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MTI MINETA TRANSPORTATION INSTITUTE

Review of Literature and Curricula in Smart Supply Chain & Transportation

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MINETA TRANSPORTATION INSTITUTE

LEAD UNIVERSITY OF

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REPORT WP 18-08

REVIEW OF LITERATURE AND CURRICULA IN SMART SUPPLY CHAIN & TRANSPORTATION

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September 2018

A publication of
Mineta Transportation Institute
Created by Congress in 1991

College of Business
San José State University
San José, CA 95192-0219

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. WP 18-08	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Review of Literature and Curricula in Smart Supply Chain & Transportation		**5. Report Date** September 2018 **6. Performing Organization Code**
7. Authors Seung Jun Lee, https://orcid.org/0000-0002-2486-495X Tianqin Shi, https://orcid.org/0000-0001-6126-7399		**8. Performing Organization Report** CA-MTI-1737
9. Performing Organization Name and Address Mineta Transportation Institute College of Business San José State University San José, CA 95192-0219		**10. Work Unit No.** **11. Contract or Grant No.** 69A3551747127
12. Sponsoring Agency Name and Address U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology University Transportation Centers Program 1200 New Jersey Avenue, SE Washington, DC 20590		**13. Type of Report and Period Covered** Final Report **14. Sponsoring Agency Code**
15. Supplemental Notes		

16. Abstract

This study provides a review of existing smart supply chain management (SCM) literature and current course offerings in order to identify unexplored implications of smart SCM. Specifically, the study focuses on curricula within the state of California to derive potential opportunities for the relevant practitioners in the Bay Area. In addition, the study further extends curriculum review to other well-recognized SCM programs around the U.S. By exploring current relevant course offerings from different academic institutions for higher education (i.e., universities), this research aims to deliver general ideas useful to knowledge practitioners in fields concerning SCM. Finally, the research illustrates a conceptual framework aimed at fostering familiarity with the necessary research topics for the evolving smart SCM.

17. Key Words Smart supply chain; smart logistics and transportation; curriculum review; IT; data analytics; innovation	**18. Distribution Statement** No restrictions. This document is available to the public through The National Technical Information Service, Springfield, VA 22161		
19. Security Classif. (of this report) Unclassified	**20. Security Classif. (of this page)** Unclassified	**21. No. of Pages** 16	**22. Price**

Form DOT F 1700.7 (8-72)

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091818

ACKNOWLEDGMENTS

The authors thank MTI staff, including Executive Director Karen Philbrick, PhD; Research and Technology Transfer Director Hilary Nixon, PhD; Research Support Assistant Joseph Mercado; Executive Administrative Assistant Jill Carter; and Editing Press for editorial services.

Cover Image Source: Future Connected City: 2086. Accessed 9/25/2018 from https://www.flickr.com/photos/143789194@N03/28650310590 and https://www.jct600.co.uk/blog/future-of-motoring/what-will-motoring-look-like-70-years-from-now/.

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INTRODUCTION

Evolving advanced Information Technology (IT) systems present both new opportunities and unique challenges for modern organizations. Firms can obtain managerial values via adopting advanced IT systems, which can result in positive organizational performance (Mithas et al., 2011). For example, business analytics, which provide advanced decision models by utilizing big data, can allow firms to improve their competitive capabilities, such as responsiveness or cost efficiency (Barton and Court, 2012; Chae and Olson, 2013; Yan and Dooley, 2013). Such technologies may affect fundamental systems within a supply chain that includes a system of organizations, resources, and processes to manage flows of products, information, and finances (Sahin and Robinson, 2002). With the emerging concept of a smart city, which involves utilizing information within a city to improve each service system's visibility (Bélissent, 2010), it is important to discover the corresponding supply chain systems in current dynamic and uncertain environments.

We consider the smart supply chain as a modern supply chain system emerging in response to the recent IT-initiated movements, such as the smart city, e-supply chain, IoT, or smart factory (Butner, 2010; Jie et al., 2015; Reaidy et al., 2015; Tu, 2018). Specifically, a smart supply chain management (SSCM) can be defined as the overall process management of goods or services involving advanced product-tracking devices and systems as the instrumentation. Academic researchers in the SCM domain have explored the fundamental idea of smart supply chain systems (Spanaki et al., 2017; Tavasszy et al., 2012; Wu et al., 2016). Although scholars and practitioners have described the concept behind smart supply chains in different ways, the studies broadly present consistent ideas: advanced technologies can affect an automated process within a system that leads to improved supply chain visibility (Butner, 2010; Mir et al., 2018; Wu et al., 2016).

In response to requirements for smart city projects around the world, current transportation or logistics systems need to adopt a high degree of smart supply chain activities. For instance, some cities have already been initiating practices, such as rerouting public buses depending on real-time traffic or applying mobile-enabled payments for public parking (Bélissent, 2010). Supply chain managers in a firm should properly leverage their supply chain system and the needed IT infrastructure to operate such novel smart supply chain applications.

The fundamental task for supply chain managers relates to cost efficiency. More specifically, to achieve smart supply chain/transportation, physical facilities—such as warehouses and terminals—should be integrated with information and communications technology at an affordable cost. Although the new technologies and processes in a smart supply chain have substantial implications on logistics and transportation management (Mir et al., 2018; Wu et al., 2016), few scholars and administrators have provided specific guidelines to help navigate the new domain. Given that the concept of a smart supply chain and the corresponding literature are still at a preliminary stage, there is an urgent need to discover what specific curricular items should be considered by the real-world practitioners.

Motivated by the lack of sufficient information regarding the smart SCM, this report provides a review of existing SCM literature and current course offerings in order to identify unexplored implications of smart SCM. Since MTI primarily considers issues relevant to regional transportation practitioners, such as Bay Area or other areas within California, we focus on curricula within the state of California to derive potential opportunities for the relevant practitioners. We further extend our review to other well-recognized supply chain programs around the U.S. By exploring current relevant course offerings from different academic institutions for higher education (i.e., universities), we aim to provide general ideas useful to knowledge practitioners in fields concerning SCM and to identify which topics would be needed to manage smart supply chains. Finally, based on this review of the smart SCM literature, the report suggests a conceptual framework aimed at fostering familiarity with the necessary research topics for the evolving smart SCM.

The study highlights unexplored smart SCM areas that have yet to be examined by transportation/logistics scholars. Based on our framework, we expect academic SCM scholars and educators to extend their managerial interests to smart SCM that focuses on transportation and logistics. In addition, the report provides high-level suggestions for transportation related practitioners. For example, supply chain managers can conceptualize the smart SCM issues that are or can potentially become noticeable challenges to the community.

In the next section, we provide an overview of literature surrounding the concept of a smart supply chain. Based on the review, the report provides a conceptual framework that includes key drivers that current academic institutions need to consider for smart SCM.

LITERATURE REVIEW IN SMART SCM

The literature on smart supply chains has been expanding rapidly since the beginning of the fourth industrial revolution (Industry 4.0), which advocates for industrial movement towards a smart factory (Hofmann and Rüsch 2017). A smart factory is a flexible system facilitated with networked manufacturing components and an efficient manufacturing system to self-optimize its performance, self-adapt to and learn from new conditions in real or near-real time, and self-govern entire production processes (Coreynen et al., 2017; Burke et al., 2017; Hessman, 2013; Oh and Jeong, 2018). Compared to a traditional factory, a smart factory features connectivity, optimization, transparency, proactivity, and agility, and it aims to address managerial challenges such as asset efficiency, quality, costs, safety, and sustainability (Burke et al., 2017). Schmidt et al. (2015) examined the implementation of Industry 4.0 by considering various managerial factors such as mass customization and optimized process time. Glas and Kleemann (2016) studied the impacts of smart factories and Industry 4.0 on procurement and supply management. Dawid et al. (2016) proposed smart manufacturing processes that are participatory for customers.

The scope of smart supply chains goes beyond the isolated manufacturing process or system and extends to, but is not limited to, the areas of customer segmentation and omnichannel (Cooke, 2014), as well as time-to-market and flexible re-optimization of plans (Dassault Systèmes, 2016). A smart supply chain is instrumented with machine-generated information, which is interconnected among various stakeholders and product/service components at all levels and the smart supply chain is intelligent enough to analyze incredibly complex and dynamic business scenarios (IBM, 2010). The future smart supply chain will have the basic attributes of connections, collaboration, customization, and flexibility (Oh and Jeong, 2018). Wu et al. (2016) examined the current status of and identified future research issues pertaining to smart SCM, while Schlüter and Henke (2017) defined a research framework of smart supply chain risk management.

Smart transportation makes the smart supply chain more achievable. Built on the Smart Freight framework developed by Lumsden and Stefansson (2007) and the Smart Logistics Setup (SLS) framework by Stefansson and Sternberg (2007), three cornerstones of the Smart Transportation Management (STM) system were identified by Stefansson and Lumsden (2009): (1) the Smart Freight that can be identified with new smart technologies such as an RFID tag, (2) the Smart Vehicle that is equipped with a vehicle computer system to identify when goods (freight) are loaded onto or unloaded from the vehicle, and (3) the Smart Infrastructure that consists of physical and digital infrastructure as well as a collection of commercial and public services provided to different client bases to enable collaborative logistics management setups.

Smart supply chains are more likely to exist in smart cities (Tachizawa et al., 2015). A smart city actively and efficiently employs information and communications technology-(ICT-) based approaches to address public issues on the basis of collaboration between firms, end-users, and local stakeholders (Caragliu et al., 2011; Allwinkle and Cruickshank, 2011; Manville et al., 2014). Smart cities can support smart supply chains by optimizing vehicle routing and transportation planning (Manville et al., 2014), improving driving safety productivity as well as transportation routing processes (Townsend, 2014), and even

reinventing the function of transportation networks (Schiller, 2014). Kumar et al. (2016) examined the impacts of a smart city on the changing nature and form of traditional supply chain and distributed manufacturing on supply chain design. In short, the extant literature shows that SSCM may require unique collaborations between supply chain members, which can potentially create additional value with given resources. In other words, innovative SCM can further improve efficient supply chain systems.

Most existing references pertaining to SSCM are research-oriented and have rarely provided educational implications in the field of either SCM or information systems (IS). For example, Smyth and Gable (2006) pointed out that only one out of nine universities in Queensland, Australia, had established a Smart Enterprise Center, or had an IS research focus on smart supply chains. Nevertheless, the study did not investigate whether that university's IS curriculum had any distinctive features related to smart supply chains or transportation management. Thus, our study evaluates and moves toward closing the research-education gap by exploring current relevant course offerings in a number of universities and hence providing educational implications on the role and scope of smart supply chain knowledge in the practice of future SCM.

CURRICULUM REVIEW: SMART SCM

The first step of our curriculum review is to identify relevant keywords by course name. Based on the key concepts in smart supply chain/transportation and the literature review, we limited our search results by focusing on the courses that contain at least one of the following keywords: “supply chain management,” “supply chain,” “value chain,” “logistics,” “transportation,” “enterprise resource planning/ERP,” “radio frequency identification/RFID,” and “SAP.”

Based on the selected keywords, we conducted the search by looking into the course catalog of universities in the state of California, U.S.A.: primarily, different campuses of California State University (CSU) and the University of California (UC). We then expanded our scope to U.S. universities outside California, primarily by looking at prominent supply chain/logistics/transportation undergraduate or graduate programs. In general, the courses containing the above keywords are offered by the following colleges or departments: Business Administration, Operations Management/Operations Research, Management Information Systems (MIS), Decision Sciences, Marketing and Logistics, Supply Chain Management, Computer Information Systems, Industrial Engineering/ Industrial Technology, and Mechanical and Aerospace Engineering.

After we filtered the courses, we determined whether each course taught smart supply chain/transportation concepts or relevant tools and skills. We only examined the courses with syllabi available online. We identified 137 courses offered by 34 universities, among which 107 are taught by business schools (colleges), 27 by non-business schools (colleges), and 3 jointly by both schools (colleges). Further, 64.2% of the courses are only for undergraduates, 34.3% are only for graduates, and the remaining 1.5% are for both graduates and undergraduates. Among these 137 courses, the syllabi of only 26 courses (19%) cover SSCM concepts, tools, or skills, as reported in Table 1.

Table 1. Information Pertaining to Courses Reviewed

California, U.S.A.	Elsewhere in U.S.A.
23 universities	11 universities
97 courses	40 courses
80 offered by business schools 17 offered by non-business schools	27 offered by business schools 10 offered by non-business schools 3 offered by both schools
59 undergraduate courses 38 graduate courses	29 undergraduate courses 9 graduate courses 2 joint graduate/undergraduate courses
17 courses related to SSCM (14*)	9 courses related to SSCM (6*)

** if the courses considered exclude those with simulations.*

In these 26 courses, ERP or SAP ERP is the most popular topic: 13 courses cover ERP. In particular, 8 out of the 13 courses offer hands-on ERP or SAP ERP experiences. This finding is not surprising, because ERP is one of the most widely-acknowledged systems of records in facilitating smart supply chains. In addition, 3 courses have a specific focus

on or have at least one section dedicated to RFID, while 9 courses offer lab sessions (excluding ERP) or simulations. Most universities use simulation platforms such as LINKS, SCODE, and ILOG LogicNet. Note that based on the course syllabi, it is sometimes difficult to judge whether these lab sessions (excluding ERP) or simulations are relevant to smart supply chain or transportation. Thus, if we exclude these courses, only 20 out of 136 courses (14.7%) cover SSCM concepts, tools, or skills. Other commonly discussed SSCM topics include the implementation of Oracle/PeopleSoft, JD Edwards, Microsoft Dynamics supply-chain management software, Autodesk Civil 3D, and the Highway Capacity Software (HCS) package. Figure 1 classifies the reviewed SSCM-related courses into different contents or topics.

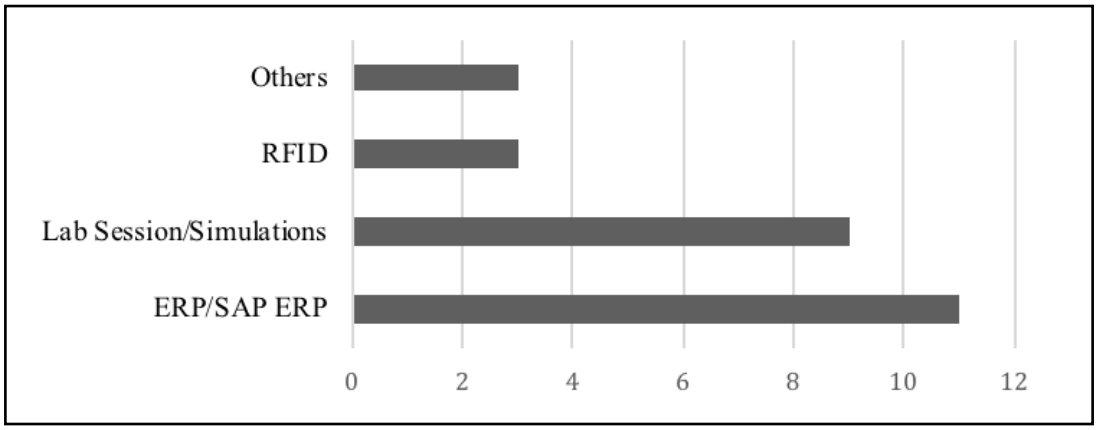

Figure 1. SSCM-Related Course Contents/Topics

Based on the above course review, only 26 out of 137 courses can be said to include SSCM-related contents or topics. The most frequently-discussed topics are ERP, SCM Lab sessions/Simulations, and RFID. The low coverage of SSCM-related contents or topics in high education courses signifies a need for further research and other efforts towards equipping students with the smart supply chain/transportation knowledge and skills needed by the real world.

SUGGESTIONS FOR EDUCATORS AND PRACTITIONERS IN SMART SCM

Considering the results of the curriculum review, we identified several contextual needs to discover current industrial movement towards smart supply chain and transportation management. The first task that academic institutions should consider relates to the interface between SCM and modern IS. In particular, courses related to the supply chain/transportation systems should consider both transportation/logistics foundations and the corresponding IT approaches, such as selection processes of proper IT devices given organizations' environments. By synthesizing these two fundamentals, future practitioners can build more realistic foundations. For example, instructors in academic institutions can offer guidance towards how to achieve meaningful findings from data obtained by RIFD. By improving SCM education using the above practices, future practitioners will grasp suitable ideas related to SSCM.

On top of synthesizing the IT contents and traditional supply chain/logistics contents, we also suggest that knowledge pertaining to innovation be taught as part of proper SSCM education. Since smart supply chain/logistics management systems are likely to follow newly updated infrastructures, it is important to learn how to create values effectively via new processes or technologies. Innovation-related contents can help future practitioners to effectively utilize smart supply chain/logistics management. For instance, the domain of entrepreneurship generally provides innovation-related perspectives: identification, analysis, and evaluation of new business opportunities. Following those aspects, academic institutions can offer instruction related to how to analyze the processes of new smart supply chain/logistics applications. By considering the three main key drivers of studying traditional SCM, exploring IT adoption, and discovering innovation-related characteristics—future practitioners can effectively practice smart SCM or logistics/transportation management.

Figure 2 illustrates the triangulation of the three key drivers that were derived from the literature review and survey of existing curricula. To understand the smart supply chain concept comprehensively, practitioners should know how to acquire meaningful information from individual data sets. After obtaining meaningful information, the practitioners should understand the importance of supply chain collaboration to better operationalize such information. Since practitioners may face newly-introduced infrastructure, they need to exploit innovation contexts for efficient value creation processes. Those processes can result in better inter-organizational information sharing, which can provide improved smart SCM. By properly adopting the framework, future educators and practitioners can build foundations of smart SCM systems more efficiently and effectively.

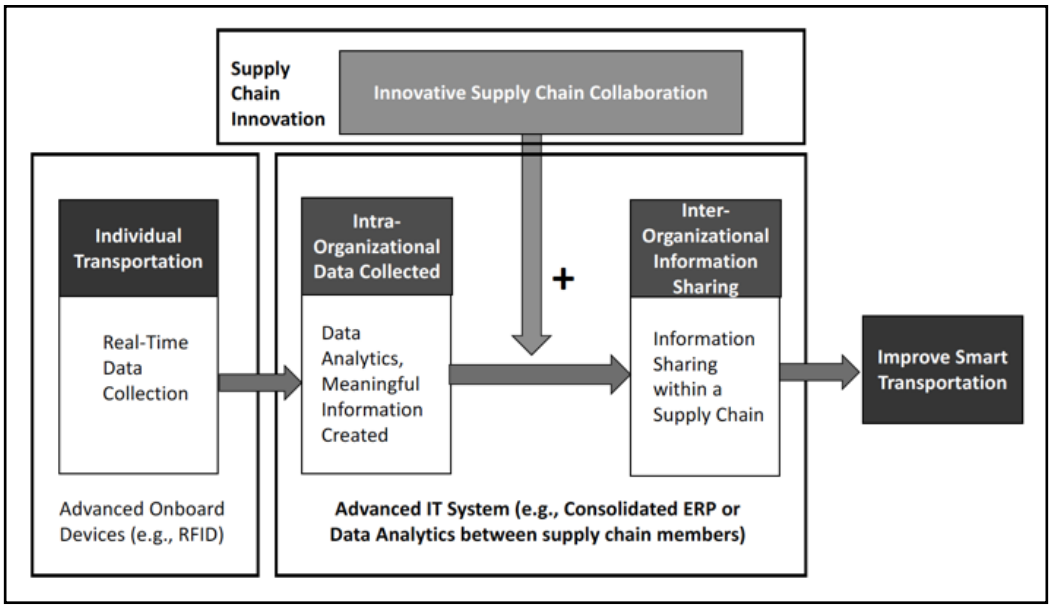

Figure 2. Framework for Effective Smart Supply Chain Management

Instructors from academic institutions can play a role: educators should provide corresponding steps and specific methodologies to the practitioners. Specifically, instructors need to deliver a conceptual explanation of the overall framework of smart supply chain systems. Traditional supply chain concepts and other contexts, such as data analytics from different domains should be provided. After that, educators should address the importance of data analytics, such as discovering the trend of traffic behaviors, or antecedents of smart transportation issues. Without understanding the processes of information creation, practitioners in the SCM domain hardly interpret the smart supply chain issues. Additionally, innovation-related contents, such as valuation and market analysis, can further moderate the comprehensive understanding of smart SCMs. In particular, such contents may lead to improve collaboration between supply chain members. By providing such combined subjects, our future practitioners (i.e., students concentrating on supply chain/transportation management) can effectively manage smart supply chain/transportation problems.

CONCLUSION

The present report investigates an extant smart logistics/transportation management literature and shows how to bridge the gap between the necessary smart supply chain contexts and existing curricula in academic institutions. The study suggests ideas that current academic institutions need to provide to tackle upcoming smart supply chain/ transportation issues. Specifically, based on the review pertaining to the smart SCM/ transportation management literature, the report provides a conceptual framework that includes key drivers for a successful smart SCM. Based on the framework, we expect instructors and practitioners to have general ideas about smart SCM drivers. Also, academic scholars can stretch their managerial interest to smart SCM, which focuses on transportation and logistics. For example, researchers who are interested in transportation management can consider additional drivers, such as the impact of consolidated IT systems between warehouses and retailers. By considering additional factors that have not yet explored in the traditional transportation/logistics management literature, academic scholars and practitioners alike can discover new managerial implications.

In short, the current report can be the stepping stone for future researchers and educators. Using the framework delivered herein, researchers can consider new research opportunities and educators can redesign their curricula to provide a better understanding of smart SCM or transportation management to the next generation of SCM/transportation practitioners.

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PEER REVIEW

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