Center Overview

26 April 2015
EXECUTIVE SUMMARY

Competitive pressures to improve the performance of global supply chains with respect to various key metrics continue unabated. The volume, velocity, and variety of data arriving in real-time and containing high-value information continues to increase, and being able to quickly transform these data into supply chain decisions is increasingly becoming a reality and a key enabler to improved supply chain performance and competitiveness. The data and communications revolution is paving the way for an explosion of automation in warehouses, at ports, and in freight transport that will transform how supply chains function. Increasing urbanization of both the developing and developed world and the growth of mega-cities is creating new markets, stressing urban infrastructures and urban supply chains, and thus magnifying the challenges of city logistics. These changes affect the nature and number of goods manufactured and transported and result in a greater need for multi-channel logistics, logistics for mass customization, and anticipatory logistics.

Supply chain complexity is heightened further by other changes and trends, including: changing freight transport infrastructures, new sources of energy, new manufacturing and freight transport innovations (e.g., additive manufacturing, the digital thread, modular and transportable production, service-embedded manufactured goods), the Internet of Things (IoT), concerns for environmental sustainability, changing public policy, investment, and growing concerns for supply chain risk. Tomorrow’s competitive landscape will require more intelligent, adaptive, and automated supply chains than today’s supply chains in order to meet speed, cost, and flexibility levels. These changes, their increasing pace, and their associated complexities raise enormous challenges and increase the need for new products, processes, and services. Indeed, these changes have potential for firm and industry restructuring, creation, and destruction.

Objective

Accelerating and de-risking the process of translating knowledge discovery into innovation and commercialization can provide opportunity and benefit to logistics companies and to service industries that consider trade, logistics, and supply chains important. To enable innovation in view of new challenges and future trends faced by the logistics industry regionally and globally, it is timely to establish a Center for Next Generation Logistics with the objective

*To perform cutting-edge research in logistics for translation into innovations and their commercialization that are intended to achieve transformative economic and societal impact.*

The Center will be university-based at the National University of Singapore (NUS), in partnership with the Georgia Institute of Technology (GT), industry, and government.
CENTER OBJECTIVE AND OVERVIEW

The Center objective can be summarized in three phases, as depicted in Figure 1:

I. To work with partners to identify challenges and perform cutting-edge research in supply chains and logistics.
II. To accelerate and de-risk translation of research results into innovations,
III. To help nurture the commercialization of innovations.

Roles

1. Collaborate with government, industry, and the venture capital community to identify where innovation and knowledge discovery are most needed and accelerate and de-risk the commercialization process.

2. Serve as a facilitator between researchers, government, industry, and the venture capital community

3. Provide policy impact analysis for the public and private sectors
   a) Pre-competitive research for collaborating public and private organizations
   b) Perform operations and strategic analysis for individual companies
   c) Identify trends useful for operations, strategy, policy, and innovation
   d) Serve as R&I thought leaders

Activity structure

1. Research
   a) Pre-competitive, mission-focused knowledge discovery
   b) Projects, e.g., company-specific research for enhanced competitiveness

2. Business Intelligence to support economic development, e.g.,
   a) Regulatory system monitoring and analysis
   b) Index development to evaluate the competitiveness of seaports in S.E. Asia

3. Education
   a) Doctoral students conducting translational research in view of innovation and commercialization
   b) Masters students who are on teams working on firm specific applied research projects

Figure 1: Knowledge Discovery, Innovation, and Commercialization
RESEARCH FOCUS AREAS

Data analytics and data-driven control

Access to large amounts of data arriving in real-time that contain high-value information and being able to rapidly (in real time or near real time) transform these data into supply chain decisions is increasingly becoming a reality. Figure 2 depicts the elements of a data-driven logistics decision paradigm and emphasizes the information loop generated between current actions and future acquired data observations.

As the number and percentage of people who live in urban areas grow, further stressing urban infrastructures and the supply chains that use them, the importance of managing the freight transportation system and using real-time information grows. The cost of adding new lane-kilometers in urban areas often makes “building out of congestion” prohibitive. These urban populations, many living in the growing number of mega-cities in S.E. Asia, want and expect more goods and products delivered faster (same day or next day). Such demand, as well as the changing cost of energy and environmental impact, has major influence on supply chain design and execution.

Another major factor is manufacturing innovations having significantly affecting supply chain design. For example additive manufacturing (e.g., 3D printing) and modular production facilities (e.g., Bayer’s Process Equipment Container Unit for the chemical industry) have small footprints and can be moved more quickly than capacity can be added to a more traditional stationary production facility. In consequence, in addition to changing transportation distribution, repositioning production capacity also can be used to adapt to demand change. However, modular production capacity may not be able to take advantage of economies of scale and hence may be more suitable when demand uncertainty is high relative to expected demand, batch sizes are small, and short lead-times are a competitive advantage (e.g., same day or next day delivery for e-commerce). Such situations suggest highly responsive supply chains suitable for build-to-order that are enabled by modular product architectures and support product differentiation late in the supply chain (postponement). These so-called ‘pull’ supply chains however are highly dependent on the use of real-time information for synchronization.

These developments require a new generation of systems and software that can explicitly extract in real-time the information value contained in large amounts of incoming data while adaptively updating distributions associated with any supply chain uncertainty (e.g., demand, supply, lead-times, etc.). Figure 3 provides an example vision of...
a complete supply chain system enabled by data-driven control, with a focus on containerized ocean freight systems. Physical system components that are owned and operated by infrastructure providers (e.g., ports), service providers (e.g., ocean carriers), and shippers (e.g., retailers or OEMs) are increasingly able both to collect data autonomously via sensors and to be effectively controlled via decision support systems. Entities are grouped into larger meta-systems that interact with each other and with their sub-systems and components.

Turning attention to some representative examples, consider near-future software to aid freight dispatchers and drivers, such as: software to help transport vehicles re-route in-route while traveling from origin to destination (dynamic routing) and/or re-sequence during a pickup & delivery tour (dynamic tour assembly), based on current congestion information, pickup requests as they come in during the day, and pickup requests that are anticipated (anticipatory routing and sequencing).

**Automation**

With the desire for high-speed, low-latency supply chains, automation is not just a key enabling technology but a technology paradigm whose implications will shape the design and management of modern supply chains for decades to come. Automation in supply chains transcends basic robotics in the form of, for example, automatic storage and retrieval systems and will arise as a seamless and intelligent integration of automation hardware (e.g., advanced robotics) with automation software (e.g., optimization) into automation technology. This paradigm shift will lead to major improvements of the following key features:

1. **Availability.** Automation will improve availability of supply chains by standardizing processes and reducing lead times along supply chains, which will result in lower latencies. Moreover, an upstream integration of information will reduce myopic decision making, which often results in misalignments of processes. A classical example of such an upstream integration is a cloud-based navigation system that not only incorporates traffic information but also communicates its routing decisions back. This information is then used to analyze and predict congestion, which is communicated back to the subsequent agents requiring traffic data. Another example is driverless trucks, which remove the need for driver rest and increase average driving speed.

2. **Reliability.** Automation allows replacing parts of processes prone to human-error (in particular under high-speed, low-latency requirements) by automation technology, which typically leads to a significant reduction of variance and volatility. Often, more importantly, it also allows reducing the severity of low probability, high consequence events, which can lead to a dramatic reduction in total cost of ownership.
3. **Flexibility.** Intelligent automation solutions (e.g., in warehouses, sea ports, airports) can be more easily adjusted to varying requirements, reducing overall setup and adjustment cost. Using automation technology supply chains can be scaled more efficiently while ensuring a more linear response in terms of error rate. Prime examples include the support of picking by machine vision identifying and correcting picking errors while maintaining consistent inventory levels. Moreover, switches from high-throughput configurations to low-latency configurations can be more easily realized.

Leveraging automation technologies will require a tight integration of automation hardware and automation software such as intelligent congestion routing algorithms in pods and other AGVs. Moreover, a reliable communication and information infrastructure is required, enabling autonomous automated entities to communicate and interact with each other. This will ensure scalability and sustainability beyond the point of more traditional master-slave approaches with a centralized decision management.

The solution to many key problem domains, e.g., Tuas maritime hub development, next generation pickup & delivery analytics, modular logistics, and supply chain risk mitigation will be enabled by automation, data analytics and data-driven control.

**BUSINESS INTELLIGENCE FOCUS AREAS**

To support high impact and accelerated translational research, innovation, and commercialization, part of the Center activity will focus on building and maintaining an understanding of industry and geopolitical conditions that both enable and constrain evolution in the logistics industry. In particular the center will engage in the following two areas in order to provide services and support to the industry.

**Regulatory System Monitoring and Analysis**

The diversity of the regulatory environment in S.E. Asia represents a particular challenge to companies engaged in business in the region, particularly cross-border e-commerce but also intra-country regulatory changes, and this challenge can be exacerbated by regulatory environment uncertainty. A possible regional leadership role for governmental agencies, in partnership with university researchers, is to (1) help industry anticipate regulatory changes in the region, (2) analyze the economic and societal impact of regulatory changes under consideration in order to better inform discourse surrounding regulatory policy formation, (3) play an active role regionally to ensure that regulatory changes are as business friendly and societally beneficial as possible, (4) and help formulate standards (in particular data standards) to facilitate fast and efficient compliance with regulatory processes. The need for regulatory monitoring prompted UPS to offer a regulatory consulting service (‘trade management services’), and Ernst&Young is offering a similar service in S.E. Asia.
Risk Mitigation

A major inhibitor for further improving the efficiency of supply chains and logistics operations is risk, in particular the risk of major disruptions. The more tightly coupled and integrated value-creation processes are, the higher the risk of disruptions and their amplification, often leading to propagation across the value chain. These risks if not properly mitigated and managed can lead to severe financial losses often offsetting the potential gain in efficiency. One of the Center’s focus areas will be the research and development of risk mitigation strategies in the context of supply chains and logistics both for endogenous disruptions (e.g., inventory misalignments) as well as exogenous disruptions (e.g., natural disasters). In view of the latter we also see a role for the Center in devising catastrophic risk management strategies and helping policy makers implement emergency management strategies that incorporate best practices.

EDUCATION

The educational role of the Center is to disseminate state-of-the-art knowledge to both academics and practitioners and will encompass:

1. Professional education programs to provide key personnel in the logistics sector with cutting-edge technology and innovation to preempt imminent changes and foster resilience in the logistics space
2. Integrated academic programs with NUS and GT to nurture the next generation of world-class logistics and supply chain engineers and executives
3. Information hub for emerging trends and innovation to ensure a seamless integration of academia and industry via vehicles such as round tables, innovation days, consulting services, and academic and business conferences.

VALUE PROPOSITION

Service - value through integration

The portfolio of services will include more traditional consulting services, rapid prototyping services, due diligence services, advisory services, etc., helping companies to integrate cutting-edge innovations into their business operations. Specific examples include: 1) the analysis of trade lanes, to identify potentially valuable city-to-city original-destination pairs so that shippers can be incentivized to open these routes. Such an analysis has to be performed in recurring time intervals; 2) monitoring and analyzing the regulatory system to help companies
anticipate and react timely to regulatory changes in the S.E. Asia area. Apart from these two mentioned examples, pre-competitive research and prototyping is a key component in the center’s service portfolio. This will provide risk mitigation for companies while engaging in new endeavors, as well as allowing the formation of consortia (with a shared economic interest) to address systemic challenges with benefits to a wide range of involved companies. Faculty will also offer consulting services to interested companies to address specific challenges that are beyond the scope of the company’s R&D, providing fast knowledge translation as well as train Ph.D. students to conduct high-profile research and development closely aligned with the needs of sponsoring companies.

Product - value through acceleration
Major impact will arise from commercialization of innovations, either together with a partner or directly through the center’s in-house incubator. As typical, the center could maintain an equity stake in the ventures it spins off as well as board positions etc. This would also ensure that the spin-offs would not exist in a vacuum but maintain their ties to the center and its technology. More broadly, the center could leverage existing funding mechanism of e.g., NUS (co-investments into startups) to enhance Singapore’s the startup culture and tightly integrate its innovation process with incubators.

Education - value through dissemination
The educational mission of the center is disseminating innovation and technology to key personnel in industry as well as the next generation of supply chain professionals. Moreover, the center will host conferences, both for academics and industry professionals to further manifest Singapore’s role as a leader in logistics as well as training professionals that create value for their respective employers with very short setup time. As part of this, the center will closely interact with companies that sponsor smaller projects (capstone projects) that will be completed as part of a student’s educational developments. This ensures an early familiarization of the next generation of professionals with pressing needs as well as allowing companies to identify talent early on, which will ultimately improve the recruiting yield.

Research - value through innovation
A main driver for the center’s success is research activities directly related to challenges and needs. Being the innovation engine of the center, research is central to all of the above endeavors and apart from merely funneling into the three pillars from above it will exist as a separate resource. The center will offer both research capacity for industry partners that need to focus on their day-to-day business as well as conducting research on the forefront of logistics and supply chain management for companies that want to explore alternative business models and innovations.