration of the supply chains from organizations<sup>1</sup>. Investment decisions in this area include the analysis of the logistics costs that could make economically unfeasible to implement certain projects. In addition, traditional tools used for economic analysis can lead to the rejection of projects because they do not consider managerial flexibility under uncertainty. In this context, this article proposes a real option approach, which allows an adequate modeling of the main risk factors. The project is characterized by the provision of an after-sales service given by a multinational company, in which the investment decision is modeled as a perpetual call option. Offering services may involve cargo-handling costs between the company and its customers as well as between the company and its domestic and international suppliers. The risk factors comprise the demand and the foreign exchange rate variables, so that the present value of the cash flows and the necessary investment follow correlated stochastic processes. The results of the analysis of a real case in Brazil indicate the feasibility of the project and suggest the immediate implementation.

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### Risks in the purchasing processes that disrupt the supply chain of a Mexican company that manufactures tools

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Globalization is a phenomenon that has brought the world closer through the exchange of goods and services, information and knowledge. For Mexico, it is very beneficial, because it allows for integrating the economy of the country with the rest of the world. However, Mexican

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companies face a survival challenge, because global supply chains show drastic changes that give rise to new and complex risks. For this reason, it is important to implement Supply Chain Risk Management (SCRM) in each of the organizations to let them be competitive in the markets. By using the Failure Mode and Effect Analysis (FMEA), the risks of the area of acquisition of materials that disrupt the supply chain of a manufacturing company of tools were identified and evaluated. The study let the firm mitigate undesired impacts via contingency plans.

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### Literature Review in Social Supply Chain Risks

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The risk management that is inherent to any company's supply chain has become a decisive issue for its growth, generating a competitive advantage. The literature on risk management is diverse; however, little has been studied about the social risks in which the supply chain of a company may be involved. Through a systematic literature review (SLR), the present study proposes a risk taxonomy and a research agenda to support future studies on social supply chain risks. With the SLR, it was noticed how recent and sparse the subject is. The expected results were achieved by developing a list of social risks found in the selected papers and the consequences that those risks can generate for a company. Finally, we suggest a research agenda that should be work in the upcoming years.

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### Risk Analysis in a Food Industry Logistic Operator with application of ISM

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This study applies the Interpretive Structural Modelling (ISM) to the risk analysis in the "Cold and Frozen" area of a food logistics operator in Chile. As a result, we got an analytical model with six categories of risks (i.e., strategic, harmless, demand, information technologies, Human

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Resources and Inventory) and their distribution is classified into four levels. The model lets us conclude that categories with bigger driving power are the strategic and the demand categories because its management will affect directly in the mitigation of the rest of the risk categories. ISM methodology has been applied in several industries, and its results have been published since the seventies. Some representative authors are Attir et al (1975), Diabat et al (2012), Mandal and Deshmukh (1993), Ravi and Shankar (2005), Thakkar et al (2006), among others. This study is structured using ideas from Diabat et al (2012) who applied the ISM methodology for the risk analysis in an Indian food industry supply chain.

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### The use of System Dynamics archetypes to study risks in the supply chain

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The increasing supply chain complexity raises uncertainty to the supply chain management (SCM). The managers need to attain more risk issues, but there is a lack of risk-prevention mechanisms. This research links supply chain risks and the System Dynamics archetypes, in order to reveal the compatibility of the archetypes to identify generating risk mechanisms. Therefore, first, supply chain risks were classified through a literature comparison, and the risks were identified in the classification for System Dynamics archetypes conceptual representation. Twelve archetypes were analyzed for several supply chain risk generating mechanisms. Four of the archetypes are presented in detail. Conclusions support the archetypes adequacy for dealing with the infrequent nature of various supply chain risks.

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### Resilient supply network design: disruptive events modeling for the coffee industry in Colombia

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This research proposes a hybrid modelling approach for the design of a resilient agribusiness supply chain. A case study in Colombia for the production and distribution of organic coffee is discussed. The models take into account the agribusiness network, which is composed of multiple echelons: farmers, transporters, processors, intermediaries and retailers. In Colombia such as in other developing countries, farmers from different owners collaborate with each other. This research considers the vulnerability conditions, and model the possible disruptions in the agribusiness supply network. It includes the evaluation of resilience measures such as availability and vulnerability. A mixed integer-programming model and a discrete event simulation are combined to design the logistics network. Conclusions about levels of availability versus high costs and connectivity are discussed.

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### The impact of Internal and External Disruptive Events on Supply Chain Resilience Strategies

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The supply chain management literature has focused on risk awareness and avoidance. This study seeks to understand if operating in risky environments can have a positive impact on developing a resilient organizational culture. First, by looking at how risks and disruptive events influence the existence of a business continuity plan and second, by looking at the impact of risks and disruptive events in the projected recovery time. The year of 2017 was a very active year for hurricanes. Hurricane Harvey devastated Houston in August, hurricane Irma struck the Caribbean at the beginning of September and hurricane Maria destroyed Puerto Rico in September, leaving the entire island without power for weeks. Natural disasters interrupt normality for countries, governments need to assess the situation and ensure the safety of the people to reduce fatalities and to ensure that needed services like health care services are reinitiated as soon as possible after the storm has passed. But not only governments are impacted, natural disasters can have a



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strong impact on business and due to the global economy, we live in, a disaster in a small country like Puerto Rico can easily have a global impact. The pharmaceutical and medical devices industries have a high production concentration in Puerto Rico, hurricane María paralyzed production in Puerto Rico for weeks, causing a potential global shortage for medicines and medical devices that are solely produced in the island. With the expectation of a hurricane season every year, why would it be reasonable to manufacture in such a risky place? Not every hurricane causes this amount of damage, in fact hurricane María has caused unexpected damage like no other hurricane in the past century.

# 6. Humanitarian logistics and relief operations



### Integrated framework for stakeholder collaboration strategy in disaster response

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The impact of disasters worldwide is substantial both to human life and to financial terms, and the stakeholder collaboration is posed as essential to improve the relief of the beneficiaries. A plurality of concurrent models, lack of common nomenclatures and scarce understanding of the role of each stakeholder describe the state of art in this subject by others. Therefore, this research offers a framework to guide stakeholders' collaboration in disaster response, which embraces three pillars: stakeholders' identification, stakeholders' expectations and needs, and response processes. The combination of these pillars in an integrated framework brings additional value to practitioners and academics involved in disaster response, ensuring that the main stakeholders are involved, their expectations and needs are considered, and the necessary processes are executed and aligned. The research applies systematic literature reviews (SLR) to develop the framework and a case study towards a first external validation. The SLR covered the analysis of 986 abstracts, 365 full text papers, discussing 106 in detail. The framework is analyzed in a case study with data from the Brazilian army, providing insights to plan the stakeholder collaboration strategically. Future research is suggested to extend the external validation to the framework in different disaster types, scenarios and other stakeholders' perspectives.

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### Kit management: The case of El Niño Phenomenon in Piura, Peru 2017

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El Niño Phenomenon (FEN 2017) is a climatological event that seriously affected the Piura Region in Peru. The northern zone of the country withstood heavy rains (i.e., 800 cubic millimeters), not from January 20<sup>th</sup> to May 15<sup>th</sup> in 2017. The main consequences were flooded areas in the city of Piura, isolated villages, damaged infrastructure, families displaced to refugee camps and an increased number of people affected by diseases such as Dengue, Zika, etc. On the other hand,

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these events showed the solidarity of the local, national and international community, which openly expressed their support by donating thousands of tons of food, cloths, tools, clothing etc. Within relief operations, the Kit Management was a fundamental activity to alleviate the suffering of those affected by the natural disaster. In this regard, important and rapid decisions such as planning, preparing, and delivering the kits to the affected areas were done as the case study shows. This case presents how two non-humanitarian organizations, Piura en Acción and Universidad de Piura, managed the kits. Piura en Acción collected up to 600 tons of donations for the Piura Region and professionals from the University of Piura managed these donations for a period of 4 weeks.

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### Humanitarian logistics to take care of Piura region after “El niño costero”

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Natural disasters that have occurred in the world have a direct impact on the welfare of people. Even by using advanced technology, today it is still difficult to predict any disaster with enough time in advance to prevent huge damage and to coordinate in a better way the actions to be deployed. Particularly, during the stage of disaster response, speed of action and the amount of humanitarian aid are crucial. Not only the government has to be involved but also other important stakeholders and organizations have the capacity to act, prevent, respond and mitigate undesired effects of a disaster. The main goal of the research is to analyze the logistics system to meet the emergency caused by the coastal phenomenon “El Niño”. First, an explanation about what is the phenomenon about, its causes and consequences in Piura during 2017 are provided. The characteristics of humanitarian logistics system and the supply chain operations are also reviewed. Finally, lessons learned and recommendations are discussed. When performing an analysis of the logistics system of emergency response it will be taken as a logistics manual for emergency care. In addition, the study helps devise a framework that might be used in a similar emergency situation in an efficient and timely manner.

### Optimization trade-offs in humanitarian logistics: A pre-disaster discussion

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Optimization methods applied to Humanitarian logistics (HL) problems have recently gained importance because of their nature to provide the best solutions and meet restrictions that any stakeholder faces during a disaster. Nevertheless, meeting stakeholders' needs in disaster relief can be challenging because of multiple competing goals. Therefore, both practitioners and academics can benefit from a better perspective of the possible trade-offs found in humanitarian logistics optimization models. This work highlights the competing relations between efficiency, effectiveness, and equity. A stochastic optimization case study is proposed to tackle the preparedness phase for floods in Brazil. Results indicate that equity can be a cheap feature to pursue when the level of inequity is limited; budget must be well-dimensioned in order to carry coverage maximization; and that penalty for unmet demand is an efficient way to control risks of scenarios with high costs and low coverage ratios.

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### Locating Points of Distribution (PODs) as a consequence of mudslides in Chosica - Lima - Peru

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The main objective of this paper is to define the amount of points of distribution (PODs), which will provide materials, medicine, and supplies for the people in need during disasters. We study mudslides in zones that have a high probability of occurrence like Chosica, Peru. The aim of these PODs is to minimize human suffering in case of a disaster. These PODs have to consider geographical and economic restrictions to minimize total costs. First, an optimization model was formulated, based on the Facility Location Model, which estimates the capacity, location and

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resources needed to serve the affected population that is affected by the disaster. Second, a geographical evaluation to position resources and locate facilities is performed. In both cases, the largest population must be reached with priority and the most urgent assets must be delivered in an efficient way.

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### Assignment of the budget for prevention projects in the north central coast of Peru

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In the present analysis, the optimal budget will be allocated in multiple projects for the prevention of natural disasters in the northern regions of Peru. Considering relevant criteria such as the degree of vulnerability, the level of poverty (Gestión, 2014), the amount of population (MIMP, 2015) and the level of spending execution during disasters in 2015 and 2016 (MEF, 2015 and 2016). We use a multicriteria analysis tool, the Analytical Hierarchy Process (AHP) to estimate the degree of vulnerability of each region that depends on various criteria. Afterwards, we use Fuzzy Logic with the purpose of obtaining the budget for each region. Based on these tools, we analyze the most affected Peruvian regions in 2017 by the coastal phenomenon El Niño that comprise Ica, Lima, Ancash, La Libertad, Lambayeque, Piura and Tumbes.

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### Optimization of military relief operations in Peru

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During 2017, Peru experienced a meteorological phenomenon called "El Niño Costero", which is characterized by unusually warm ocean temperatures in the Equatorial Pacific. It generated anomalous heavy rains and consequent floods, landslides and electrical storms in northern Peru, especially in Piura, where over 400 thousand people and over 90 thousand houses were affected

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(Instituto Nacional de Defensa Civil, 2017). Interviews were conducted to the authorities of the affected cities. They revealed the magnitude of the disaster, and various logistics problems when carrying out the evaluation, prioritization, mobilization and distribution of humanitarian aid. The Armed Forces of Peru are the first responders, making available their humanitarian logistics capabilities for the support of the affected population. This research evaluates various humanitarian logistics processes, with special emphasis on the role played by the Peruvian Navy, with the support of the main national authorities such as the INDECI, which is a national body responsible for disaster management. Interviews, fieldwork and quantitative analysis of the main logistics processes were used to build a model. The formulation minimizes transportation costs and maximizes load capacity of the Navy, from the point of entry to multiple affected areas.

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### Allocation of Local Relief Warehouses to Affected Areas for Distribution Planning of Humanitarian Supplies

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The higher frequency and larger impact of disasters around the world has made Humanitarian Logistics (HL) an important research field. One of the key factors is the location of Local Relief Warehouses (LRW) in affected areas to reduce people's suffering by the minimization of the response time. Some areas are particularly interesting because of their vulnerabilities. Peru, is a vulnerable country due to its location in the fire belt and the impacts of climate change. In the most earthquakes and mudslides, the lack of management in prevention and response to disasters results in hundreds of deaths and millions of people affected. Therefore, analyzing the uncertainty in the number of people affected, the variability of the road network, the availability of humanitarian resources, and the number of warehouses must be considered to improve the efficiency of these humanitarian supply chains. This paper proposes an integrated solution to minimize response time through the allocation of LRW to affected areas. The model is solved using multicriteria optimization and heuristics that include a dynamic visual interface to ease the decision-making processes.

### Multiple criteria facility location problem: An application in the Kurdistan region of Iraq to supply goods to internally displaced person camps

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There is a recognized need for facility location models in humanitarian logistics due to the increasing number of disasters in the last years. Facility location has been the focus of most of the research in the search for an effective and efficient planning in disaster management operations. However, literature has not addressed real-world problems in detail. The principal objective of this project is to introduce a deterministic Mixed Integer Linear Programming (MILP) model with multiple criteria for a real problem. This study used discussions with decision-makers to identify the problems. In addition to the proposed model, the results extend our knowledge of how to interact with stakeholders to understand their real needs.

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### NGO's supplier selection and procurement cost reduction with multidimensional auctions

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This paper presents two models of multidimensional auctions to reduce costs and process time in the procurement from an international NGO efficiency. A first model uses combinatorial auctions and is suited for procurement where suppliers can benefit from cost complementarities. A second model uses volume-discount auctions and is suited for volumetric purchases where discounts for large quantities are common. Several design considerations for this type of auction will be reviewed, as well as the mathematical formulation of the winner determination problem, which can be solved under Excel.



# 7. Sustainability in supply chains



### Assessment of eco-driving techniques – An approach based on the sustainability of urban waste collection

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Despite being prevalent in all urban areas, waste collection is still not entirely addressed by the literature body. Actually, eco-driving applications have been neglected. This study proposes an assessment based on a sustainable approach to incorporate a broader range of eco-driving techniques. These techniques are applied to the urban waste collection fleet of the Municipal Urban Cleaning Company (COMLURB), in Rio de Janeiro, Brazil. We analyzed two supplementary scenarios: a waste transfer operation to a single delivery point, and a stop-and-go household waste collection (multiple delivery points). As result, the practice of eco-driving is an important approach for waste collecting, since it improves sustainable measurements and provides an economic incentive according to the mileage driven. The practice not only has effects on fuel economy by saving around US\$18.5 thousand per month for a fleet of 43 vehicles, but it also reduces the CO<sub>2</sub>-equivalent emission factor up to 7.1%.

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### Impact of CO<sub>2</sub> Emissions on Inventory Replenishment under Uncertain Demand

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Caballero-Morales, S.O.<sup>1</sup>; Martínez-Flores, J.L.<sup>1</sup>, Sánchez-Partida, D.<sup>1</sup> and Cano-Olivos, P.<sup>1</sup>

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Although transportation is crucial for the appropriate flow of products throughout the supply chain, the emission of pollutants has negative effects on social and environmental issues. While negative effects of these pollutants on the economic aspect of the supply chain are implied, these are not explicitly studied or analyzed. Thus, in this work an integrated methodology to analyze the effect of CO<sub>2</sub> emissions on inventory planning is presented. With this methodology, we determined that the CO<sub>2</sub> transportation costs can significantly increase the economic lot

quantity under the continuous revision model (Q, R). Also, in presence of uncertain demand, the CO<sub>2</sub> transportation costs can increase due to an increase in the ordering frequency.

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### An integrated model design for a lignocellulosic biomass biofuel supply chain

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Concerns for world energy security, together with the negative effects generated by climate change, have driven biofuel production using lignocellulosic biomass. However, the high logistics costs of this supply chain have put the viability of its commercialization at risk. Supply chain design is an essential decision, which looks not only for cost efficiency, but also for an equilibrium with social and environmental impacts. This research proposes a model for the design of a sustainable lignocellulosic biomass supply chain, in which location decisions are integrated with those of inventory, in a multi-period, multiproduct formulation. Regarding localization decisions, facilities may be established during periods different from the initial period. Additionally, they may experience a process of capacity expansion during the planning period. The Colombian coffee region is used as a case study. Utilizing the  $\epsilon$ -restriction method, a series of chain configurations were obtained for ethanol production, using stems, pulp, and mucilage. The results generated allow for observation of the model's flexibility in the periods in which facilities may be opened. Additionally, the advantages of expanding capacities in existing facilities, and avoiding the need to open new facilities, are presented.

# The Influence of Road Gradient and Real-Time Traffic Conditions for CO<sub>2</sub> Reduction in Capacitated Vehicle Routing Problems

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The upsurge in atmospheric CO<sub>2</sub> levels has brought the attention of humankind during the last couple of decades. Global temperature has risen, ice sheets have been melting and natural disasters have been happening more frequently and with more intensity than before. New generations are urgently calling for organizations to bring sustainable practices that minimize energy consumption. This paper tries to provide an immediate but also long-term solution to nowadays-hottest topic, CO<sub>2</sub> reduction. We aim to facilitate organizations an efficient tool that allows for competing by using clean energy. We introduce a dynamic Capacitated VRP that reduces CO<sub>2</sub> emissions considering the road gradient. We solved the proposed mathematical formulation using nature-inspired metaheuristics. Even though this is a work in progress, key findings highlight a deviation of less than 6% of distance from the optimal distance route and 2% in terms of emissions. Furthermore, the computational time is very efficient and the quality of the solutions is high.

# 8. Innovations in education-related to SCM



### The impact of the integration of several learning strategies in Business Engineering students

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New learning techniques have been incorporated in the last decade to motivate the students of the Z-Generation, who are characterized by searching for their self-learning processes and being permanently exposed to information. The significant challenge for educators is to get their attention with different educational models than the traditional methods. This paper incorporates several learning strategies (e.g., presentation, case method, multimedia cases, simulation, and gamification) in the context of engineering education. Specifically, this research examines the effect of those methodologies on student academic achievement and the learning environment. We conclude that these techniques can be a useful approach to develop an entrepreneurial mindset in Business Engineering students. Therefore, they may be considered powerful tools to sustain entrepreneurship education.

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### Training future Supply Chain competences using the Mount Everest simulation

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Companies need to strive for business excellence, with a big part depending upon managing their supply chains in an effective way. Moreover, companies have been entering the fourth industrial revolution, a revolution based on strong technological changes that might shape novel ways of working with new set of competences being required by workers. Among these competences, some of the most relevant include soft and interpersonal skills related with Integration, Trust, Communication and Collaboration (ITC2), all expected to become particularly relevant for future supply chains to succeed. This paper shows a new innovative way of teaching

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ITC2 competences, using a course-pack based on the Mount Everest simulation (and case study) from Harvard Business Publishing. This simulation, originally intended to teach leadership concepts (focused on three levels: organization, individual and group), makes students reflect and discuss about the importance of ITC2 to accomplish complex tasks towards fulfilling a common goal. After conducting experiences with graduate and undergraduate students in Peru, Uruguay and Colombia, we conclude that using the Mount Everest simulation (together with the Mount Everest case study) can be a very effective way of raising students' awareness about ITC2 competences required in future SC professionals.

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### Study of the application of project-based learning (PBL) method in an operations management class

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Henriquez Machado, R.J.<sup>1</sup>

1. Universidad de La Sabana, Colombia

This research shows an application of the Project-Based Learning method in an Operations Management class by the use of a semester project. This project includes visiting a real business and the use of a game that links topics from the class to the real life. We analyze the impact in the learning process of the students and their academic development.

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### Portable laboratory as strategy to active learning in the teaching of SCM

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González, C.<sup>1</sup>

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This descriptive and experimental approach aims to improve the teaching strategy of engineering through active learning. The case study is performed in the graduate engineering course of supply chain management. This exercise seeks to demonstrate the advantages of experiential learning compared to the classical master class. The methodology that was carried out began with the investigation of the literature related to active learning. Later, a syllabus focused on active learning was developed to make the student conceive, design, implement and operate a supply chain. It was possible to show differences in learning between a group of students who

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faced this new technique and another using the traditional technique. The results show that the group of students who learned using experiential techniques were able to remember faster and more accurately to speed up their decision-making process. This exercise contributes to the subject of research in engineering education, since the proposed method promotes the training of more qualified engineers when they make decisions. The proposed model allows to develop better skills for decision making at the business level.

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### Logistic cycle adjustment using a learning curve

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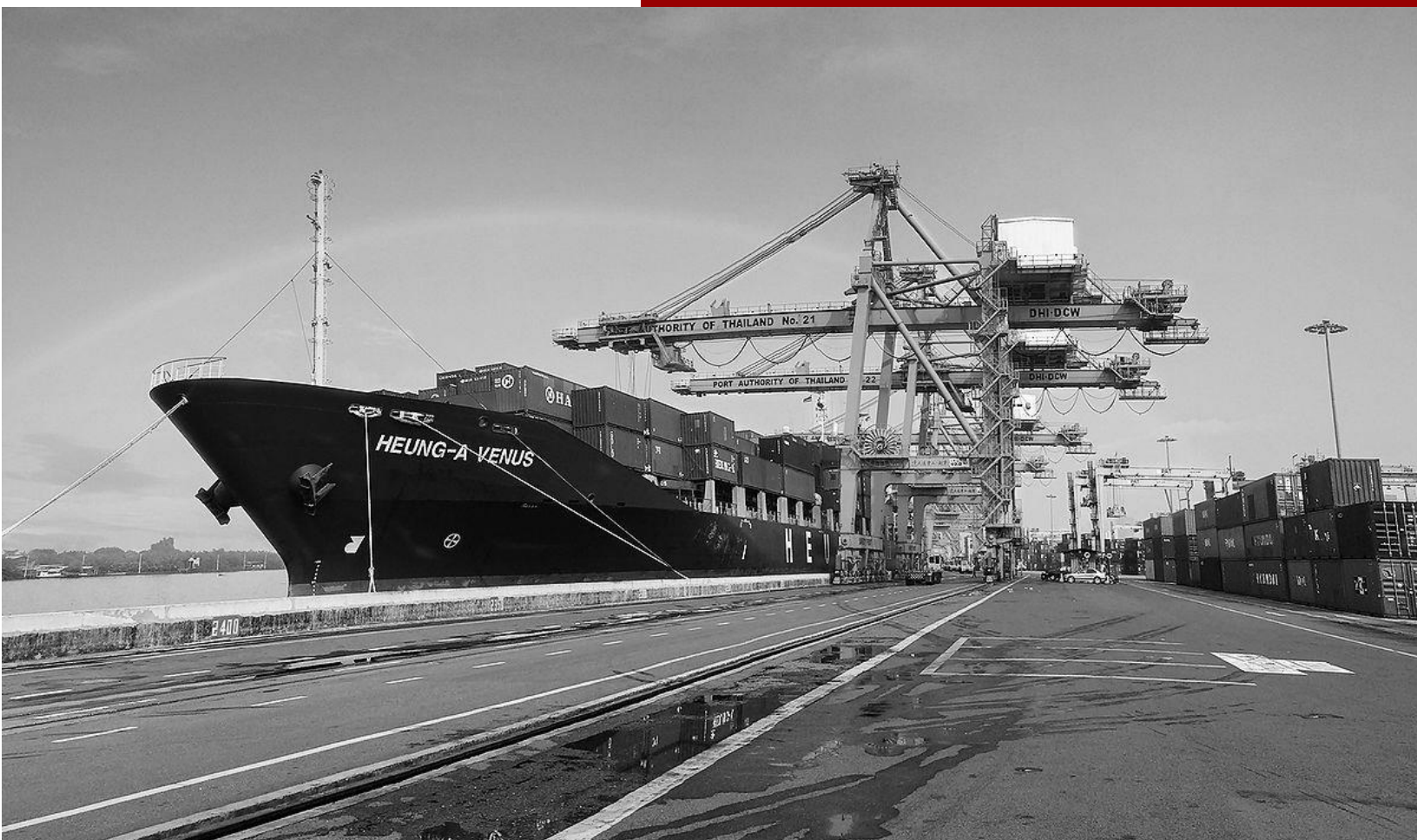
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2. University of Ibagué, Colombia

The objective of this research is to extrapolate the concept of learning curves to supply chain and more specifically, its logistics cycle to adjust cycle order and to reduce delivery time. To achieve this, the logistics network of two companies is described, the duration of their order cycle is determined and a statistical simulation is used to consider certain specificities. Finally, the learning curve of the entire supply chain was elaborated and conversion factors were calculated and tabulated. This result was used to readjust logistics cycle, and it was possible to demonstrate that the consideration of learning allows the reduction of delivery time for client.



# 9. Logistics public policy-making and infrastructure



### **Analysis of Impact of Public Policies on Productivity in Urban Freight Transport. Case Study: "Quito, Ecuador"**

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Urban freight transportation in the Metropolitan District of Quito (MDQ) is a sector with huge opportunities. Therefore, many of the regulations have inconsistencies. The present study compiles the main disadvantages of these regulations in freight transport in MDQ. The main objective is to analyze the impact of public policies and regulations on the productivity. This was done through the revision of rules of the Road Law, Traffic Law and Municipal decrees. A set of interviews conducted by the Pichincha Chamber of Heavy Transport helped collecting primary data sources. The results obtained were characterized by the losses and problems faced by the freight transportation companies with respect to public regulations in the sector. It concludes that the main problems are the result of contradictions between regulations and the real practice. In addition, the companies surveyed lost an average of 5.46 hours of work a day due to wrongly established schedules. The average cost paid for unproductive time was estimated at 19% and the cost of the infrastructure of the load generator accounts for 15% in the industrial sector.

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### **Identification of incremental factors of GHG generation from road cargo transport sector, as a premise for the design of a new logistics and mobility policy in Mexico.**

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The objective of this research is to identify the incremental factors of greenhouse gas (GHG) emissions generated by the Mexican Road Cargo Transport. This can be used later as transition indicators from infrastructure and transport policies towards logistics and mobility policies that contribute to the Sustainable Development Goals. This work makes an extensive review, finding that, since the nineties, the Mexican road cargo transport has been developing in an environment of lax regulation and permissiveness. These two features have triggered an exponential growth of small companies called man-truck. Unfortunately, it has caused problems such as cut tariffs, lack of competitiveness in the sector, fuel consumption increase and higher levels of GHG emissions derived from bad practices. The lack of maintenance, absence of programs to promote training of driver, overloaded vehicles and improper use of federal and municipal roads are common challenges.

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### Challenges to manage different Supply Chains in the same industrial cluster: a case study at Manaus Industrial Pole

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This paper presents the challenges of managing different supply chains in the same industrial cluster that shares the same logistics infrastructure (i.e., ports, airports, customs, bureaucratic rules), but due to intrinsic characteristics of their products, the cluster needs a differentiated treatment in agility performance from customs authorities. This analysis used the Uncertainty Supply Chain Model (USCM) (Lee, 2002). A selection of the main products in this industrial cluster was done. The products were classified according to their features that were matched with specific supply chains defined in the USCM, based on interviews and visits. The industrial cluster under study accounts for 95% tax collection in the Amazonas State, and approximately 90 thousand direct employees. This state is representative in the Amazon Region, and has the lowest rate of deforestation, due to the industrial cluster based in the region since almost fifty years ago.

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The result is the need for a public policy that recognizes the necessary agility differences, and that guarantees the competitiveness of these supply chains at a global level.

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### Transamazônica Highway: the challenge of economic and social development

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This paper presents the Transamazônica Highway. This is a spatial integration project whose first stage was launched in 1974. In these 43 years, other stages of the highway were completed, without finalizing some intermediate stages. The original idea was to connect Brazil with Peru. However, due to geographic challenges like isolation, lack of essential services and difficulties in material supplies, the project affect surrounding communities (like Labrea) to the main road segment of the project. A literature review of the original design and the construction of the highway was carried out, as well as visits to the unpaved road segments that currently exist. The discussion on environmental impacts is always present in Amazonian regions. There are justifications against the construction and completion of the road as well as defenders of its completion to promote social inclusion. We identify the last stretch of the Transamazônica Highway and we analyze pros and cons.

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### Express Logistics Strategy - An economic impact in Peru

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International supply chains of different companies use a logistics network, such as express or regular courier to facilitate its business operations. In this study, Peruvian Express services' analysis have been made, presenting its direct relation with an economic growth of the country measured in commercial terms. Correlation and regression analyses were performed. They show a strong relation between the external trade of revenues and imports via express shipments. A direct and positive relation between both variables has been evidenced, estimating an increase of

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US\$161.4 million of trade exchange for each \$US1 million of shipping express investment increase. The supply chain, which represents the international express service in Peru, has been analyzed and it shows strategic improvement opportunities, which allow driving the sector to promote economic growth in the country.

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### Cluster Models: A Competitiveness Case Study between Manaus Industrial Pole in Brazil and Paraguay Free Trade Zone in Ciudad Del Este

---

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Special Economic Zones are one of the main strategies of emerging economies to attract foreign investment and boost industrial activity. This is the case of Brazil and Paraguay, where a free zone called Manaus Industrial Pole (PIM) was installed in Manaus, Brazil and a second free trade zone in Ciudad del Este, Paraguay, respectively. These industrial cluster models support similar demanding agents: the larger consumer poles in South America. The start of the operations at Paraguay Free Zone opened a discussion about the capacity of PIM to maintain and attract new manufacturing units in its industrial park. In this sense, the research question is stated as: "is Paraguay Free Trade Zone a threat to keep the Manaus Industrial Pole?" The survey was based on use of the (1) PIM's official statistical database, (2) Paraguay government documents and (3) report of Brazilian investors. The variables isolated were measured for a comparative analysis. The results show the need for PIM to improve its logistics infrastructure and improve taxes and labor legislation according international practices to maintain economic dynamism in Manaus.

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### Methodological Approach for Locating Specialized Medical Centers. Study case of Bogotá.

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In Colombia, the healthcare system has a deficit in its service capacity. This carries the undesired consequence of a weak coverage and a longer waiting time for specialized medical services. Thus, patients are forced to search for private medical insurance services. Therefore, private companies offer different types of insurance, still with low coverage for citizens. These companies require improving their coverage by locating new healthcare facilities in many cities. This research aims to adapt supply chain design methods to the healthcare setting by formulating a mathematical model based in integer programming that considers budget, capacity, and demand constraints that affect the sustainability of the new healthcare facilities. The proposed methodology includes three phases: First, the business design phase is proposed. Second, the evaluation of the relevant variables of the business model is determined. Finally, the location model is implemented to help decision makers have insights on optimal and near-optimal solutions. Finally, the methodology is tested in a case study from an insurance firm in Bogotá.

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### An Optimization Model for the Intermodal Terminal Location Problem under Decentralized Management

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The performance of an intermodal transport system depends heavily on the location, type and capacity of its intermodal terminals. In general, decisions on these issues are controlled by government entities at the national and/or local levels. The government entities are expected to make these decisions in the best public interest, while a decentralized scheme might bring potential terminal users that will take advantage of their operations according to their own best interest (i.e., to minimize their own transport costs). In this paper, we propose an optimization model aimed to assist government entities in the planning (or re-planning) of a network of intermodal terminals (e.g., railroad terminals). The model allows for determining the optimal locations and types/capacities of the terminals to operate nationally in a decentralized management context. The objective is to minimize the socio-economic costs of transporting freight and installing, operating and maintaining the terminals.

# 10. Student competition



### Freight Demand Estimation in High Commercial Density Areas as a Next Step in the km<sup>2</sup> Methodology Case of Study in Quito - Ecuador

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Growing urban areas and worldwide population moving towards urbanization, leads to major concerns regarding urban logistics and last mile operations. In Latin America, the problem grows critically. Volatile emerging economies and unstable political situations feature major limitations for strong logistic solutions. In the city of Quito, traffic regulations only consider hour restrictions for vehicle mobility, without any other policies that benefit urban goods movement. To improve the complex logistics situation in the city, several studies have been done with the purpose to identify the logistics profile of Quito, and with the km<sup>2</sup> methodology propose solutions such as optimal location of loading and unloading bays. The main objective is to estimate freight demand from previous km<sup>2</sup> areas studied. Analyzing information such as delivery preferences by day, hour, commodity levels, and operative dynamics of shops, freight demand can be modelled and delivery trips can be created with the freight trip-generation approach. Information of interest from shops within the area was collected and further analysis for characteristics and other models regarding freight demand and freight trip generation are presented.

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### Optimal Allocation of Rail Yards: a combined simulation and optimization approach

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This paper presents the development and implementation of a combined simulation and optimization methodology for a decision-making process at the strategic level in a large Brazilian general cargo railway, operated by Valor da Logística Integrada (VLI S.A.). The objective was to determine the design of a single rail corridor, of approximately 700 kilometers in Southeastern Brazil, by defining the number and position of new crossing railroad yards required to serve the plurennial-projected volume. In order to minimize the total cost, this tool verified the tradeoff



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between the levels of investment demanded for the construction of these yards and the financial impact generated by the average delay of the trains in the railway circulation. Results highlight the flexibility of the proposed single-line railway model, presenting a good computational performance that is feasible for practical applications. The simulation-optimization tool was previously verified and validated with real data presenting an error lower than 5% in results for all planning areas.

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### Strategic Supply Chain Design: A Mexican Case Study

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We proposed a Mixed-Integer Programming (MIP) approach for the strategic supply chain network design of a transnational company with a three-stage, multi-product in a multi-period model. Several methods have been considered to solve this problem, mainly based on Linear Programming, we decided to go with a MIP model because it allowed us to obtain a full vision of the supply chain network, while also letting us consider the current security problems in Mexico and the associated risks. We addressed this case study as a large-scale mathematical model that includes 64,805 binary variables and 260,281 constraints. In order to solve this problem, the obtained results consider an optimality GAP of 1%. The results could lead the company to improve the design of its supply chain network.

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### Location of a new business unit of the company Edu Holding Group and the price's fixing for the services that it will offer using the systems AHP and Fuzzy

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In this study, we applied the Analytic Hierarchy Process to identify the best alternative to locate a new business unit of the company Edu Holding Group. In a second phase, we incorporate a Fuzzy logic method to establish the rates of the services that will be offered in agreement by the

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established criteria. The results show huge improvements concerning previous solutions and ways to locate other business units in the past.

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### Risk Analysis of Transporting Goods by Road in Brazil

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Identifying and managing risks of a supply chain is crucial for the competitiveness of a company. There is null research focus on the risks of operating in Brazilian markets. The purpose of this paper is to analyze and assess the risk of cargo thefts in the country, supporting companies that are designing or intend to redesign their supply chain. The methodology considers the analysis of historical data from Jan 2015 to Nov 2017, aiming to evaluate the risk based on its probability and its impact. The findings reveal a scenario of criminality of transporting goods in Brazil, where the use of force, violence, and threats to steal goods are the most likely scenario to occur for vehicles in route or parked nearby the distribution center. On the other hand, the cargo crimes of higher impacts are concentrated in the routes to customers. This paper provides a better comprehension of the risks of transporting goods by road in Brazil, and contributes to an efficient design of a supply chain by identifying the risks and assessing the location of the crimes and their modus operandi.

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### Nanostores-based strategies to combat the increasing obesity rates in Mexico

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Industrialization, rapid urbanization and overpopulation present in most megacities of Latin American economies, have fueled dramatic changes in shopping patterns. Consumer packaged goods (CPG) are more readily, cheaply, easily available than healthy products. These CPGs are the main products bought at nanostores, reaching up to 90% of the sales of nanostores, and constitute one of the main causes of obesity. Mexico is among the most obese countries in the

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world with a 72.5% adult obesity rate. Using data collected from 500 surveys and from 328 interviews, this paper links the current obesity rates with the nanostore footprint and the assortment of CPGs in them. Interactions among diverse variables such as junk food intake, the number of visits to nanostores, the willingness to walk to a retailer, and the retail choice preferences among end consumers were identified via chi-square hypothesis testing and multiple linear regression models. A systems dynamics model is built to understand the interactions between relevant factors, from which it was concluded that nanostores could act as leverage points to reverse the obesity trends. Results show the need for CPG manufacturers to embrace responsibility, modify current product catalogues, and supply chains. By using nanostores, logistics strategies should be developed to ensure accessibility and availability to nutritious food, which meets Mexico City metropolitan area inhabitants' dietary needs.

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### Rethinking the Supply Chain Strategy of a Latin-American SME

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Castro, B.<sup>1</sup>; Tanco, M.<sup>1</sup>; Pérez-Franco, R.<sup>2</sup>; Castelli, D.<sup>1</sup>; Fernandez, V.<sup>1</sup>; Teles, J.<sup>1</sup> and Escuder, M.<sup>1</sup>

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This work shows the process of capturing, evaluating and improving the Supply Chain Strategy (SCS) of an Uruguayan SME. This project introduces a variation of the Conceptual System Assessment and Reformulation (CSAR) methodology that was adapted to a mid-sized company located at the outskirts of Montevideo. The firm works in the cleaning product market with a national coverage, with owned products and international brands that provide a cost-effective and supplementary portfolio. The case study presents the application of the methodology in a company that was undergoing a change of mid-term strategy, and leading to dynamic challenges when trying to capture their SCS. In this work, all the company was considered at its entirety in order to construct and improve their SCS.

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### A Choice Model for Retail Selection in Emergent Markets

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Since the turn of the century, the growth of modern retail formats in emerging countries has brought increased competition for the nanostores. Thus, understanding, what are the main drivers for making the decision about where to buy among retail formats is key for the survival of nanostores. Using a logistics regression, we explain consumer's preference to buy in a specific retail format, identify relevant factors that pertain either to differential characteristics of the store or to the purchase and consumer profile. Implications of the study as well as suggestions for further research are discussed.

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