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A Proposal for Supply Chain Management Research That Matters: Sixteen High Priority Research Projects for the Future

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A PROPOSAL FOR SUPPLY CHAIN MANAGEMENT RESEARCH THAT MATTERS

Sixteen High Priority Research Projects for the Future

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Executive Summary

On May 4th, 2016 in Milton, Ontario, the ***World Class Supply Chain 2016 Summit*** was held in partnership between CN Rail and Wilfrid Laurier University's Lazaridis School of Business & Economics to realize an ambitious goal: *raise knowledge of contemporary supply chain management* (*SCM*) *issues through genuine peer-to-peer dialogue among practitioners and scholars*. A principal element of that knowledge is an answer to the question: ***to gain valid and reliable insights for attaining SCM excellence, what issues must be researched further?*** This White Paper –which is the second of the summit's two White Papers– addresses the question by proposing a research agenda comprising 16 research projects. This research agenda covers the following:

(i) *The current state of research knowledge on issues that are of the highest priority to today's SCM professionals*

(ii) *Important gaps in current research knowledge and, consequently, the major questions that should be answered in sixteen future research projects aimed at addressing those gaps*

(iii) *Ways in which the research projects can be incorporated into student training and be supported by Canada's major research funding agencies*

That content comes from using the summit's deliberations to guide systematic reviews of both the SCM research literature and Canadian institutional mechanisms that are geared towards building knowledge through research. The major conclusions from those reviews can be summarized as follows:

(1) While the research literature to date has yielded useful insights to inform the pursuit of SCM excellence, several research questions of immense practical importance remain unanswered or, at best, inadequately answered

(2) The body of research required to answer those questions will have to focus on what the summit's first White Paper presented as four highly impactful levers that SCM executives must expertly handle to attain excellence: ***collaboration***; ***information***; ***technology***; and ***talent***

(3) The proposed research agenda can be pursued in ways that achieve the two inter-related goals of creating new actionable knowledge and building the capacity of today's students to become tomorrow's *practitioners* and *contributors to ongoing knowledge growth* in the SCM field

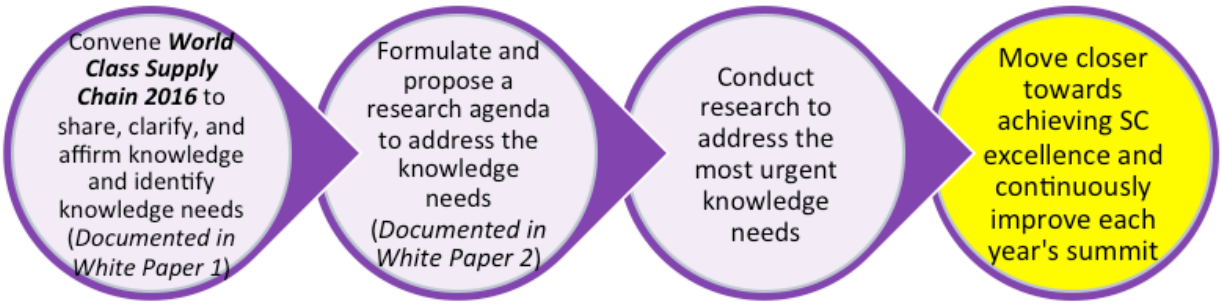
This White Paper's details underlying these conclusions build on the information presented in the summit's first White Paper (found at https://legacy.wlu.ca/news_detail.php?grp_id=31&nws_id=15107&pv=1). That is, while the first White Paper (White Paper 1) identified general SCM themes for which the research needs are most urgent, this White Paper goes further along the path of industry-academia knowledge co-creation. It does so by *examining and articulating those needs* against the backdrop of available research findings, *translating the needs into specific research projects* that should be pursued, and *providing guidelines* for how those projects can be carried out.

Introduction and Overview

Through their sincere peer-to-peer dialogue, executives and scholars at the inaugural May 4th, 2016 summit ***World Class Supply Chain 2016***, met their goal of raising our collective understanding of SCM. Yet, while realizing this goal through sharing, clarifying, and affirming knowledge that is relevant to the pursuit of supply chain excellence, these executives and scholars were fully aware of areas about which meaningful knowledge is lacking or, at best, incomplete and uncertain. Their awareness of knowledge gaps that matter raises a crucial question: ***What research is most urgently needed in order to yield knowledge that results in greater confidence about which specific courses of action will yield SCM excellence?***

This paper's main purpose is to answer that question by proposing a research agenda that is tuned to genuine SCM concerns. The importance of that purpose is particularly evident in the insights by Lambert and Enz (2015) and Stank *et al*. (2011). For example, it is clear from these authors' observations that two major reasons for judging current knowledge to be inadequate are (a) noticeable disparities between many scholarly research articles and real SCM concerns and (b) many non-scholarly writings that purport to be solutions to SCM problems amount to baseless promotional hype lacking a sound foundation of knowledge. With that in mind, the work of fulfilling this paper's central purpose involved three elements: (i) develop a clear understanding of the relevant research needs suggested by the discourse at the summit and within the broader SCM community (e.g., discourse in the research literature on SCM), (ii) specify those needs in the more concrete terms of research projects that have implications for business practice, and (iii) provide guidelines and frameworks for undertaking those research objectives. These three elements represent just one stage in the progression of knowledge towards the goal of SCM excellence (see Figure 1 below).

Figure 1: Progression of Knowledge Towards SCM Excellence



For clarity and ease of exposition, the four-lever framework introduced in White Paper 1 is used here to organize the discussion of the proposed research agenda. That framework highlights the following as four very influential levers to be managed in pursuing SCM excellence:

LEVER 1: Collaboration – *the act of working with another party* (*e.g., another organization*) *to produce or create value that could not be created by the sole effort of one party*

LEVER 2: Information – *what supply chain parties must know* (*about matters such as customer demand, costs, and prices*) *in order to avoid making flawed decisions*

LEVER 3: Technology – *the particulars (e.g., level of sophistication/modernity) of physical equipment, information systems, procedures, etc. that are used to facilitate SCM activities*

LEVER 4: Talent – *reflected by the expertise of personnel responsible for SCM activities*

The four-lever framework proved effective in capturing the essence of what would appear to be a disparate array of knowledge needs that were noted at the summit and echoed in the scientific research literature. These include visionary supply chain leadership, humanitarian SCM, e-commerce, baby boomers exiting the workforce, environmentally sustainable (green) SCM, etc. Coverage of these topics within the framework of the four levers will proceed in the remainder of this report as follows. First, the next section (beginning on page 5) subdivides the discussion of each lever into three parts:

(i) An overview of evidence-based knowledge about the lever;
(ii) A summary of important lever-specific knowledge gaps
(iii) An outline of **four** proposed research projects that should be undertaken (and the central question that each project should answer) in order to address the identified knowledge gaps.

With four projects for each lever, this paper's proposed research agenda comprises **sixteen** high priority projects. The following is a summary of the major knowledge needs that these research projects will satisfy.

1. How to develop successful collaborations with more than two partnering firms.
2. How to govern an inter-firm collaboration as it evolves over time.
3. Reasons to collaboratively pursue the goal of environmental sustainability.
4. How to mitigate the negative effects of collaborations that are too close.

} ***Collaboration*** Lever Projects

5. The costs and benefits of timely information flow within supply chains.
6. The strength of the business case for ***Big Data***.
7. Proper controls to assure the veracity of information used in ***Big Data Analysis***.
8. Staffing guidelines for decisions about employing data scientists.

} ***Information*** Lever Projects

9. Appropriate inter-firm information systems for technologically different firms.
10. Ways for small firms to collectively overcome barriers to technological readiness.
11. How to mitigate adverse effects of technology change on vulnerable workers.
12. Technology vendor actions to enable successful adoption of the right technology.

} ***Technology*** Lever Projects

13. Specific new skills required for managing modern supply chains.
14. The SCM expertise required in non-commercial organizations.
15. Ways to reduce potential problems linked to transformational leadership.
16. How to design student co-op jobs to enhance students' leadership capacity.

} ***Talent*** Lever Projects

Following the description of the sixteen projects, the paper then uses a sample comprising six of the projects to demonstrate that students at all levels of university study –from bachelor's through to PhD programs– can play vital roles in carrying out the research projects. That demonstration highlights the paper's position that research and student training are inextricably linked quests that can be undertaken simultaneously. Specifically, by taking on the role of being their professors' research partners on the proposed projects, students will gain at least two types of knowledge that are valuable before and after graduation: knowledge of both (1) how to conduct meaningful SCM research and (2) the SCM phenomena being researched. To realize these knowledge gains for students and for practitioners seeking to use a research project's findings in their organizations, funding is sometimes required. To this end, the paper presents an overview of Canadian organizations that have a mandate to support knowledge creation.

What Do We (Need to) Know About Each Lever of Excellence?

What we know about Lever of Excellence 1: COLLABORATION

Evidence-based knowledge

Overwhelmingly, the voluminous writings on inter-firm collaboration are predicated on justified confidence that collaboration *has the potential* to improve supply chain performance; see, e.g., the Chan and Chan (2014) review of research that uses formal mathematical models of supply chains to demonstrate that potential. *How* to realize that potential is a dominant preoccupation of researchers, especially those who study actual collaborations. Evidence-based knowledge from those researchers can be distilled into three major areas: (i) the ***meaning*** of collaboration (*what does collaboration really mean*?), (ii) the importance of ***trust*** as a determinant of successful collaboration, and (iii) the immense ***difficulty*** of achieving effective collaboration (hence the apparent rarity of such collaborations). As regards the crucial matter of defining collaboration clearly, Whipple and Russell (2007) introduced a framework to show that collaboration is not a one-dimensional concept. What makes it multi-dimensional is that there are different degrees (types) of collaborations. Thus, it is somewhat meaningless to recommend that a firm collaborate with supply chain partners without also specifying the type of collaboration being recommended. Drawing heavily on their interviews of 21 managers in retail and manufacturing firms, the authors proposed a framework showing that collaboration can be categorized into the following three types:

Type I (Short-term orientation): Collaborative Transaction Management: This is focused on facilitating the exchange of transaction data and is the first step in building a strong base from which more advanced forms of collaboration can evolve. Success in collaborative transaction management is highly dependent upon the ability to standardize transactional data and utilize technology support tools to exchange data automatically. The authors cited Vendor Managed Inventory (VMI) as an example of Type I collaboration.

Type II (Medium-term orientation): Collaborative Event Management: This is focused on joint planning and decision-making around key events/issues (e.g. creating a joint business plan, sharing information regarding new product introductions/new store openings). Observed Type II features include increased forecast accuracy, lower required safety stock levels, improved in-stock levels, improved promotional servicing, and increased sales. The authors presented *Initial* Collaborative Planning, Forecasting, and Replenishment (CPFR) as an example of Type II collaboration. The authors defined initial CPFR as being enough to follow the guidelines of the Voluntary Interindustry Commerce Standards without including the generation of order forecasts.

Type III (Long-term orientation): Collaborative Process Management: This is focused on collaborative management of processes– demand and supply processes– so that true cross-enterprise/cross-functional integration occurs." The authors presented *Advanced* CPFR as an example of Type III collaboration, where advanced CPFR goes beyond initial CPFR by including the generation of order forecasts.

A key contribution of this typology is to help avoid muddled discussions about what type of collaboration a firm is engaged in. For example, if the inter-firm relationship is focused on immediate short-term concerns

(e.g. rectifying a misdirected delivery) and involves only a few people who are all at the operational level, and the data exchanged are transactional, then the collaboration is Type I. This is very different from a Type III collaboration in which the involved personnel form an inter-firm social network that includes strategic-level decision makers, who focus on long-term concerns and who exchange more than just explicit transactional information but also tacit and unstructured information.

As for the matter of the ***trust*** (typically defined as *confidence in a supply chain partner's reliability and integrity*), research findings validate the intuitive and frequently repeated maxim that the creation and maintenance of collaboration require a foundation of trust. One example of research that provides the validation is by Fawcett et al. (2012), who used data from interviews of 106 companies to ascertain the antecedents of successful chain alliances and the evolution of supply chain collaboration strategies. A more recent example is Delbufalo (2012), in which the research findings were obtained through a comprehensive meta-analysis of 229 peer-reviewed studies of supply chain trust over a 20-year period 1990 - 2010.

Studies that have sought to understand the task of reaching more highly evolved forms of collaboration – e.g., Type III collaboration in the model by Whipple and Russell (2007)– invariably acknowledge that the task is ***difficult***. This difficulty manifests in the paucity of firms engaged in those higher order collaborations. More importantly, the research has consistently noted that major sources of the difficulty are the barriers to achieving ***trust***. Stank et al. (2011) and Fawcett et al. (2012) are just a few of the studies to have put forward guidelines to overcome trust barriers and foster positive attitudes towards collaboration. Although some of those guidelines are yet to undergo rigorous empirical tests of their efficacy, they have convincing rationales; e.g., guidelines such as mutually developing performance metrics and incentives, investing in additional personnel to make the collaboration work, cultivating trust-sensitive talent, and having supply chain sophistication at each firm.

What we need to know about Lever of Excellence 1: COLLABORATION

Summary of Knowledge Gaps

Four of the highest priority knowledge needs are about issues of (i) the ***governance*** of supply chain collaborations, (ii) collaboration on objectives that are not *ostensibly* about profits (e.g., ***environmental sustainability***), (iii) collaborations that are ***non-dyadic*** (i.e., involving more than two partner companies); and (iv) potential ***negative*** effects of collaboration. These correspond to the following four proposed research projects.

Proposed Projects to Address the Knowledge Gaps

PROJECT #1-COLLABORATION: *How must the collaboration/trust development guidelines for dyadic partnerships be modified for useful adaptation to partnerships of three or more organizations*? This project could provide much needed managerial insights for developing non-dyadic partnerships; e.g., one involving a supplier, manufacturer, and the manufacturer's immediate downstream customer. Kembro and Näslund (2015) shed light on this need through their literature review, which shows that, vis-à-vis the vast number of papers on dyads, what has been written on non-dyadic collaboration is far too limited to provide any genuinely actionable knowledge. A second question that this project would have to address is at what point the number of collaborating firms becomes so administratively cumbersome that costs begin to outweigh benefits.

PROJECT #2-COLLABORATION: *How must the governance structure evolve with the stage of inter-firm collaboration (Type I, II, or III in the Whipple and Russell (2007) model)*? The review in Delbufalo (2012) and the conclusions by Varoutsa and Scapens (2015) in their study of the aerospace sector note that research is needed in order to produce practical ideas for how collaborations should be governed. Such ideas would have to address how the balance between the governance mechanism's *formality* and *flexibility* should evolve and be tailored to account for factors such as organizational context and relationship history.

PROJECT #3-COLLABORATION: *Why is it worthwhile for logistics service providers (LSPs) and clients to collaborate in pursuing the objective of environmentally sustainable logistics, even though that objective is not ostensibly geared towards immediate and obvious financial success*? In light of plausible findings that environmental sustainability investments can lower a company's share price (see Dam and Rektova, 2014), it is rational to doubt that, in the absence of regulatory mandates, any company would want to collaborate on such an investment. Research is needed to examine if that doubt is based on failure to accurately assess the full set of benefits that would accrue to each collaborator (LSP and client) and to the supply chain as a whole.

PROJECT #4-COLLABORATION: *What safeguards are required to avoid or minimize the potential negative outcomes of inter-firm relationships that are too close*? To build on the summit discussions that identified some concerning consequences (e.g., unauthorized disclosure of company secrets, proprietary businesses practices, and innovations), this project would look at possible safeguards, particularly in terms of their operation and efficacy.

What we know about Lever of Excellence 2: INFORMATION

Evidence-based knowledge

In the SCM context, information is a concept that can be viewed as having two broad elements or purposes. One is *visibility*, which is concerned with access to quality intelligence for supporting SCM decisions and activities. The other is *transparency*, which is to ensure that the public interest impacts of a firm's SCM practices (e.g., sourcing) can be ascertained from the firm's reports (definition adapted from Doorey, 2011). With respect to *transparency*, a key finding from Egels-Zandén et al. (2015) is that since a consequence of a given firm's act of being transparent is disclosure about a supply chain partner (e.g., a supplier), there is no guarantee that the partner will agree to the disclosure. The finding, which the authors draw from their case study of Nudie Jeans, means a choice between two outcomes: multi-party consensus to be transparent or partnership cessation; e.g., cancel contracts with suppliers who refuse to comply with the disclosure.

As regards *visibility* of quality information, its importance is very clear in insights from the extensive body of research on what is termed the *bullwhip effect* (*BWE*): the problem of information distortion that manifests itself in the variability and scale of upstream supply chain activities (production and distribution) being wastefully out of line with the scale and variability of (downstream) demand by end customers. The BWE research literature –a comprehensive review of which can be found in Wang and Disney (2016)– has yielded compelling evidence that chain-wide *visibility* of downstream information is essential for avoiding the waste that comes from information distortion. Outside of the BWE research stream, evidenced-based knowledge about visibility has also come from papers that confirmed the following about information quality:

- Information can be viewed as having 10 dimensions of quality (Miller, 1996)

1. Relevance	2. Accuracy	3. Timeliness	4. Completeness	5. Coherence
6. Format	7. Accessibility	8. Compatibility	9. Security	10. Validity

- Improved information quality leads to improvements in:
  - *Product quality*. Ding et al. (2014) reached this conclusion from a survey study of the Australian beef processing industry.
  - *The quality of managerial decisions*. Ge and Helfert (2013) found that to be true in their study that used behavioural experiments as the mode of scientific inquiry. This corroborated the result in Rossin (2012), who used simulation experiments.
  - *Supply chain flexibility* (defined as a firm's ability to adjust production levels or product functions/features and to handle nonstandard orders). This was one of the findings by Nagarajan et al. (2013) in their survey-based study of small manufacturing firms in India.
  - *Logistics operations* (improvements such as transport service planning, vehicle routing, customer service, transport asset utilization, and cost and time efficiencies). A paper reporting this finding is Popovič and Habjan (2012) who studied three Slovenian trucking companies.

What we need to know about Lever of Excellence 2: INFORMATION

Summary of Knowledge Gaps

More research-based knowledge is needed in order to facilitate cost-benefit assessment of investments to improve particular ***information quality*** dimensions such as timeliness. Research is also needed on ***Big Data***, usually defined as data that are too large and complex for traditional data processing applications to handle. As evidenced by recent reviews of the research literature –e.g., Wang et al. (2016), Wamba et al. (2015), and Hazen et al. (2014, 2016)– the supply chain community's many discussions of Big Data (BD) and BD Analytics (BDA) have served more to expose critical knowledge gaps than to produce adequately validated insights. For example, while BDA retains some fundamentals that have existed for many decades (e.g. use of time honoured descriptive, predictive, and prescriptive decision support analytics such as optimization and statistical models), there is yet to be a final word on the managerial implications of BD characteristics such as *variety*; i.e., the variety of data for BDA contains more than just the traditional numerical and structured data used in mathematical modeling. Research projects to obtain the needed knowledge on information quality and Big Data should address at least the four major questions specified below.

Proposed Projects to Address the Knowledge Gaps

PROJECT #5-INFORMATION: *What are the costs and benefits of more timely provision of information to logistics service providers (LSPs) who operate a transportation network's links (i.e. carriers) and nodes (e.g., intermodal facilities)*? The major project outcome would be to enable reliable and valid cost-benefit analysis of investments in initiatives for LSP clients to give their LSPs timely information for advanced and accurate logistics/transportation planning. This project would aim to build on recent works that quantify the benefits in financial terms for long-haul road transportation (see, e.g., Zolfagharinia and Haughton, 2014) by equivalently quantifying the costs. This kind of work would also be useful in international maritime transportation networks, where the information of interest would be what the origin port and the ocean vessel transmits to the destination port; i.e., information that is used to schedule the series of container moves from ocean vessels through to terrestrial vehicles that deliver containers to consignees.

PROJECT #6-INFORMATION: *What factors determine the strength of the business case for investing in Big Data*? It is plausible that for some companies, traditional structured data and proven data mining analytics will continue to yield value, at least for now. For such companies, immediately investing beyond their current stage of data/analytics may be financially unwise; i.e. the investment exceeds the incremental gains in business intelligence. Knowing if and when there is a genuine business case for BD requires a rigorous and systematic approach to ascertaining BD costs and benefits; some of which may not be readily obvious or easily quantifiable. One of this project's main aims would be determine how those costs and benefits are affected by factors such as how BD resources are acquired (i.e., owned or via outsourcing), whether a company makes the investment on its own or with a consortium of supply chain partners, and the importance the company places on non-financial BD outcomes; e.g., the environmental sustainability BD gains posited by Hazen et al. (2016).

PROJECT #7-INFORMATION: *What initiatives must be deployed to maximize the veracity of information used for BDA*? It can be argued that long experience in handling structured data have produced time-tested quality assurance mechanisms to help safeguard data veracity; e.g., statistical quality control charts proposed by Hazen et al. (2014). The same cannot be said for the wide variety of data envisioned in more sophisticated BD; i.e., not just a firm's internally generated and standardized transactional data but also externally generated, irregularly received, and non-standard data that include text, audio, images, and video. This project would seek to determine what initiatives yield cost-effective quality assurance for SCM-relevant data that are non-traditional.

PROJECT #8-INFORMATION: *What is the relationship between a company's optimum number of data scientists and its supply chain analytics (SCA) maturity (experience)*? A prominent part of the discourse on BD is the specialized job function of **data scientist** –someone highly competent in finding, managing, manipulating, and interpreting BD with a view to providing ongoing business intelligence. One perspective among executives is that having a dedicated team of data scientists is vital in getting value from BDA (see Accenture, 2014). This perspective draws attention to unknowns regarding what a given company's team size should be and how the company's SCA maturity influences team size. In addressing those unknowns, this research project could use as a point of reference the framework that Wang et al. (2016) proposes for categorizing companies according to their level of SCA maturity.

What we know about Lever of Excellence 3: TECHNOLOGY

Evidence-based knowledge

Invariably, each paper within the research literature on the nexus of SCM and technology has focused on producing knowledge in one or both of the following main areas:

(i) ***The validity of hypothesis about the SCM benefits of technology***; e.g., Ranganathan et al. (2013), Yao et al. (2009), and Vickery et al. (2010). The latter study of first tier suppliers to US car companies showed that it is the *complementary* impact of supply chain information technology (SCIT) and other supply chain organization initiatives (SCOI) that yields improved supply chain performance

(ii) ***Factors that either encourage or deter acceptance, adoption, or successful implementation of technology***; e.g., Autry et al. (2010), Hausman and Stock (2003), Patterson et al. (2003), and Parasuraman (2000). The latter paper introduced a 36-item scale to gauge people's propensity to embrace cutting edge technology: the *technology readiness index* (TRI). The TRI has since been refined by Parasuraman and Colby (2015). The crux of research-based knowledge in this area is that the range of factors span four categories: characteristics of (a) *individuals* involved as decision makers and technology users; (b) the *technology* under consideration; (c) the *organization* itself; and (d) the organization's *internal and external environment*.

Although much of this knowledge is based on digital information and communication technology (ICT) such as enterprise resource planning (ERP) and electronic SCM (e-SCM), the key insights would also hold true for physical equipment technology (in which digital technology is becoming increasingly essential). An example of such insights is the finding in ICT studies that influential technology adoption factors include uncertainty about the returns on investment and ease of integrating the new technology with the company's existing technologies; see, e.g., Evangelista and Sweeney (2006). What would also hold true for physical equipment technology are two of the most consistently validated findings from ICT studies: (1) top management's evident support for the new technology is vital and (2) getting people to accept the new technology often takes much more effort than fixing the new technology's technical challenges (see Stank et al., 2011).

What we <u>need to</u> know about Lever of Excellence 3: TECHNOLOGY

Summary of Knowledge Gaps

To help improve the strategic technology management process (from identification of a potential need for new technology through to implementation), there is more for researchers to clarify with respect to four themes: (i) ***imbalances in technology readiness*** across partners (an observation in Stank et al., 2011); (ii) the unique particulars of technology adoption in ***small firms***; (iii) ***people-related considerations*** in technology adoption; and (iv) the role of ***technology providers***. Following on the next page are proposed research projects to answer specific questions on those themes.

Proposed Projects to Address the Knowledge Gaps

PROJECT #9-TECHNOLOGY: *If two supply chain partners have markedly different technology readiness indices (TRIs), what is the appropriate level of sophistication in the inter-organizational ICT that connects the partners*? Since it is probably infeasible for the partner with the lower TRI to catch up with its partner *immediately* by making a significant technology transition, then relevant issues for this project to explore would include what is the right transition pace and how the more technologically ready partner might facilitate and lead an appropriately paced and mutually satisfactory transition.

PROJECT #10-TECHNOLOGY: *How can the social influences from interactions among small firms facilitate greater technological readiness*? For small firms, research findings have produced what could be viewed as a dispiriting finding: that they tend to have lower levels of readiness to embrace technological *change* –see, e.g., Lin (2014) and Peltier et al. (2012). At the same time, the seminal work of Tingling and Parent (2002) has spawned a body of technology adoption studies affirming the Di DiMaggio and Powell (1983) theory that prevailing norms within a firm's peer network will influence its decisions. Thus, a rational conjecture is that processes for interaction among small firms (roundtables, association meetings, workshops, etc.) can be catalysts to overcome the usual small firm obstacles to technology adoption. A major goal in future research to examine this conjecture would be to determine the interaction process parameters that foster (a) technology adoption in general and (b) multiple small firms undertaking joint adoptions that might be infeasible for a single small firm.

PROJECT #11-TECHNOLOGY: *What must be done to minimize the organizational upheavals when workers with limited skills and educational attainment are displaced by technology*? Although discourse about worker displacement by technology has long existed, the SCM community must revisit that discourse with fresh perspectives for at least two reasons: (i) the rapid proliferation of new logistics and SCM technologies (drones, augmented reality, etc.) and (ii) the significant differences between those technologies and earlier technologies used in, for example, warehouse and transport operations. At a minimum, this project would try to ascertain, based on case studies, what human resources management practices are effective for making the workforce transition to more technologically advanced supply chains. One such case could be that of Walmart once it moves ahead with plans to use drones in facilitating warehouse inventory management. The case study focus would include a test of the assertion that Walmart employees no longer needed for manual inventory management tasks could transition to repairing and servicing the drones.

PROJECT #12-TECHNOLOGY: *What must technology providers/vendors do to facilitate technology users' successful implementation of appropriate SCM/logistics technologies*? As Perego et al. (2011) noted on pp. 471-472 in their review of studies on ICT for transportation and logistics, the role of technology providers and vendors is among the areas in which research-based knowledge is lacking. To address that knowledge gap, the research project proposed in this White Paper would have to confront at least three issues: (i) how proactive and involved the technology provider must be at different stages of the user's decision cycle (from technology needs assessment through to implementation); (ii) how to ensure that the technology is marketed on the basis of a clear, genuine, and convincing business case rather than just on impressive technical features that users may not even want; (iii) what unique provider/vendor strategies are required for the special case of technologies that are still undergoing active refinement (i.e. *beta* technologies).

What we know about Lever of Excellence 4: TALENT

Evidence-based knowledge

When it comes to talent, the need for knowledge can be distilled into two core questions that would be of greatest interest to SCM professionals: First, what expertise is required for success? Second, what factors either foster or thwart realization of the benefits that talent can bring to an organization? Answers from the long and rich history of research on talent have become so firmly established that they are no longer viewed as new findings. Instead, they are now widely accepted as givens. Two of these givens are (1) while some elements of good leadership are innate, there are elements that can be learned (see, e.g., Spreitzer and Quinn, 1996) and (2) the expertise required for success in today's business world must include a mix of business and technical skills that cultivate effective working relationships across a diverse range of personnel and international locations (see, e.g., Hohenstein et al., 2014)

Beyond such obvious and taken for granted knowledge, research has also produced findings that provide novel and insightful perspectives on a critical problem: ***the problem of assuring a sustainable supply of SCM talent***. A key insight from the research is that attracting students to the SCM field ***before*** their post-secondary education begins should be among the suite of solutions to the problem. This was one of the key findings in the study by Leon and Uddin (2016), who sought to ascertain what factors influence students' career path choices and when those choices are made. In particular, two of the study's findings are:

- ✓ Across different business and management fields, between 24% and 34% of students decide on a career field prior to their freshman year (a further 13%-17% decide during their freshman year)
- ✓ 39% per cent of the students stated that *previous exposure to the SCM field* would have helped in persuading them to choose SCM over the field they were majoring in

Signals of what action to take to build the talent pool and the urgency of those actions become clear when one considers these findings by Leon and Uddin (2016) along with findings that confirm a shortage of SCM talent (see, e.g., the R.A. Malatest & Associates (2012) study of the Canadian situation). Indeed, the literature's signals of what actions will help to attract talent are largely consistent with ideas proposed at the World Class Supply Chain 2106 Summit.

What we need to know about Lever of Excellence 4: TALENT

Summary of Knowledge Gaps

Although common sense and a robust body of properly validated research findings provide much of the needed knowledge on talent, several important knowledge gaps remain. From a combination of gaps that (a) Stank et al. (2011) presented as critical, (b) are described in post-2011 literature reviews that this author perused –e.g., Hohenstein et al. (2014) and Ronald (2014)– and (c) emerged from the content of the World Class Supply Chain 2016 Summit, the following are four high priority questions for future research projects.

Proposed Projects to Address the Knowledge Gaps

PROJECT #13-TALENT: *What specific new skills are required for managing modern supply chains*? The project to answer this question would have to account for the influence of emerging workforce dynamics such as the gradual replacement of baby boomers by millennials and evolving definitions of workplace diversity to cover more than traditional issues of gender, race, etc. Among other purposes, this could facilitate more precise specification of competences required of modern SCM executives; i.e., it would enable updating of existing competence catalogues that applied to earlier periods; e.g., the competences that Murphy and Poist (1991, 2007) compiled for logistics executives.

PROJECT #14-TALENT: *What SCM talent is needed for success in non-commercial organizations*? Although researchers have acknowledged the critical role of SCM in non-commercial contexts such as humanitarian disaster relief supply chains (see, e.g., Leiras et al., 2014 and Day et al., 2012), the research literature on SCM talent is dominated by commercial/for-profit settings. This signals a need for precise understanding of matters such as the extent to which the SCM skill set cultivated in/for commercial contexts must be refined, re-oriented, and extended for maximum effectiveness in the non-commercial sphere.

PROJECT #15-TALENT: *What talent management strategies are required to minimize undesirable outcomes of the interface between followers and transformational leaders*? Sharma and Kirkman (2015) note that counterproductive outcomes are possible and result in psychological distress for both leaders and followers. Reasons for distress include the leader's *perceived* excessive empowering and motivational efforts starting to wear on and exhaust the followers. The authors posit that the effects of transformational leadership may have an inverted "U" shape; i.e., the effects are initially positive and rising, reach a peak, and then become negative as psychological distress mounts. The project proposed here would be a response to the authors' call for more research to understand those outcomes in order to help firms identify them, predict when they might occur, and to deploy pre-emptive measures to minimize aforementioned psychological distress.

PROJECT #16-TALENT: *How should students' co-op job activities in the logistics and SCM fields be structured to enhance the students' leadership capacity*? A challenge for employers in structuring co-op jobs is to find the right balance between (a) getting optimum productivity from the student employee and (b) providing opportunities to nurture the student's innate leadership skills and add new leadership skills to the student's repertoire. Guided by an intent to address that challenge, this proposed project would involve developing principles for exemplary co-op job structures based on empirical data. Such data would include actual co-op job details as well as the employer's and student's *ex-post* assessments of the co-op experience.

Students as Research Partners

As indicated in the introduction, this section of the report is premised on the view that postsecondary students should not be mere recipients of knowledge from professors but can be their professors' vital partners in conducting research to produce new knowledge. As such, the 16 research projects proposed herein can be carried out to satisfy the priority needs of not only ***practitioners*** (knowledge to facilitate attainment of SCM excellence) but also of ***students*** (knowledge for a successful future, whether in research professions or in management practice). This means structuring the projects so that professors can work collaboratively with students as research co-investigators. This can be done for students across the full range of program levels –from students in undergraduate programs through to those in PhD programs.

At the earliest program level (i.e., undergraduate student co-investigators) the research would tend to have a focus on obtaining *initial answers* to the projects' research questions; e.g., in general, such projects would use case studies and practitioner reports as foundation for preliminary detection of hypothesis to be refined and articulated for more in-depth inquiry. At the latest program level (doctoral student co-investigators) the research would have a longer term (multi-year) focus and a more ambitious goal: *obtain answers that make genuine scientific contributions to the body of research-based knowledge*; i.e., answers that come from rigorously testing various hypotheses with extensive data. Sources of such data include multiple case studies, statistical data bases, large scale surveys, and comprehensive computer simulation models of real-world supply chain operations.

Using 6 of the 16 projects to illustrate, the remainder of this section presents ideas for deploying this co-investigator approach. These ideas make use of a treasured curriculum design feature that typifies business school programs in SCM and other fields. That design feature is to provide students with opportunities to conduct independent research under faculty supervision and guidance. Table 1 on the next page outlines the range of those opportunities: from research-based essays/reports that are among assignments within individual courses through to doctoral dissertations. Table 1 is based on the curriculum structure in Wilfrid Laurier University's Lazaridis School of Business and Economics.

Table 1: Research-Related Curriculum Elements in Business Schools

Generic title of curriculum element or course	*Program Level* Bachelor's Program	Master's Programs	PhD Program
Major program-completing dissertation/thesis		√	√
Directed/independent research (individual student)	√*	√*	√
Applied business research by student teams		√	
Live case study by student teams	√	√	
Applied projects and research within individual courses	√*	√*	√*

√ = the curriculum element or course is offered in the Lazaridis School programs; √* = multiple courses

Examples of Possible Projects with PhD Students as Co-Investigators

PROJECT #3- COLLABORATION – *Why is it worthwhile for logistics service providers (LSPs) and clients to collaborate in pursuing the objective of environmentally sustainable logistics, even though that objective is not ostensibly geared towards immediate and obvious financial success*? This project can be pursued as an integral part of a student's doctoral dissertation work. A starting point for this project would be to have the PhD student build mathematical models that account for how the investments to reduce a product's carbon footprint affect the profits of the:

(a) firm that produces the product
(b) producing firm's LSP
(c) supply chain if both firms collaborate to make the investments.

Such models could provide insights to aid decisions concerning, e.g., the economically optimal investment in carbon reduction, the share of the investment between the firms, and the appropriate public policy parameters (carbon taxes, etc.) to encourage carbon reduction.

PROJECT #10- TECHNOLOGY – *How can social influences from interactions among small firms facilitate greater technological readiness*? Because this project contains multiple sub-layers of managerially significant questions beneath what is stated above, it is worth the investment of time necessary to yield a PhD dissertation. A few examples of issues that the sub-layer of questions can tackle would concern how the efficacy of different forms of interaction are influenced by:

(i) the technology's development stage (***beta technology*** versus fully developed technology)
(ii) the industrial sectors the firms belong to (manufacturing, retail, other services, etc.);
(iii) whether the technological innovation is to exploit an economic opportunity or to comply with externally imposed dictates (e.g., to reduce carbon emissions).

Examples of Possible Projects with Master's Students (MBA and MSc) as Co-Investigators

PROJECT #5- INFORMATION – *What are the costs and benefits of more timely provision of information to LSPs who operate a transportation network's links (i.e. carriers) and nodes (e.g., intermodal facilities)*? A student in a one-year MSc degree program could pursue this project as his/her major thesis topic in order to yield knowledge about matters such as: (i) *specific benefits reaped by each member of the supply chain*; (ii) *the impact of the LSP's actions to compensate for the absence of the timely information*, and (iii) *how the benefits vary by whether the LSP is asset-based* (owns much of the physical assets it uses) or is *low/non-asset-based* (uses physical assets from other organizations).

PROJECT #14- TALENT – *What SCM talent is needed for success in non-commercial organizations*? In MBA applied research projects requiring faculty-supervised student teams to analyze and resolve an actual organization's managerial issues, it is not uncommon for (a) the organization to be in the non-commercial sector and (b) the scope of the analysis to include staffing/personnel needs. Reaching sound conclusions from that analysis requires keen understanding of business processes in organizations engaged in not-for-profit activities such as food bank operations, blood collection and distribution, disaster relief, and health care. As such, an MBA applied research project would be an ideal vehicle for addressing the knowledge gaps that gave rise to the above question and for providing MBA students with important practical knowledge about SCM talent requirements in the non-commercial sector.

Examples of Possible Projects with Undergraduate Students as Co-Investigators

PROJECT #12- TECHNOLOGY – *What must technology providers/vendors do to facilitate technology users' successful implementation of appropriate SCM/logistics technologies*? Deployment of technology or an innovation tends to loom large in assignments where undergraduate student teams compete to come up with the best solution for a ***live case*** (a case in which an actual organization urgently requires solutions in real-time). In some assignments, the focal organization is a technology developer/vendor wrestling with challenges such as understanding the (potential) user markets and those users' ***business priorities***. This type of assignment in which the technology under consideration has SCM/logistics applications would shed some light on promising answers to the stated research question. Furthermore, it would facilitate students' deeper understanding of what is involved in (a) focusing the promotion of those technologies on what matters to users and (b) the vendor's responsibilities at each stage of interactions with users.

PROJECT #15- TALENT – *What talent management strategies are required to minimize counterproductive outcomes of the interface between followers and transformational leaders*? Through an undergraduate student's work on a directed research/readings course, key outputs towards preliminary answers to this question would include testable research hypotheses. The student would have to systematically review key readings such as recent scientific research on *transformational leadership* (e.g., Defee, et al. 2010) and Dennis Tourish's 2013 book titled "***The dark side of transformational leadership***". Beyond helping to meet the research goal of plugging gaps in existing knowledge about transformational leadership, the project would also satisfy the pedagogical goal of raising the student's awareness of ways to mitigate the potential undesirable outcomes associated with transformational leadership.

Canadian Sources of Research Support

The resource requirements of research projects can vary significantly based on factors such as (a) *student level* (PhD, master's, bachelor's), (b) *project duration* (from multi-year doctoral work down to assignments that take up only part of a course or an academic term/semester), and (c) *information/data requirements* (e.g., research requiring field work trips versus desk research). For example, no abnormal financial resource requirements will arise for a project to produce a student's research-based essay that draws on publicly available data and is done under the auspices of directed research course. At the other extreme, a project that will culminate in a PhD student's dissertation requires funding to support the student's tuition and cost-incurring research activities over several years. In such situations, the required finances may exceed the support that should reasonably be expected from the academic institution and the organization(s) that will participate in, and directly benefit from, the research project.

This will necessitate applying to external research funding agencies for additional research support. In Canada, four of the agencies most relevant to research on logistics/SCM issues are:

- Mathematics of Information Technology and Complex Systems (MITACS; https://www.mitacs.ca). As the name implies, MITACS focuses on projects that involve ample use of mathematical modeling. Thus, projects such as computer simulation models of logistics/SCM operations are good candidates for MITACS funding. All MITACS-funded projects require a *partner organization* (the organization that is facing challenges to be addressed by the research) and are typically no longer than a year (e.g., a four-month research internship at the partner organization). MITACS uses a cost-sharing model in which MITACS and the partner organization match each other's funding of the research.
- The Natural Sciences and Engineering Research Council (NSERC; http://www.nserc-crsng.gc.ca/). Like MITACS, NSERC is also an appropriate funding source for logistics/SCM research projects in which tools such as mathematical and computer modeling play a fundamental role. NSERC support for such projects ranges from short term (up to six months) to long term (5 years). Not all projects are required to fall under the cost-sharing scheme; i.e., NSERC supports basic research that need not have or declare an immediate or explicit link to any particular organization.
- The Social Sciences and Humanities Research Council (SSHRC; http://www.sshrc-crsh.gc.ca/). SSHRC is similar to NSERC in that it also funds research over different durations (between several months and several years) and does not limit its support to projects that require matching funds from partner organizations. However, SSHRC differs from NSERC in that logistics/SCM research projects that use methodological concepts outside of mathematical/computer modeling and engineering are eligible for SSHRC funding.
- The Ontario Centres of Excellence (OCE; http://www.oce-ontario.org). As with MITACS, OCE-funded research projects tend to be short term and require the student to be an intern (between 4 and 24 months) at a partner organization that provides support (cash and in-kind) to match OCE's support. The project must have a strong R&D component; e.g., a research project to develop an innovative computer-based decision support method or tool to address the partner's SCM challenges.

Conclusions and A Look Forward

Volumes have been written on SCM in myriad sources –scholarly journals, textbooks, industry periodicals, magazines, and reports, blogs, on-line forums and the like. Thus, it is tempting to believe that we know just about all there is to know about SCM and, consequently, that executives should have no doubt about exactly what actions guarantee SCM excellence. However, that belief would be mistaken because there are still critical questions for which valid and reliable evidence-based answers are yet to be found. This report articulates 16 such questions based on information from (a) a one-day supply chain summit for peer-to-peer dialogue among SCM thought leaders from industry and academia and (b) an extensive set of scholarly articles that portray the state of evidence-based knowledge on key SCM topics. The 16 questions comprise four questions associated with each of the following four levers that SCM executives must proficiently manage in pursuing supply chain excellence: ***collaboration***, ***information***, ***technology***, and ***talent***.

To provide actionable guidelines for addressing those 16 questions, this report presents each question in the form of a proposed research project. Moreover, the report clarifies how students can be involved as essential research partners on these projects. That involvement is to ensure that the work of producing knowledge for today's SCM practice also achieves an important pedagogical purpose: students' *active* learning about the SCM topic being researched and about how to conduct research that matters. In recognition of the fact that some of the 16 proposed research projects will require resources (financial and otherwise) that might exceed the means of academic institutions and the organizations that benefit from the research results, the report also presents information on Canada's major research funding bodies.

To be sure, the research agenda proposed herein is not presented as a complete set of research projects for the SCM community to undertake. Instead, the 16 projects are meant to provide methodically conceived reference points for inspiring two reactions from the SCM community. First is to exercise the freedom to conceive, not only of helpful tweaks to the proposed projects but also of additional projects that have the same ultimate purpose: ***knowing more in order to enable progressive SCM practices***. Second is to come along on the journey to know more by tackling research projects such as those discussed in this report. The work of preparing the report will be a success if the SCM community of scholars, practitioners, and students embark on that journey without being deterred by the virtual iron rule that knowing more means knowing that there will still be more left to be known.

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