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Lean Supply Management in the Canadian Agri-food Sector

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Abstract

This thesis examines a novel conceptualization and operationalization of the lean supply management (LSM) construct and investigates its practical relevance for the Canadian agri-food sector. The thesis consists of three integrated essays, intended to advance the LSM scholarly theorization and managerial understanding. The first essay offers a systematic literature review to gain a better comprehension of the current state of research on LSM regarding its definition, practices, and frameworks, as well as context and contingencies related to its implementation. The second essay offers a conceptual development of the LSM construct presenting a new definition and a new contextual contingent model that is supplemented by an empirical validation of its practical utility through a Delphi study. The new model shows an alignment association between supply challenges and performance objectives that aligns and influences the selection of lean pillars. Findings identified the main supply challenges faced by Canadian agri-food processors and the lean pillars used to address them when pursuing specific performance objectives, their associations, and alignments. The third essay offers a qualitative inquiry to deepen the understanding of LSM in the Canadian agri-food sector using multiple case studies, which reveal how and why LSM is being utilized in the industry. This study determined the specific lean concepts, tools, and practices to deploy to achieve performance objectives when facing supply challenges. Results from this thesis contribute new insights to reorient the scholarly examination of LSM and practical illustrations to guide managers in LSM implementations.

Keywords:

Lean supply management; literature review; conceptualization and theorization; context and contingencies; Delphi survey; lean pillars, concepts, tools and practices; supply challenges; performance objectives; case studies.

Summary for Lay Audience

The agri-food sector plays an important role in the Canadian economy; however, given its intrinsic characteristics, it is constantly exposed to supply challenges, for example, in terms of cost fluctuations, defective products, late deliveries, and safety issues. A beneficial approach to address those challenges may be the use of lean, which is a philosophy initiated and developed in Japan by Toyota Motor Company that entails the continuous improvement of operations by elimination of wasteful activities while upholding respect for people. The extension of lean from manufacturing plants to the supply chain is known as lean supply management (LSM).

This thesis examines the application of LSM in the Canadian agri-food sector by offering three important contributions: (1) a review of previous articles about LSM, (2) a LSM study consisting of three rounds of surveys, and (3) a descriptive narrative of the use of LSM by six medium-large manufacturing food companies. The results of this study identify the main supply challenges faced in this industry and the lean practices preferred to address those challenges, aligned to specific objectives. The findings also illustrate how and why these companies apply lean principles when dealing with their suppliers. Managers interested in the lean philosophy may benefit from this work by enhancing their understanding of LSM when learning from real experiences of successful lean implementations.

Co-Authorship Statement

I hereby declare that this thesis incorporates some material that is a result of joint research.

Chapter 3 (Essay 2) was coauthored with Dr. Larry Menor and Dr. P. Fraser Johnson. Multiple joint discussions with my co-authors were maintained to examine the proposed conceptualization and theorization of LSM. In addition, important feedback was received to review and refine the design of the instrument for the Delphi study before its application. However, as the first author, I was in charge of the preparation, literature review, collection of data, analysis of results, and complete writing of this article.

Additionally, Chapter 2 (Essay 1) and Chapter 4 (Essay 3) received multiple reviews for minor adjustments and refinement.

With the above exceptions, I certify that this thesis and the research to which it refers is fully a product of my own work.

Dedication

This work is dedicated to my wife, son, and daughter.

Also, to my parents and the memory of Jose Filometor Cuesta Holguin.

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The PhD journey at Ivey Business School at Western University has been a challenging but rewarding experience in my life. Returning to the academic world after being in the industry for several years demanded additional effort, which was strengthened by a network of support that deserves my gratitude.

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CHAPTER 1

1. Introduction

1.1 General introduction

The agri-food sector is a critical contributor to the well-being of all Canadians, employing 2.3 million people. It is the largest manufacturing industry in the country with total sales of food and beverage processing of $114.9 billion in 2018 (Government of Canada, 2020). However, the agri-food industry—whose supply network encompasses the efforts of growers and producers, processors, wholesalers, distributors, and retailers—continuously faces challenges and risks related to ensuring (1) food safety; (2) quality, timeliness, and cost of servicing buyer demands; and (3) management of requisite labour productivity and morale (Dani, 2015). Therefore, the operational functionality and improvement of agri-food actors who service buyers' demands warrants ongoing managerial attention to address these challenges and risks. Lean management represents a viable operational functionality and improvement approach given its general emphasis on a commit all (e.g., personnel, functions/departments, organizations) continuously engaging in "doing the right way and finding the better way" efforts necessary to fulfill customer demands (Danese et al., 2018).

Toyota Motor Company is widely viewed as the exemplar of lean management, and its Toyota Production System has served as an operational model for manufacturing and service organizations aspiring to improve performance in terms of safety, quality, cost, delivery, and workforce morale (cf. Liker &Franz, 2011). In practice, the lean management approach entails the identification and elimination of waste from the operational system in order to improve the efficiency and effectiveness of work efforts and flows (Shah & Ward, 2007). For this thesis about the Canadian agri-food sector, lean management in the supply context entails the adoption of lean pillars (Jasti & Kodali, 2015) and the utilization of an array of lean approach-related concepts, tools, and practices (CTPs) in order to simultaneously increase processors' productivity (efficient use of firm resources), consistency (uniformity of offerings/outcomes), visibility (observability of flows and operational system functioning), and learning (acquisition of useful knowledge)—as well as decrease operational variability (deviation from standards)—with regards to fulfilling

(addressing) specific supply management responsibilities (challenges) (Naranjo et al., 2020). Improving processors' productivity, consistency, visibility, and learning while also decreasing variability is likely critical to any managerial effort intended to address the earlier identified agri-food industry challenges and risks (cf. Dudbridge, 2011).

The application of lean management approach-related CTPs by suppliers, for example, affects the supply performance for many of today's product and service brands. For example, recently, Cargill and other food processors have faced serious disruptions due to labour shortages in their Canadian manufacturing plants and in their suppliers' farms (Black et al., 2020). Lean practices, such as Shojinka or low cost and flexible labour planning, may be useful. Also, Olymel, Smithfield Foods Inc., and JBS were forced to shutdown some of their slaughterhouses and manufacturing plants due to Covid-19 infected workers, which compromised throughput (Tunney, 2020). Some beneficial practices that they could have used involve the undertaking of kaizen blitzes to aid in addressing workers' safety. Also, Beef Products, Inc., a South Dakota ground-beef processor, implemented the lean practice of Jidoka, stopping contaminated products at the source for Salmonella prevention, to avoid shipping tainted cattle downstream (Robinson, 2013).

Shojinka, kaizen blitzes, and Jidoka are three of many lean management approach-related CTPs applicable to operational settings that—as highlighted by Cargill, Olymel, Smithfield Foods Inc., JBS, and Beef Products, Inc.—could affect supply performance.

The overarching research problems for this thesis includes the following: a) lack of consensus about the definition and understanding of the concept of lean supply management (LSM) and its main elements, b) limited exploration of LSM in the Canadian agri-food context using empirical methods, c) absence of inclusion of performance objectives as an intermediate linkage between lean solutions and supply challenges, and d) misconceptions about the correct association of supply challenges with lean solutions.

The research purpose of this complete study to address the aforementioned problems can be summarized in the following points: a) to clarify and better understand the domain of LSM via a novel definition, b) to empirically explore and determine how and why Canadian agri-food processors are using LSM, c) to incorporate performance objectives as an intermediate linkage in the identification of, the most recurrent and critical supply challenges faced, and the lean solutions used by Canadian agri-food processors, and d) to clarify the associations and alignments of supply challenges, performance objectives, and lean solutions via an alternative framework.

In summary, the main purpose of this thesis is to study how firms determine which lean pillars to adopt and which CTPs to deploy in pursuit of a performance objective when facing a supply challenge. The main motivation for this research originated in the extant literature, which is silent on the contextual role of performance objectives and/or the contingent consideration of supply challenges in the determination of which lean pillars to adopt and lean CTPs to deploy. In consequence, this thesis investigates the following general research questions, examined in three essays:

> **Research Questions-Essay 1:** What is the state of research on LSM definitions? What are the main LSM practices and frameworks in the current literature? What LSM-related context and contingencies have been studied?

The main research objective/outcome of Essay 1 is to conduct a thorough examination of past literature and provide a synthesized review of previous LSM studies targeting three critical facets to clarify the current state of LSM research.

> **Research Questions-Essay 2:** What constitutes LSM when examined through a contextual contingent approach? What constitutes the supply challenges, LSM performance objectives, and lean pillars in the Canadian agri-food sector?

The main research objective/outcome of Essay 2 is to examine and advance the practical foundational underpinnings of an initial conceptual model of LSM through identifying (1) what frequent/severe performance objectives-based supply challenges are faced by Canadian agri-food firms and (2) what are important performance objectives-based solutions (i.e., lean pillars) for Canadian agri-food firms. Also, the goal of this research is to advance the specification of a practically relevant definition of LSM.

> **Research Questions-Essay 3:** How is the LSM approach being utilized by Canadian agri-food processors to address supply challenges? Why is the LSM approach being utilized by Canadian agri-food processors to address supply challenges?

The main research objective/outcome of Essay 3 is to provide an in-depth, focused, descriptive, and exploratory investigation of the specific lean solutions-focused CTPs adopted and deployed to address performance objectives-based supply challenges for several Canadian agri-food firms. Research propositions emanating from this qualitative study can advance scholarly theorization and managerial understanding of distinct approaches to LSM.

For the whole study, the scholarly and managerial contributions resulting from this thesis are three-fold. First, this study offers a new systematic literature review, encompassing three facets of study—LSM definitions, LSM practices and frameworks, and context and contingencies—to clarify the current state of research on LSM. Second, this study presents a new LSM definition and a new contextual contingent model which is empirically validated to identify which supply challenges are faced and which lean pillars are used by Canadian agri-food processors to address those challenges in relation to specific performance objectives. Third, this study provides descriptive, exploratory research of the use of lean CTPs in the Canadian agri-food industry. As such, the compilation of these three studies is aimed to enhance the understanding of LSM by reorienting its scholarly examination and advanced theorization and by aiding managers in decision-making and action-taking to minimize costs and improve service levels through LSM deployment.

1.2 Overview of the three essays

A multi-method design was employed in this research, and distinct empirical data sources were collected and analyzed to examine Canadian agri-food sector processors, especially those medium-large in size. As indicated above, three essays are presented.

The first essay presents a systematic literature review of LSM, focusing on three important facets of interest: definitions of LSM, practices and frameworks, and context and contingencies influencing the implementation of LSM. A thorough review of 86 articles is offered to establish a solid foundation of current research and understanding of LSM. Several typologies for each facet are offered, complemented with the identification of commonalities among previous LSM studies.

The second essay of the study design presents a thorough conceptualization and theorization of LSM via a novel framework, complemented empirically by the use of a Delphi study (Dalkey & Helmer, 1963) to generate practitioner experts' consensus on three main issues: a) definition and framework for conceptualizing lean management in the supply context, b) identification of common supply problems faced by Canadian agri-food processors, and c) lean considerations as potential solutions to address challenges aligned to performance objectives.

The third essay of the study design encompasses six in-depth case studies of medium-large sized Canadian agri-food processors to describe their specific lean approach-related CTPs applications and their ramifications, which is complemented with an investigation of the specific matching of Canadian agri-food processors' applications of lean approach-related CTPs with

distinct procurement problems (supply challenges) to improve their functionality to fulfill demands for their own products and services.

A more detailed explanation of each of the three essays is presented next.

1.2.1 Lean supply management: A systematic literature review (Essay 1)

Despite the fact that the topic of LSM has been studied for more than 20 years, there still exists lack of consensus about its conceptualization and theorization, and in many cases the difficulties associated with extending the lean philosophy to the supply chain have been undermined (Tortorella et al., 2017). The last two decades have shown an amplified interest by scholars in the topic of LSM, reflected in an increased number of publications in academic journals; however, there is still lack of agreement when discussing the fundamental concepts of LSM, namely, LSM definitions, LSM practices and frameworks, and LSM implementation affected by context and contingencies. Therefore, this first study offers a complete review of LSM past research that has appeared as academic manuscripts or part of scholarly conference proceedings. The main goal of this study is to organize and classify the current existing literature in terms of three critical LSM facets in order to gain a better understanding of these constructs.

The first part of the study presents a review of eleven past LSM literature reviews, which were categorized in several groupings depending on the scope and approach of each review, defining generic or applied reviews and unidimensional or multidimensional studies. Different foci of study were identified from these reviews; some of them have offered general bibliometric analysis, tabulating the number of scientific articles classified by journals, years, origin, and so on, whereas other reviews have analyzed the study of the LSM construct considering its inherent elements, such as practices, barriers, and benefits. None of these reviews, however, has offered an integrated review consolidating the analysis of the three LSM facets that I explored using a systematic approach: LSM definitions, LSM practices and frameworks, and context and contingencies affecting LSM implementation.

The methodology employed in this paper followed the guidelines by Durach et al. (2017) and established five major phases. In Phase 1, the research questions were formulated, which inquired for the current status of LSM research. In Phase 2, the inclusivity criteria were defined and the location of articles was conducted using a combination of keywords directly related to the purpose of the study and a thorough and detailed review of articles published in academic journals indexed by *Scopus* and *Web of Science* databases, following de Sousa et al. (2018); this process identified

853 papers. Phase 3 consisted in the selection and evaluation of articles and resulted in a final portfolio of 86 publications. The analysis and synthesis of literature were executed in Phase 4 for each of the facets of interest, defining different criteria for the grouping of each of them and adjusting the best format for the tabulation of results. Finally, Phase 5 reported the results obtained by presenting for each facet two separate sections: (1) a section offering a brief descriptive analysis of each article plus the identification of similarities or common foci and (2) a core section discussing the results and implications of findings in each facet.

The final section of this essay offers the conclusions and limitations and summarizes the findings by synthesizing the answers to the research questions initially defined. The main goal of this research study is to serve as a foundation for the next two studies by presenting a concise review and analysis of previous LSM studies.

1.2.2 Conceptualization and theorization of lean supply management: A Delphi Study (Essay 2)

In order to advance scholarly theorization and managerial understanding as well as meaningfully test research hypotheses on LSM, there must first be clear, coherent, and compelling conceptualization and theorization of LSM, which is lacking to date. There remains too much diversity regarding the boundaries of LSM, and the multiple existent frameworks reveal an apparent lack of conceptualization and theorization. The topic of LSM is still in its formation stage and needs further evolution because its concepts are not fully developed (Jasti & Kodali, 2015). Therefore, this study proposes a new approach to better understand LSM, incorporating context and based on contingencies.

The first part of this study introduces a revised envisioning of LSM by offering a new definition and a conceptual contextual contingent model to explain the linkages between supply challenges and lean pillars based on fulfilling specific operational performance objectives. Such performance objectives refer to the following goals: 1) increase productivity, 2) increase consistency, 3) increase visibility, 4) reduce variability, and 5) increase learning.

Regarding the theorization of LSM, I draw on the practice-based view (PBV) (Bromiley & Rau, 2016). PBV asserts that the use of imitable practices in a selective manner can impact firm performance; considering that firms leverage operational practices and resources towards an end, the adoption of lean pillars and use of lean CTPs are beneficial to address specific functioning problems in an operating context.

The second part of this study validates the contextual contingent model via a Delphi study (Landeta, 2006) by exploring the critical supply challenges identified by experts, the main lean pillars, and the performance objectives that are prioritized. Because the study involved participants, approval was obtained from the Western University Non-Medical Research Ethics Board prior to conducting the research (see Appendix 1-1). The Delphi study generated practitioner experts' consensus on a practically relevant definition and framework for conceptualizing lean management in the supply context and identifying common procurement problems faced by Canadian agri-food suppliers. The Delphi study consisted of three rounds.

The first round of the Delphi study involved three main sections. In the first section, participants were asked to select the main supply challenges associated with different performance objectives. The second section encompassed the identification of the main lean pillars that allow companies to address each of the performance objectives. Finally, in the last section, the experts were asked about their own understanding of LSM.

For the second round, participants received a summary of the first-round results consisting mainly of several tables summarizing the preferred choices of each participant in the first round. A tabulated count of challenges and lean pillars related to each performance objective was summarized. Based on that input, participants were queried to evaluate the different options by using Likert scales. For the supply challenges, they were asked to evaluate the criticality by selecting the frequency and severity of each option. For the lean pillars, they had to assess the value of each alternative aligned with the performance objectives. Finally, in terms of conceptualizing LSM, each participant determined the importance of each proposed element associated to the main construct of analysis.

The third and concluding round displayed, again, the results from the previous round, but in a different format. The sample means of aggregated values and not the individual results were represented in a graphical manner summarizing the averages for each element associated to supply challenges and lean pillars. The task of each participant in the final round was to select their top three choices applicable not to their companies but to the whole sector, based on the data received from the whole group of experts.

The main findings obtained from the second study were the identification of the different supply challenges impacting the Canadian agri-food sector and the lean pillars used to address such challenges when pursuing different performance objectives. The results showed that there is an

alignment association between supply challenges and performance objectives, and this association influences the selection of lean pillars.

The insights received from a selected group of experts in LSM, all of them practitioners, generated valuable information to clarify my proposed conceptualization of LSM.

1.2.3 Lean supply management: Multiple case studies in the Canadian agri-food industry (Essay 3)

The study of LSM entails several challenges that arise from the lack of consensus about its definition and framework. Therefore, having offered a systematic literature review of LSM (Essay 1) and presented a clear, coherent, and compelling conceptualization and theorization of LSM (Essay 2), this third study empirically describes the utilization of specific lean CTPs to address particular supply challenges and pursue performance objectives, illustrating the application of my LSM contextual contingent model. Application of the model involved working with case study participants; accordingly, approval was obtained from the Western University Non-Medical Research Ethics Board prior to conducting this research (see Appendix 1-2).

This third essay encompasses an exploratory and descriptive study of multiple case studies involving Canadian agri-food processors that have implemented lean principles LSM. Specifically, I examined, from the processor's perspective, the "how?" and "why?" considerations associated with the application of lean management approach-related CTPs intended to address specific supply challenges and risks. Additionally, I investigated the nature of and ramifications resulting from lean approach-related CTPs applications by Canadian agri-food processors with regards to more efficiently and effectively dealing with suppliers that fulfill buyers' demands (Hines et al., 2004; Bhasin & Burcher, 2006; Begam et al., 2013). As indicated earlier and based on the diversity of definitions and frameworks found in past literature, LSM has still not been completely understood and its boundaries have not been clearly defined; therefore, the case study is a suitable and useful method for this research (Rowley, 2002; Yin, 2018) to leverage the results obtained from the Delphi study (Landeta, 2006).

Regarding the research design, my sampling selection was purposeful (Patton, 1990), combining multiple strategies, *operational construct sampling*, *intensity sampling*, and *confirming cases sampling*, with a specific representation of multiple case studies consisting of six Canadian agri-food processors in the confectionery and protein subsectors, which are most suitable to lean implementations (Costa et al., 2018). Two single pilot study cases were also conducted to test the

research instrument and become familiarized with the industry (Taylor, 2006). Within each company, key informants were identified and invited to collaborate with my research efforts, adapting Meyer (2001) and using three criteria for sampling informants: a) top management level, b) multiple informants, and c) knowledgeable informants: those who were leading the implementation of LSM.

My choice of data collection was guided by my research questions, so I used triangulation (Yin, 2018) by combining three specific sources: in-person interviews, virtual interviews, and archival data to enhance the rigour of my study and eliminate discrepancies. Once the data were collected, I began the data analysis phase using thematic analysis for coding and identification of the main themes aided by specialized software. The data were structured into three main categories: first order categories, second order themes, and aggregate dimensions. Several patterns emerged from each case and were compared using cross-case analysis to identify similarities and differences among the six cases. The discussion of results allowed me to offer multiple propositions that emanated from the analysis and helped me to address the research questions.

In conclusion, the main objective of the case studies was to collect valuable information to illustrate my contextual contingent LSM model, which was proposed earlier in the second study.

1.3 Thesis structure

This thesis is structured and formatted following the Integrated-Article specifications of Western University's School of Graduate and Postdoctoral Studies.

Chapter 1 is this introduction, Chapters 2, 3, and 4 contain Essays 1, 2, and 3, respectively. Finally, I present general conclusions of the thesis and identify future avenues of research in Chapter 5. All sources referred to throughout the thesis are provided in the reference list at the end of the thesis, followed by the appendices of each chapter.

The use of first-person pronouns ("we" and "our") is noticed in Chapter 3 (Essay 2) because this chapter was developed as a coauthored manuscript.

CHAPTER 2

2. Lean supply management: A systematic literature review (Essay 1)

2.1 General Introduction

The extension of lean practices to the supply chain, known as lean supply management (LSM), has been described as challenging, complicated, and contingent on several factors (Tortorella et al., 2017b).

Even though the topic of LSM has been studied for more than 20 years, there are still some inconsistencies when trying to define LSM, conceptualize it, offer a framework, or understand the role of contingencies impacting lean deployment along the supply chain. In reality, a consensus has not been achieved about LSM, and there still exist multiple definitions, conceptualizations, and operationalizations that have emerged across previous studies and have created implementation challenges. Additionally, contextual factors related to the adoption and implementation of LSM have barely been studied in the literature (Berger et al., 2018), and there exists a scarcity of theory concerning contextual variables and LSM. Previous studies have differed on the inclusion of the most relevant contextual factors related to LSM, when in fact, a suitable identification of the effect of contextual factors on LSM is critical to making adjustments in the supply chain structure and policies (Tortorella, et al., 2017b).

Furthermore, heeding Soni and Kodali (2016), who stated the need for critical reviews of extant literature to identify gaps and develop unifying theories and frameworks, which in the field of LSM have not yet been fully developed (Jasti & Kodali, 2015), I performed this systematic literature review to clarify where the LSM current literature stands in terms of three facets that enhance the understanding of LSM: definitions, practices and frameworks, and context and contingencies. For this research, each facet is understood in the following terms: (1) definitions are explanations of the meaning of LSM; (2) frameworks and practices exhibit the different elements of LSM and how they may interact (Jasti & Kurra, 2017); and (3) context refers to the setting for operating within; it reflects an organizational circumstance (Ginsberg and Venkatraman, 1985) that can be controlled by managers (McKone et al., 1999) (e.g., the pursuit

of a performance objective), and contingencies are the characteristics of a particular context (Netland, 2016) (e.g., supply challenges, lean pillars).

The overarching goal of this chapter is to identify and discuss the state of LSM research, and the specific objectives of this study are threefold: i) examine the different definitions of LSM, ii) review and identify key LSM practices and frameworks mentioned in the literature, and iii) explore past studies encompassing contextual factors and contingencies related to LSM efforts. Therefore, aligned to the objectives of this study, three research questions were defined:

1) What is the state of research on LSM definitions?
2) What are the main LSM practices and frameworks in the current literature?
3) What LSM-related context and contingencies have been studied?

An important contribution of this chapter is the compilation of these three facets of LSM, which have not been analyzed together in the past. This multi-dimension study integrates the review of past LSM definitions, practices, frameworks, contexts, and contingencies as an inquiry perspective to investigate the current conceptualization of LSM from a holistic approach. Scholars and managers can benefit from this systematic review of LSM to better understand the essence of the different elements of LSM and the impact of contextual factors on LSM to guarantee successful deployment efforts. This chapter is organized as follows: Section 2 presents a quick review of past studies that perform literature reviews of LSM; Section 3 explains the methodology used for this study; Section 4 shows the results of a descriptive analysis under three important facets of LSM: definitions, practices and frameworks, and context and contingencies; Section 5 contains a discussion of results; and finally, Section 6 presents the conclusions and limitations of this study.

2.2 Literature review of past LSM systematic reviews

When conducting a systematic literature review, certain guidelines must be adopted given that each discipline is different, and some idiosyncrasies must be considered. The importance of these adjustments allows us to understand the reality and "how to know something about that reality" (Durach et al., 2017, p. 68). The review of past studies about LSM has seen an important increase in the last decade, considering the evolution of the concept and its global implementation.

This study identified 11 different LSM systematic reviews, which were selected using a targeted bibliometric search considering a specific set of keywords. Following Jasti and Kodali (2015), based on the target focus of analysis of each article, to better visualize the scope of each article, I

have separated the reviews into two categories: 1) Generic: those reviews of LSM with no specification of a particular sector or industry and targeting the exclusive study of LSM, and 2) Applied: those reviews that explored LSM within a specific industry (healthcare, pharmaceutical) or attached to other topics (sustainability, industry 4.0). Additionally, for the first group, generic reviews, two patterns were established: a) articles focusing on only one dimension (frameworks, time-evolution) and b) reviews incorporating multiple dimensions (practices, barriers, context). The characteristics of each study are summarized in Table 2-1.

Half of the articles studied covered a period of time between 1990 and 2015, while the other half covered a time span also including the last five years (1990-2020). Out of the 11 articles reviewed, most of them appeared in specialization/specific topics journals, but only five were published in OM discipline-related journals (*International Journal of Production Research, Production Planning and Control, International Journal of Lean Six Sigma*). This study adopted the guidelines defined by Durach et al. (2017), which are explained in the methodology section. A general overview of the 11 articles is offered next, separated into generic and applied reviews.

First, starting with the generic and most relevant articles, Drohomeretski et al. (2012) offered a classification of LSM articles into five categories and concluded with a framework linking different LSM practices with competitive priorities. Another fundamental contribution in terms of literature reviews constitutes the work by Jasti and Kodali (2015), compiling 30 previous LSM frameworks but exploring only one dimension (single dimension or uni dimension). They recognized the lack of participation of practitioners, the absence of reviews of theories, and the scarce empirical verification of past LSM studies, reflecting LSM's initial stages of development. They identified 82 LSM-related standard practices and offered a new framework with eight lean "pillars", presented in Appendix 2-1. Past literature clustered similar lean concepts, tools, and practices (CTPs) into groupings called "pillars" (Pozo et al., 2017; Soni & Kodali, 2013), where CTPs are first-order management elements and pillars are second-order classification categories (Pozo et al., 2017; Soni & Kodali, 2013). Two additional literature reviews, generic and uni dimension, focused on the evolution of LSM. First, Singh and Pandey (2015) categorized the literature in chronological order identifying three main periods of LSM evolution: network management phase, lean environment phase, and leagility[1] phase. Second, de Sousa et al. (2018)

[1] The integration of lean and agile manufacturing paradigms in the supply chain (Naylor et al., 1999)

Table 2-1. Previous systematic literature reviews of LSM

Paper	Journal	Study period	Articles reviewed	Keywords used	Contribution	Grouping
Drohomeretski et al. (2012)	*Proceedings IISE*	1996-2011	122	Lean supply, LSCM, lean logistics, SCM, lean network	Review of scientific production and categorization by goals. Identification of practices and performance measures.	Generic LSM-Multi dimension
Martinez-Jurado and Moyano-Fuentes (2014)	*JCP*	1990-2013	58	Lean, LM, LP, Lean Manufacturing, TPS, LSC, LSCM, lean supply (Plus Sustainability and SCM terms)	Review of articles linking LSM and sustainability. Indirect focus on LSM and therefore limited universe of study.	Applied LSM
Jasti and Kodali (2015)	*PPC*	1988-2013	30	NA	Review of past LSM frameworks and offering of a new framework synthesizing 82 standard elements in eight pillars. Claim for future reliability and validity analysis.	Generic LSM-Uni dimension
Khorasani et al. (2015)	*Proceedings ASEM*	1982-2014	22	Supply chain, SCM, LSC, lean healthcare	Identification of seven topics to be considered in healthcare LSM implementation. Limited focus on only one sector and reduced sample size.	Applied LSM
Singh and Pandey (2015)	*JSCMS*	1996-2013	59	Lean supply chain, lean, supply chain	Classification of papers in terms of year, industry, journal, and country. Focus on evolution in time. Three phases of research are established: Networks, Environment and Leagility.	Generic LSM-Uni dimension
Berger et al. (2018)	*JMEI*	1996-2017	60	Lean supply, practices, challenges, barriers, contextual factors	Review of 60 articles extracting practices, barriers and contextual factors related to LSM implementation. Claim for studies exploring relations between barriers and contextual factors.	Generic LSM-Multi dimension
de Sousa et al. (2018)	*IJIME*	1999-2018	57	Lean supply chain*	Offers bibliometric indexes including years, journals, topics, methods, countries. Centrality and betweenness of countries. Limited discussion of central topics of LSM.	Generic LSM-Uni dimension
Argiyantari et al. (2020)	*JIEM*	2009-2019	30	lean supply chain, supply chain, pharmaceutical	Specific focus on the pharmaceutical industry. Classification of LSM studies into 4 categories: area, objective, element and method. Claim for further exploration.	Applied LSM
Garcia-Buendia et al. (2020)	*IJPR*	1996-2018	522	Lean AND supply chain	Presents most relevant LSM themes and their evolution identifying four thematic areas: methods, key factors, internal efficiency, and performance. Lacks parsimony.	Generic LSM-Multi dimension
Khorasani et al. (2020)	*IJLSS*	1995-2018	280	LSC, healthcare, supply chain, health service	Identification of main techniques for implementing LSM in healthcare and contextual factors. Associations between target areas and applications.	Applied LSM
Nunez-Merino et al. (2020)	*IJPR*	1996-2019	78	lean, supply chain, industry 4.0	Review of studies relating LSM and information technologies (industry 4.0). Focus more on technology life cycle approach.	Applied LSM

LSCM: Lean supply chain management, SCM: Supply chain management, LM: Lean manufacturing, LP: Lean production, TPS: Toyota production system

IISE: Institute of Industrial and Systems Engineers, JCP: Journal of Cleaner Production, PPC: Production Planning & Control, ASEM: American Society for Engineering Management, JSCMS: Journal of Supply Chain Mgmt. Systems

JMEI: Journal of Management & Engineering Integration, IJIME: International Journal of Industrial & Manufacturing Engineering, JIEM: Journal of Industrial Engineering and Management

IJPR: International Journal of Production Research, IJLSS: International Journal of Lean Six Sigma

described the countries whose researchers have been more active in investigating LSM and the articles with the highest impact factors.

Other complete literature reviews, generic and multidimensional, on LSM were developed by Berger et al. (2018) and by Garcia-Buendia et al. (2020). The first paper examined practices, barriers, and contextual issues and mentioned the importance of acknowledging contextual factors when determining a proper selection of lean practices. The second paper showed the increasing trend in the number of publications about LSM in the last decade and the evolution of its scope as it has become more strategic for the organizations.

Second, regarding the applied reviews, three articles examined the healthcare and pharmaceutical sectors. Khorasani et al. (2015) revealed the three major topics covered by their 22 selected papers: technology, implementation factors, and distribution channel. Khorasani et al. (2020) focused on the relationships between applications (lean practices) and target areas (objectives) being moderated by contextual factors. Argiyantari et al. (2020) categorized articles in four dimensions: supply chain area, lean supply chain objective, lean supply chain elements, and research approach. Complementary topics related to LSM have also been explored in literature reviews. For example, a study by Martinez-Jurado and Moyano-Fuentes (2014) examined past papers linking lean management, supply chain management (SCM), and sustainability. Another example is the study by Nunez-Merino et al. (2020) of papers linking industry 4.0 and LSM. They explored the evolution of prior research, discussing mature and emerging technologies and the digital transition to lean supply chain 4.0.

In conclusion, these past reviews provide important guidelines; however, as illustrated above, none of these previous studies has conducted a systematic literature review targeting simultaneously the three specific facets proposed in this study of LSM: definitions, practices and frameworks, and context and contingencies. However, a compelling conceptualization of a construct first requires a formal conceptual definition, followed by the identification of clear properties, which leads to better measures of the concept (Wacker, 2004). The omission of these critical elements may render previous papers beneficial but incomplete; therefore, this study offers a broader and more comprehensive scope to contribute to a better understanding of LSM.

2.3 Methodology

The first part of this section describes the procedure used for the selection of the articles included in this study. The second part explains how those articles were classified for analysis.

2.3.1 Literature Selection

Given the shortcomings mentioned in the introduction regarding past systematic literature reviews, (e.g., by limiting their focus on manufacturing and the intersection with topics such as sustainability and industry 4.0 only, or by conducting exclusive single dimension analysis), I adopted the guidelines suggested by Durach et al. (2017) and used their new review paradigm, applied in this case to LSM; therefore, a detailed and structured procedure was enforced. Additionally, complementary ideas were incorporated to design and implement this study, specifically following the multi-stage approach used by Caldera et al. (2017) to ensure objectivity and transparency. This systematic review encompassed five phases, depicted in Figure 2-1 and explained in the following paragraphs.

The first phase consisted of defining the purpose and research question of this study, which were discussed in the Introduction section. In that regard, I stated that the main goal of this study is to advance the understanding of LSM by clarifying its definition, conceptualization, and contingent adoption and deployment, based on a thorough analysis of past scholarly efforts.

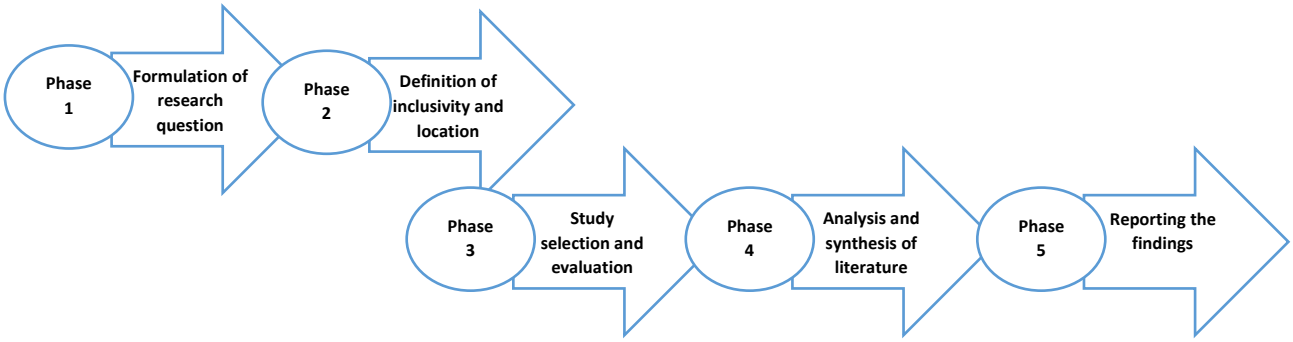


Figure 2-1. Phases of literature review (From Durach et al. (2017) and Caldera et al. (2017))

In the second phase, I first defined the inclusion criteria: articles related to LSM containing LSM definitions, LSM practices and frameworks, and contextual factors or contingencies. Once the inclusion criteria were established, I determined my research procedures and chose the keywords to be used for the retrieval of preliminary papers. I followed the approach suggested by de Sousa et al. (2018) and targeted the articles published in academic journals indexed by *Scopus* and *Web of Science* databases. The selection of these databases guaranteed a comprehensive coverage of resources, considering *Scopus* is the largest bibliometric database (Akmal et al., 2018)

and *Web of Science* is seen as the most significant source of information for bibliometric analyses in the sciences (Chen et al., 2014). The literature selection process is depicted in Figure 2-2.

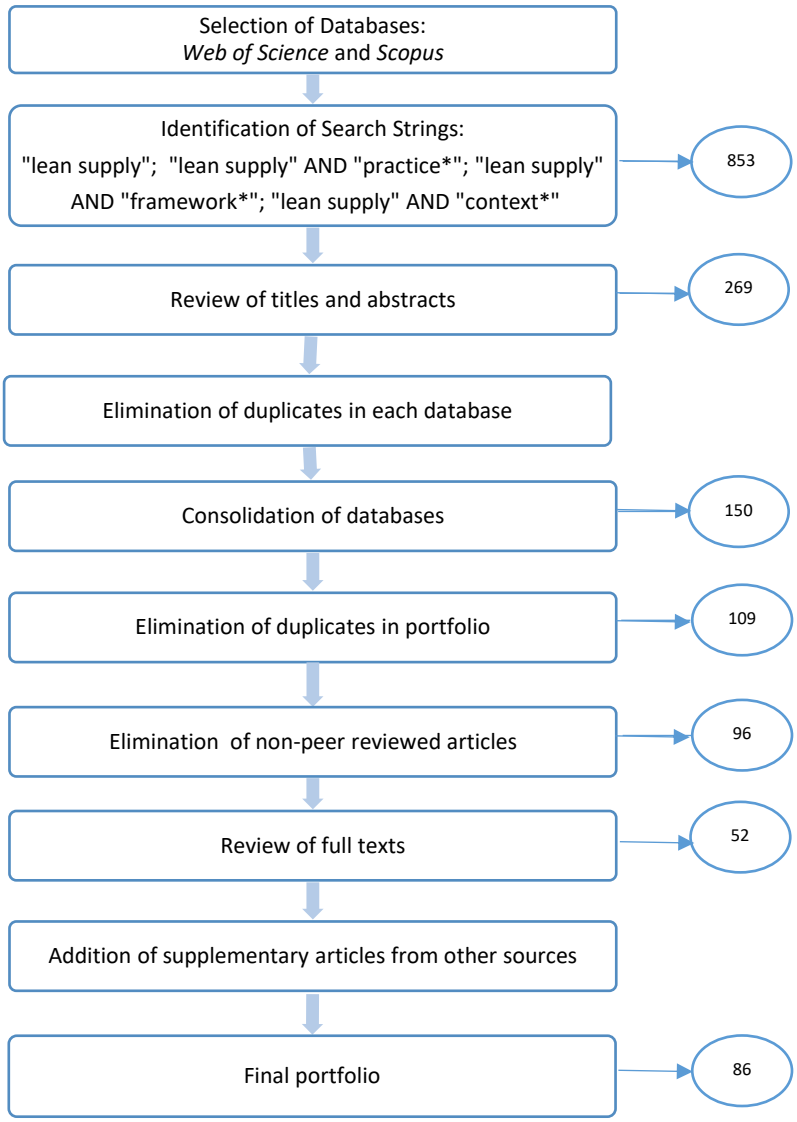


Figure 2-2. Summary of literature selection

Multiple searches were conducted using a combination of keywords, which were directly related to my research purpose and research questions; specifically, the following terms were used: “lean supply”, “lean supply AND practice*”, “lean supply AND framework*”, and “lean supply AND context*”, which allowed me to obtain a broad baseline sample of 853 articles.

In the third phase, the selection of pertinent literature was executed. I applied the inclusion and exclusion criteria defined in phase two. Initially, a quick review of the titles and abstracts of articles was the mechanism to filter the 853 articles obtained in each of the iterations using different keywords. When consolidating the different searches, it was necessary to eliminate duplicate articles that appeared within each database and between databases. Next, I prioritized only the articles that appeared in peer-reviewed journals (although this constraint was relaxed in the next filtering steps). At this point, I conducted a detailed relevance test that went beyond the review of titles and abstracts, I examined the full text of each article thoroughly to capture its details and to reduce the sample of primary studies to the preliminary synthesis sample (52 articles shown in Appendix 2-2). The last step in this stage consisted of adding up additional articles (extra 34 additions shown in Appendix 2-3) that had been collected from the results of previous broader studies and some past literature reviews and that were relevant to this research. These supplementary articles were not shown as part of my initial search in the two databases because of the stringent limitation of the keywords used in the process, but instead, were identified indirectly via references from other articles related to lean management (snowballing approach) and from other bibliographic sources (technical reports, proceedings, books). Ultimately, 86 articles defined my final portfolio (synthesis sample) after a detailed process of systematic selection (Table 2-2).

Table 2-2. Keywords, databases and number of publications

	Quantitative databases	
Keywords	**Web of Science**	**Scopus**
"lean supply"	188	352
"lean supply" AND "practice*"	49	90
"lean supply" AND "framework*"	48	62
"lean supply" AND "context*"	24	40
Total at each database	309	544
Selection initial review (titles and abstracts)	109	160
Less duplicate articles in each database	55	95
Total (preliminary portfolio)	150	
Less duplicate articles in portfolio	109	
Only articles from peer-reviewed journals	96	
Selection after final review (full texts)	52	
Final Portfolio (with extra additions)	**86**	

Phase four involved the organization, classification, and analysis of papers, and synthesis of results, which was achieved by creating multiple tables and using supporting tools. In the first stage of this phase, a new thorough review of the full text of each article was deemed necessary to code the relevant data. Following the guidelines suggested by Durach et al. (2017), relevant study details were extracted on both levels—general information (title, author, publication details) and specific information (details and methods)—complemented with a brief summary of their main findings and elements related to my study. The coding procedure was facilitated by the use of multiple spreadsheets to organize and separate the articles into each facet of study. The second stage of phase four demanded the analysis and integration of my portfolio of articles to carefully examine similarities and differences that enabled me to synthesize my results.

Finally, in phase five, I interpreted and reported the results using a descriptive and thematic approach. Following the recommendations of Tranfield et al. (2003), a two-step presentation of my research findings is offered; the Results section displays a descriptive analysis of the primary studies, divided into my three areas of interest (definitions, practices and frameworks, and context and contingencies), whereas the Discussion of results section presents a thematic analysis consisting of a consolidated narrative derived from the study synthesis. Additionally, I designed different tables summarizing the inputs and outputs of this research.

2.3.2 Literature Classification

The final sample of articles selected in the portfolio, consisting of 86 papers, was assessed against the three facets defined for this study and aligned to my research questions, namely LSM definitions, LSM practices and frameworks, and LSM context and contingencies.

First, a review of past definitions was needed to clarify the current understanding of LSM in past literature. Next, the review of LSM studied practices and frameworks was required to reveal the current conceptualization of LSM, especially given the lack of standard constructs as previously observed (Soni & Kodali, 2012). Finally, the analysis of context and contingencies related to LSM studies also gained focus in this study given the need for their further exploration.

2.4 Results

This section presents a review of the articles identified concerning LSM definitions, LSM practices and frameworks, and LSM context and contingencies. Each subsection offers a descriptive analysis and groupings of articles based on similarities.

2.4.1 Current LSM definitions in the literature

Wacker (2004) discussed the need for the development of sound formal conceptual definitions as the underpinning of all theory-building empirical research. Therefore, the first area of interest of this chapter explores the state of current research regarding LSM past definitions and main elements. This section presents a brief descriptive narrative of the main articles related to LSM that offer a definition of this construct. In this review, four different groupings, not mutually exclusive, have been identified based on the emphasis offered by each LSM definition analyzed: (1) objective-based, (2) structure-based (3) perspective-based, and (4) approach-based.

First, one stream of authors has defined LSM from an objective-based focus, in which efficiency in terms of cost reduction and waste elimination should be considered the top priority for LSM. Lamming (1996) produced one of the seminal articles about LSM; he proposed that LSM is the product of an operating attitude that recognizes cost deviations from perfection to provide long-term customer satisfaction. He differentiated LSM from SCM, stating that the former emphasizes the elimination of waste and the levelled relationships between buyer-supplier. A highly cited definition of LSM was proposed by Vitasek et al. (2005) as a set of organizations linked by flows, working collaboratively to reduce costs and waste and meet customer needs. The emphasis on cost reduction, time reduction, and elimination of waste and non-value-added activities has been common for multiple researchers when defining LSM (Afonso & Cabrita, 2015; Drohomeretski et al., 2012; Perez et al., 2010; Singh & Pandey, 2015). Additional important elements mentioned by these researchers are flexibility, process simplification and optimization, and continuous improvement to improve effectiveness and maximize profit. Another stream of researchers has prioritized the elimination of waste to achieve distinct goals, such as a level schedule in the supply chain (Mason-Jones et al., 2000; Naylor et al., 1999), a continuous flow of resources from suppliers to customers (Averill, 2011; Goldsby et al., 2006; Stratton & Warburton, 2003), and the reduction of complexity and error (Myerson, 2012).

Second, another focus under which LSM has been defined and conceptualized encompasses a structure-based emphasis in which relationships with suppliers are the core focus of LSM. For example, Nellore et al. (2001) characterized LSM by the use of just-in-time delivery, design for manufacturing, and early involvement of suppliers in component development via frequent interactions between suppliers and buyers. Nightingale (2005) highlighted a required balance between cooperation (collaborative relationships and coordination mechanisms) and competition

by using few suppliers, partnerships with suppliers, early integration of suppliers, and continuous improvement. In a similar way, Adamides et al. (2008) stated that LSM is characterized by proactive, system-wide, collaborative relations and proper integration.

Third, a perspective-based definition has been used by researchers, such as Bailey (2015), who clarifies that LSM is not only a set of tools to reduce inventory and waste but it entails a cultural shift that focuses on problem-solving and collaboration across the entire supply chain. Additionally, other definitions have included this focus by defining LSM as an operating attitude or as a way of thinking (Lamming, 1996; Nightingale, 2005).

Fourth, more recent articles have used an LSM approach-focused definition; for example, Khorasani et al. (2015) see LSM as a new approach to supplier networks that requires long-term supplier strategic partnerships and a highly integrated SCM system. Similarly, other researchers consider LSM as a strategy to improve efficiency and flexibility of processes, operations, and supply chains (Afonso & Cabrita, 2015; Nimeh et al., 2018).

Table 2-3 shows a compilation of all these articles, indicating their main definitions, key elements, and the main focus of study. The primary shortcoming identified is the lack of formal conceptual definitions (Wacker, 2004) because most of them ignore the abstraction component and offer only the elements or properties that lead to better measures of the concept without first clarifying the underlying abstract component. Finding measurements before evaluating the formal conceptual definition causes measurable properties to be amorphous and subject to modifications based on each study.

2.4.2 Present status of LSM practices and frameworks

Previous research in the field of Operations Management, such as the work by Meredith (1993), argued that the normal research cycle requires the inclusion of descriptive and explanatory stages before incorporating the testing stage. Aligned to these guidelines, for the advancement of LSM scholarly theorization and managerial understanding, there is the need for my exploration of past studies to inform the main LSM practices and frameworks previously studied, using a descriptive approach. As such, I have categorized past studies into different groups based on their focus, namely lean-agile, environment, relationships, industries, implementation, and performance (see Table 2-3).

Table 2-3. Papers presenting LSM definitions

Source	Definition of LSM	Key elements	Focus
Lamming (1996)	An operating attitude aimed to identify cost deviations from perfection, needed for customer satisfaction	Cost reduction	Objective-based Perspective-based
Naylor et al. (1999)	LSM develops a value stream to eliminate all waste (including time) to enable a level schedule based on market knowledge, an integrated supply chain and lead time compression	Waste elimination Collaboration	Objective-based
Mason-Jones et al. (2000)	LSM develops a value stream to eliminate all waste (including time) to enable a level schedule	Cost reduction	Objective-based
Nellore et al. (2001)	LSM is characterized by the use of just-in-time delivery, design for manufacturing and early involvement of suppliers in component development via frequent interactions between suppliers and buyers	Collaboration	Structure-based
Stratton and Warburton (2003)	LSM is associated with enabling flow and reducing wasteful variability	Waste elimination	Objective-based
Vitasek et al. (2005)	A set of organizations directly linked by upstream and downstream flows of products, services, information and funds that collaboratively work to reduce cost and waste by efficiently pulling what is needed to meet the needs of the individual customer	Cost-waste reduction Collaboration	Structure-based Objective-based
Nightingale (2005)	LSM is a new way of thinking about supplier networks that requires cooperative supplier relationships while balancing cooperation and competition	Collaboration	Structure-based Perspective-based
Goldsby et al. (2006)	LSM aims to provide a flow of goods, services and technology from suppliers to customers without waste	Waste elimination	Objective-based
Adamides et al. (2008)	LSM is characterized by supply chains and networks formed and maintained by proactive, system-wide collaborative relationships among all-tier suppliers and customers	Collaboration	Structure-based
Perez et al. (2010)	LSM focuses on elimination of waste and valueless activities through continuous improvement to reduce cost and achieve flexibility in already available products	Cost reduction Waste elimination	Objective-based
Averill (2011)	LSM is based on the value defined by the customer, the continuous flow, and focus on elimination of waste and carrying out value-added activities	Waste elimination	Objective-based
Myerson (2012)	Lean supply emphasizes the minimization of all resources used in supply chain management by using lean practices to reduce waste, complexity and error	Waste elimination	Objective-based
Drohomeretski et al. (2012)	LSM focuses on cost reduction and increased flexibility in providing products and uses continuous improvement to eliminate waste and non-value-added activities throughout the supply chain	Cost reduction Waste elimination	Objective-based
Afonso and Cabrita (2015)	LSM is a strategy to optimize supply chain processes (cost-time) by simplification and by reducing waste and non-value added activities	Cost reduction Waste elimination	Objective-based Approach-based
Bailey (2015)	LSM is not only a set of tools to reduce inventory and wastes, but it implies a cultural shift to collaborate and solve supply chain problems	Collaboration	Perspective-based
Singh and Pandey (2015)	LSM is a series of activities or solutions to eliminate waste, reduce non-value-added operations, and improve the value-added in the supply chain to maximize profit through cost reduction	Cost reduction Waste elimination	Objective-based
Khorasani et al. (2015)	LSM is a new approach to supplier networks based on long-term strategic partnerships and a solid integrated supply chain management system	Collaboration	Approach-based
Nimeh et al. (2018)	LSM represents an optimal strategy for manufacturers to improve efficiency and flexibility of their operations and supply chains	Waste elimination	Approach-based

First, numerous articles have studied the combination of lean and agile practices, sometimes referred to as a leagile supply chain. Soni and Kodali (2012) proposed a framework containing six main lean supply chain pillars when evaluating the main elements of three types of supply chains (lean, agile, and leagile) in the Indian manufacturing industry. Qi et al. (2011) concluded that agile capabilities build on top of lean capabilities and they proposed eight main groups of lean practices. Haq and Boddu (2017) identified the main enablers for leagile supply chains depending upon the competitive priorities of the market. Other studies in the auto industry have illustrated the integration of lean and agile practices, for example, showing how they coexist around the decoupling point of the supply chain (Ambe & Badenhorst-Weiss, 2010) or assessing the level of agility and leanness of companies (Azevedo et al., 2012b).

Second, other articles have explored LSM and the environment (i.e., lean, green, and resilient supply chains); for example, Al-Aomar and Weriakat (2012) outlined the main challenges and offered a framework for the combined adoption of lean and green practices in the supply chain. Martinez-Jurado and Moyano-Fuentes (2014) reviewed the literature integrating LSM with environmental and economic sustainability metrics and Ruiz-Benitez et al. (2018) concluded that lean supply chain practices act as drivers of resilient supply chain practices to improve operational and economical performance.

Third, other papers have focused more on the relationships with suppliers; for example, Barla (2003) studied a mathematical model for the selection of suppliers in a lean supply chain using seven different attributes and illustrating the model's application via a case study in the glass industry. So and Sun (2010) found that a supplier integration strategy, by incorporating information sharing, e-business, and systematic supplier selection, favours the adoption of lean in the supply chain. Manzouri and Rahman (2013) established parallelism of SCM theories with LSM principles, highlighting the role of strong relations with suppliers.

Fourth, some papers have discussed the application of LSM practices in particular industries: agri-food, textiles, healthcare, and construction. In the agri-food sector, Perez et al. (2010) examined the barriers for the implementation of LSM in the Catalan pork sector, Taylor (2006) described how the use of value chain analysis and lean practices improved two UK-based pork-industry supply chains, and Vlachos (2015) narrated how lean techniques were deployed in a UK tea company. In the textile sector, Hasan et al. (2020) assessed the implementation of LSM in the garment sector in Bangladesh, concluding on the lack of a holistic approach and showing that not

all practices were applicable to the sector. In the healthcare sector, past studies have offered frameworks to improve the quality of care for patients in hospitals (Almutairi et al., 2019; Chakraborty & Gonzalez, 2018). Finally, Eriksson (2010) explored the implementation of lean solutions in a construction project.

Fifth, scholars have also investigated LSM implementation challenges. Some authors have offered practical recommendations and solutions to lean a manufacturing supply chain (QAD, 2003; Stummer, 2009), for example, by mastering six attributes: demand management, cost and waste reduction, process standardization, industry standardization, cultural change, and cross-enterprise collaboration (Manrodt et al., 2008), by leveraging Information Systems (IS) solutions when deploying LSM (Adamides et al., 2006), by reducing defect rates and simplifying product design in a global supply chain (Levy, 1997), and by defining the appropriate sequence to implement lean and LSM (Moyano-Fuentes, et al., 2020).

Sixth, during the last five years, multiple authors have also studied the positive impact of lean practices on performance (supply chain, market, or financial performance). Different sets of LSM practices have been explored, including cellular layout, 5S, and visual management (Saudi et al., 2019), JIT system, flow of information, customer relations, supplier relations, and waste reduction (Nimeh et al., 2018), and supplier feedback, JIT delivery, supplier development, and involved customers (Tortorella et al., 2019b). Also, sets of higher level LSM constructs impacting performance have been analyzed, for example, customer management, information management, and quality management practices (Kumar Singh & Modgil, 2020), supplier-buyer relationships, lean manufacturing practices, and lean design practices (Jayaram et al., 2008), and logistics management, elimination of waste, continuous improvement, and top management commitment (Tortorella et al., 2018b). Another group of articles has focused on more specific outcome variables, for example, analyzing the effect of lean practices on cost, time, quality delivery, and flexibility (Afonso & Cabrita, 2015; Arif-Uz-Zaman & Ahsan, 2014; Marodin et al., 2017).

Finally, other studies have examined, in more detail, the characteristics of lean practices, their measurements, and their classifications, including, for example, the interrelationship between lean pillars (Soni & Kodali, 2016), the development of scales to measure LSM (Moyano-Fuentes et al., 2019), and the categorization in clusters of related practices (Al-Aomar & Weriakat, 2012; dos Santos et al., 2020; Tortorella et al., 2018b).

Following Argiyantari et al. (2020), Table 2-4 displays the pairing between 41 selected articles from this review and eight lean pillars (Hasan et al., 2020; Jasti & Kodali, 2015; Soni & Kodali, 2016).

Table 2-4. Tabulation of lean pillars and frameworks based on taxonomy by Jasti and Kodali (2015)

		LSM Dimension							
	Focus	**IT**	**SM**	**EW**	**JIT**	**CRM**	**LM**	**TMC**	**CI**
Levy (1997)	Implementation		x	x	x	x			
González and Suárez (2001)	Implementation	x	x	x	x		x	x	x
Barla (2003)	Relationships		x						
QAD (2003)	Implementation	x	x		x	x	x	x	
Cigolini et al. (2004)	Implementation	x			x		x	x	
Vitasek et al. (2005)	Implementation			x	x			x	
Adamides et al. (2006)	Implementation	x			x			x	x
Taylor (2006)	Industries		x	x	x			x	x
Found and Rich (2007)	Implementation	x	x	x	x		x	x	x
Jayaram et al. (2008)	Performance		x	x	x	x			x
Manrodt et al. (2008)	Implementation			x	x			x	
Stummer (2009)	Implementation	x	x		x			x	
Ambe and Badenhorst (2010)	Lean-agile	x		x	x			x	x
Eriksson (2010)	Industries		x	x	x	x		x	x
Perez et al. (2010)	Industries		x	x	x	x		x	
So and Sun (2010)	Relationships	x	x		x			x	
Qi et al. (2011)	Lean-agile	x	x		x	x		x	x
Al-Aomar and Weriakat (2012)	Environment		x	x	x	x	x		x
Azevedo et al. (2012b)	Lean-agile		x		x	x			x
Soni and Kodali (2012)	Lean-agile	x	x	x	x	x	x	x	x
Manzouri and Rahman (2013)	Relationships			x	x			x	x
Arif-Uz-Zaman and Ahsam (2014)	Performance	x		x	x			x	x
Martinez and Moyano (2014)	Environment	x	x				x	x	
Afonso and Cabrita (2015)	Performance		x	x		x		x	x
Jasti and Kodali (2015)	Performance	x	x	x	x	x	x	x	x
Vlachos (2015)	Industries	x		x	x	x		x	x
Soni and Kodali (2016)	Performance	x	x	x	x	x	x	x	x
Haq and Boddu (2017)	Lean-agile	x	x		x	x	x	x	x
Marodin et al. (2017)	Performance	x	x		x	x			
Chakraborty and Gonzalez (2018)	Industries	x	x	x	x			x	x
Nimeh et al. (2018)	Performance	x	x	x	x	x			
Ruiz-Benitez et al. (2018)	Environment	x	x		x			x	x
Tortorella et al. (2018b)	Performance		x	x	x	x	x	x	x
Almutairi et al. (2019)	Industries			x	x	x			x
Moyano-Fuentes et al. (2019)	Performance		x	x	x		x	x	x
Saudi et al. (2019)	Performance			x					
Tortorella et al. (2019b)	Performance		x		x	x			
dos Santos et al. (2020)	Performance	x	x		x	x	x		x
Hasan et al. (2020)	Industries	x	x	x	x	x	x	x	x
Kumar Singh and Modgil (2020)	Performance	x	x	x	x	x	x	x	x
Moyano-Fuentes et al. (2020)	Implementation			x	x		x	x	x
		23	**30**	**27**	**37**	**22**	**16**	**30**	**27**

IT: Information technology management, SM: Supplier management, EW: Elimination of waste, JIT: Just-in-time production
CRM: Customer relationship management, LM: Logistics management, TMC: Top management commitment, CI: Continuous improvement

Table 2-5. LSM Frameworks: elements, linkages, and use

	Focus	Key elements	Linkages and use
González and Suárez (2001)	Implementation	Product variables, organizational variables, environmental variables. Operational and complementary practices	JIT implementation entails operational practices and complementary practices. Influenced by product, organizational and environmental variables
Adamides et al. (2006)	Implementation	Information technology solutions and lean supply chains	Integrated software solution for the design and operation of lean supply chains
Found and Rich (2007)	Implementation	LSM operational elements (product-influenced) and LSM relational elements (organization-influenced)	Contingent product and organizational variables determine LSM effectiveness. LSM requires high performance operational and relational variables
Jayaram et al. (2008)	Performance	Relationship building, lean manufacturing, lean design, financial performance	Relationship building should precede lean strategy (lean design and lean manufacturing), which in turn influences firm performance
Ambe and Badenhorst (2010)	Lean-agile	Lean and agile supply chains. Competitive advantage (innovation, cost, service, quality)	Strategic use of lean and agile supply chain concepts to gain competitive advantage (Decoupling point)
So and Sun (2010)	Relationships	Supplier integration strategy (info sharing, e-business, selection) and continued adoption of lean manufacturing (regular and ongoing use)	Supplier integration has positive effect on lean manufacturing adoption. Supplier selection and regular lean use favour lean adoption
Al-Aomar and Weriakat (2012)	Environment	Green supply chain and lean supply chain issues, objectives, practices	Conceptual model integrating principles of green and lean supply chains in the construction industry
Soni and Kodali (2012)	Lean-agile	Strategic management, manufacturing management, marketing management, logistics management, supplier management, collaboration management	Competitive strategy and supply chain strategy support six LSM elements to achieve cost efficiency
Afonso and Cabrita (2015)	Performance	LSM goals (cost, quality, time, flexibility) and balanced scorecard BSC perspectives	Alignment between lean goals and BSC perspectives to introduce a measurement performance system to assess leanness degree
Jasti and Kodali (2015)	Performance	IT mgmt., supplier management, elimination of waste, JIT production, CRM, logistics management, top management commitment, continuous improvement	Top mgmt. commitment supports the other seven elements to achieve LSM excellence
Soni and Kodali (2016)	Performance	Strategic management, manufacturing management, marketing management, logistics management, supplier management, collaboration management	Interrelation between pillars and constructs of a proposed LSM framework. Strategic management is the base and collaborative management the peak
Marodin et al. (2017)	Performance	Lean shop floor (LSF), LSM customer relationship, LSM supplier relationship, inventory/quality	Moderating effects of LSM supplier and customer relationship on the effect of LSF practices on inventory and quality
Chakraborty and Gonzalez (2018)	Industries	Technology integration, supplier relationship management, lean orientation	Use of lean principles to improve patients' quality care via integrated supply chain, streamlined flow of resources and collaborative external relations
Nimeh et al. (2018)	Performance	LSM practices (JIT, flow of information, supplier and customer relationship, waste reduction), supply chain performance, market performance	LSM practices affect supply chain performance. JIT, flow of information and CRM affect market performance
Ruiz-Benitez et al. (2018)	Environment	Lean supply chain practices, resilient supply chain practices, operational and economic performance	Lean SC practices promote resilient SC practices to improve operational and economical performance
Almutairi et al. (2019)	Industries	Lean practices in hospital supply chain management	Four phases for lean implementation in hospital supply chains: preparation, assessment, developing and steady states
Saudi et al. (2019)	Performance	Lean practices (cellular layout, 5S, visual management), organizational structure, supply chain performance	Positive association between lean practices and supply chain performance mediated by organization structure
Tortorella et al. (2019b)	Performance	LSM practices, LSM performance, industry 4.0 products and processes	Moderation effect of industry 4.0 (product and process) on the relationship of LSM practices and performance
Moyano-Fuentes et al. (2020)	Implementation	Internal lean management implementation, LSM implementation, internal efficiency	LSM implementation mediates the effect of internal lean implementation on internal efficiency

Table 2-5 shows the foci, main elements, linkages, and uses of the 19 studies offering LSM graphical frameworks. In brief, aligned to the findings offered by Jasti and Kodali (2015), the results depicted in Table 2-4 and Table 2-5 indicate a deficiency in standardization of the different lean CTPs to develop LSM frameworks, which reflects the different perspectives of the researchers in the field of LSM and inhibits a concise and coherent conceptualization of LSM.

2.4.3 Research on LSM-related context and contingencies

My review of past literature reveals that the distinction between contextual factors and contingencies still seems to be blurred. Such confusion has precluded their joint consideration as two separate constructs. For example, Marodin et al. (2016) refer to the "contingent" nature of lean production and describe several "contextual factors" that affect the degree of use of lean practices, using the terms contingency and contextual factor as synonyms. Similarly, Sousa and Voss (2008) used the terms contextual variables and contingency variables interchangeably. Shah and Ward (2003) examined three contextual factors affecting lean manufacturing implementations but no contingencies were considered. A separate examination of context and contingencies articles related to LSM is presented next.

2.4.3.1 Research on LSM-related context

There is limited research that considers general contextual factors affecting the implementation of lean practices (Tortorella et al., 2017b). Most of this literature has focused on the business context and not on the operational context, that is, exclusively on common business and organizational contexts as critical considerations. Camacho-Minano et al. (2013) compiled and reviewed the existing literature that empirically examined the impact of lean practices on financial performance, revealing that the most representative contextual factors studied were company size, years of lean implementation, and industrial sector, followed by age, capacity, company context, and national context.

A group of Brazilian researchers has contributed multiple studies investigating the role of contextual factors in LSM implementations. These articles have explored different relationships, for example, between LSM practices and performance (Tortorella et al., 2017a), LSM implementation and contextual factors (Marodin et al., 2016; Tortorella et al., 2017b), and the association of LSM practices in the presence of distinct contextual factors (Tortorella et al., 2018a). The preferred studied contextual factors included company size, tier level, lean implementation experience, and onshore supply. Additional contextual factors that have been examined are number

of employees, annual revenue, educational level, continuous improvement teams, age of the plant, and unionization (Tortorella et al., 2015). Karim and Arif-Uz-Zaman (2013) proposed a methodology for lean implementation in manufacturing organizations that differentiates each company status in terms of product type, order volume, and demand quantity.

Another group of scholars have focused on the study of country context or the specific supply chain as contextual factors. For example, in a study of the Spanish sawmill industry, Gueimonde-Canto et al. (2011) suggested that contextual factors inherent to each supply chain influence the relationship between cooperation with suppliers and buyers and performance. In the automotive industry, studies have described the influence of business and economic environment factors on LSM in Brazil (Arkader, 2001) and the implicit effect of geographical concentration in a Portuguese automaker (Azevedo et al., 2012a). Rahman et al. (2010) also reviewed the impact of lean practices on performance in the Thai manufacturing sector, including company size and company ownership as contextual factors. In the agri-food industry, several studies determine the effect of ownership type, company size, and the adoption of quality systems on the implementation of lean practices in the halal food supply chain in Malaysia (Manzouri, 2012; Manzouri et al., 2014; Manzouri, et al., 2013). Dora et al. (2016) concluded that top management commitment, training, resources, organizational culture, and structure were critical for lean adoption success in small and medium-sized food enterprises (SMEs). In service industries, the feasibility of the application of LSM with some adaptations has been illustrated in healthcare, the hospitality sector, and local government purchasing (Erridge & Murray, 1998a; Erridge & Murray, 1998b; Tortorella et al., 2019a), also suggesting the importance of training suppliers (Cudney & Elrod, 2011) and defining desired outcomes for successful implementations (Adebanjo et al., 2016). Another study by Hadid and Mansouri (2014) offered a conceptual framework of lean service and performance, incorporating six contextual factors: company size, age, process type, internationalization, business strategy, and cost management systems. Finally, the workings of lean supply in a global purchasing context were explored by Nellore et al. (2001).

Table 2-6 depicts a list of the articles discussed in this section including the taxonomy proposed by González-Benito and Suárez-González (2001), which contains three categories: (1) environmental variables (e.g., socioeconomic factors relative to location and culture), (2) organizational variables (e.g., size, structure, technology, and personnel), and (3) product variables (e.g., product life cycles, type of processes, and characteristics of products).

Table 2-6. Papers presenting LSM contextual factors

	Contextual variables	Grouping	Contribution
Erridge and Murray (1998b)	Public sector	Environmental	Compatibility of LSM practices with local government purchasing with some adaptation needed and specific selection
Erridge and Murray (1998a)	Public sector	Environmental	Need to adapt LSM practices to fit into the public sector. Cost reduction and improved competitiveness opportunities
Arkader (2001)	Social, economic, political factors	Environmental	LSM in a developing country context. Still need to recognize the strategic role of suppliers
Nellore et al. (2001)	Global purchasing	Environmental	LSM and priced-based global purchasing can co-exist and be preferred based on the complexity of products to be sourced
Rahman et al. (2010)	Size and company ownership	Organizational	Adoption and impact of lean practices in Thai manufacturers. Effect of size and ownership
Cudney and Elrod (2011)	Industry, size, location	Environmental, organizational	Comparison of LSM in manufacturing and service industries
Gueimonde-Canto et al. (2011)	Specific industry and position in the supply chain	Environmental	Contextual factors affect the relationship between cooperation and performance
Azevedo et al. (2012a)	Industry	Environmental	Positive impact of green and LSM practices on sustainability metrics
Manzouri (2012)	Country, Industry, size	Environmental, organizational	Benefits for halal food companies in Malaysia implementing LSM
Camacho-Minano et al. (2013)	Size, years of implementation, industry other (age, capacity, company and national context)	Environmental, organizational	Review of past studies indicate mixed impact of contextual factors on financial performance
Karim and Arif-Uz-Zaman (2013)	Production type, order volume, demand quantity	Organizational, product	Methodology to implement lean considering organizational context
Manzouri et al. (2013)	Quality systems, ownership type, company size, type of product	Environmental, organizational	Company size and ownership type affect LSM implementation
Hadid and Mansouri (2014)	Size, age, internationalization, process type, business strategy, and cost-management system	Environmental, organizational, product	The impact of lean service on performance is affected by contextual factors
Manzouri et al. (2014)	Age, ownership, size, quality certifications	Organizational	Identification of main LSM practices that benefit halal food companies
Tortorella et al. (2015)	Number of employees, age, unionization, education level, CI team, annual revenue	Organizational	Contextual factors affect organizational learning capabilities in companies implementing lean
Adebanjo et al. (2016)	Country, industry	Environmental	Prioritization of performance measures and their relationship with LSM practices. Drivers and resources
Dora et al. (2016)	Organizational factors, intrinsic factors food-processing sector	Organizational, product	Effect of contextual factors on lean manufacturing adoption
Marodin et al. (2016)	Tier level, plant size, lean experience	Organizational	Contextual factors affect the degree of use of lean production practices differently
Tortorella et al. (2017a)	Tier level, plant size, lean experience, onshore supply	Environmental, organizational	Supply chain context matters when implementing LSM. Degree of effect depends on each factor
Tortorella et al. (2017b)	Tier level, plant size, lean experience, onshore supply	Environmental, organizational	Effect of contextual variables on level of implementation of LSM.
Tortorella et al. (2018a)	Lean experience, onshore supply	Environmental, organizational	Relationship between LSM practices is affected by contextual factors
Tortorella et al. (2019a)	Industry	Environmental	LSM practices can be applied in the hospitality sector with some adaptations

From these results, it is observed that past studies have mainly explored multiple business and organizational factors (i.e., business contexts); however, what seems to be lacking, based on these papers, is the study of different operating contexts, which due to their high relevance deserve more attention and empirical scrutiny.

2.4.3.2 Research on LSM-related contingencies

Additional studies have also discussed the role of contingencies associated with the implementation of LSM. Such articles appear in Table 2-7.

Table 2-7. Papers presenting LSM contingencies

	Contingent variables	Grouping	Contribution
González and Suárez (2001)	Size, centralization, logistics, internationalization, focus	Environmental, organizational, product	Organizational factors affect the implementation of LSM
Cigolini et al. (2004)	Industry, type of supply chain, structure, product life cycle, product complexity	Environmental, organizational, product	Framework for SCM strategies. Selection based on businesses characteristics
Found and Rich (2007)	Fast moving, consumer goods industry	Organizational, product	Product and organizational variables must be included in LSM implementation
Adamides et al. (2008)	Operating conditions	Organizational, product	Information and communication tools facilitate LSM by addressing contingencies of demand and operation
Found et al. (2007)	Strategy and alignment, leadership and behaviour-engagement, processes and tools-techniques	Organizational	Organizational and managerial aspect to sustain a global lean supply chain (Lean iceberg model)
Qi and Chu (2009)	Size, type of industry, supply chain strategy	Environmental, organizational	Linkage between supply chain strategies and supply chain integration
Jajja et al. (2016)	Age, size, ownership, exporters/non-exporters	Environmental, organizational	Alignment between SC strategy, supplier tactics and performance

As stated previously, González-Benito and Suárez-González (2001) studied the organizational factors determining the deployment of LSM; they categorized such contingencies into three categories: environmental, organizational, and product-related variables. Based on that study, Found and Rich (2007) emphasized the relevance of a contingency approach involving product and organizational variables by offering a framework for high-performance LSM, separating the operational from the relational side of LSM. Product variables, production volume, product standardization, and demand variability were observed as contingencies in the packaging industry.

Other researchers have studied contingencies regarding the two types of supply chains, lean and agile. Cigolini et al. (2004) cited the main techniques and tools that are part of a lean supply chain strategy when exploring the primary factors impacting the selection and adoption of a particular

type of supply chain. They offered a new contingency model incorporating product life cycle phase, product-complexity, and supply-chain-type in a multi-industry empirical study.

Another study by Qi and Chu (2009) found positive relationships between two types of supply chain strategies (lean and agile) and two types of integration (internal integration and external integration), also showing how company size and industry type influenced the association. Finally, most recently, Jajja et al. (2016) targeted the Indian and Pakistani markets to explore relationships between buyer supply chain strategies (lean and agile), supplier practices, and buyer performance. Although positive relationships were found in all cases, the contingency analysis showed statistically significant differences in the results when adding company age, company size, ownership, and internationalization level.

Other articles show an emphasis on strategic management. For example, Found et al. (2007), argued that strategy and alignment, leadership, and behaviour and engagement for the creation of sustainable lean systems are contingencies not clearly visible. Also, Adamides et al. (2008) showed how information and communication technology can facilitate LSM implementations and reconfigurations, even in cases of adverse contingencies of unstable demand or operating conditions.

Even though these studies use the terminology of contingencies, the implied meaning and specifically, the variables studied, show an overlap with some contextual factors described in the previous section, which demonstrates the lack of clarity to differentiate context and contingencies, exemplified by their common use as interchangeable terms, when in fact they may be seen separately in order to advance LSM scholarly theorization and managerial understanding. This conclusion reinforces the need for a new LSM definition and framework that separates the concepts of context and contingencies.

2.5 Discussion of results

Based on the results from the previous section, which offered a descriptive analysis of past literature, I now present a discussion of results that summarizes my main findings. I have separated this discussion into three fundamental aspects aligned to the research questions of this study, in terms of LSM definitions, practices and frameworks, and context and contingencies.

2.5.1 Discussion of LSM definitions

Regarding the definition of LSM, as stated previously, there is a lack of consensus reflected in the multiple definitions in terms of the different foci, which has complicated previous efforts to

conceptualize LSM. Although some similarities were discovered among 18 different definitions, there are still substantial differences when conceptualizing LSM. In general terms, past researchers have included isolated ideas regarding the definition of LSM; some have prioritized the elimination of waste and cost and time reduction, while others have emphasized the need for levelled relationships between supplier and customer with no superiority of either part, while others have referred to the importance of establishing long-term partnerships based on trust and confidence.

The identification of different elements resulted in four groupings based on the focus of those definitions: (1) objective-based, (2) structure-based, (3) perspective-based, and (4) approach-based. These different groups illustrate the diversity of LSM definitions, each with a diverse focus, lacking a complete integration of the main critical elements that constitute LSM. Most of them have overlooked the recommendations about formal conceptual definitions offered by Wacker (2004), for example, in terms of clarity, precision, parsimony, the use of abstract-level components, and the avoidance of measurable attributes. Accordingly, these poor construct conceptualizations of LSM have resulted in the difficulty to: (1) develop measures to faithfully represent it, (2) specify the relation to its measures (risk of measurement model misspecification), and (3) enhance the credibility of hypotheses (MacKenzie, 2003). In that sense, there is a need for a revised conceptual development of LSM that generates consensus in the community of scholars, incorporating additional considerations (such as the ones aforementioned), a definition that considers LSM as an approach with an objective-based focus, and involves contextual factors, contingencies, and their associations, alignments, and influences, which have not been mentioned in past studies.

2.5.2 Discussion of LSM practices and frameworks

Based on the tabulated results in Table 2-4, in terms of the focus of past LSM practices research, the grouping that has received the most interest by researchers is “performance”, with 32% of the articles analyzed showing this focus. The second highest group was “implementation”, with 24%, and the third major group was “industries”, with 17%. Such numbers reflect that scholars prefer to focus on practical research relevant to managers and the need for defining appropriate strategies for a successful deployment, which vary depending on the intrinsic characteristics of each individual industry. It is also noted how the focus of these studies has changed during the last 20 years, initially with a high emphasis on implementation and recently placing more weight on performance, noticing an absence of updated studies regarding LSM implementation focus.

Contemporary researchers have prioritized studies related to LSM performance, possibly assuming a degree of maturity of research on LSM implementation; however, this seems to be detrimental to this field of study and therefore more investigation is needed.

A horizontal analysis reflects that few articles mention the whole set of eight pillars proposed by Jasti and Kodali (2015) and the majority of articles (66%) entail between four and six of these pillars, which presumes a possible selection of lean pillars depending on the objective or the problem addressed in each study. Such supposition should be explored further. It is observed that the pillar that has been most frequently studied is just-in-time production, followed by supplier management and top management commitment, which coincides with findings of past reviews (Argiyantari et al., 2020; Tortorella et al., 2017a). These results confirm the alignment between lean production and LSM, the extension of lean principles to the supply chain, and the importance of leadership in LSM implementations. Additional important pillars frequently included in past studies are the elimination of waste and continuous improvement, reaffirming their critical role as core elements of LSM. Conversely, the pillar that has been referenced the least by the scholarly community is logistics management, also aligned to results obtained by Tortorella et al. (2017a), uncovering potential opportunities for further research, especially on outbound logistics.

Regarding LSM frameworks, half of the scanned articles display graphical associations within the elements of LSM or between the elements of LSM and other external constructs. Similar to the main emphasis of articles studying LSM practices displayed in Table 2-4, the leading focus of articles in Table 2-5 is LSM performance frameworks (42%). This result reveals that the examination of relationships between lean practices and performance indicators has guided recent studies and thus has overshadowed other studies on LSM implementation frameworks.

In brief, these findings show the extant variety of LSM practices and frameworks, revealing the lack of consensus in the field. Most studies have disregarded the role played by context and contingencies, considered critical elements in LSM implementations (Tortorella et al., 2017a). Therefore, there seem to be some gaps in the most recent literature concerning the exploration of LSM implementation frameworks that hinder a proper conceptualization and better understanding of this construct. This implies the need for a revised perspective to envision LSM from an alternative view (MacInnis, 2011). What is lacking is a proposed LSM framework, starting with a conceptual model that offers an approach- and objective-based focus, prioritizing the implementation of LSM and considering the role of performance objectives and supply challenges.

2.5.3 Discussion of LSM-related context and contingencies

As observed in the previous sections, past research has examined multiple contextual factors and contingencies when studying LSM definitions, practices, and frameworks (using the terms interchangeably and not exactly as was defined in Section 2.1 for this thesis). The tabulation of articles in Table 2-6 and Table 2-7 shows a preference to discuss contextual factors (63% of the articles) over the analysis of contingencies (37% of the articles). However, not only contextual factors must be considered in LSM implementation (Tortorella et al., 2018a) but also the effect of contingencies to define the appropriate selection of lean pillars.

Numerous articles have studied relationships between lean practices and performance metrics or the associations among lean practices, incorporating the role of contextual variables directly as part of their models or indirectly as control variables. The typology offered by González-Benito and Suárez-González (2001), applied to the articles in Table 2-6 and Table 2-7, revealed that organizational variables (44%) (company size, company age, ownership, and years of lean implementation) and environmental variables (42%) (country and supply chain sector) are the categories with higher interest by scholars in LSM research. Less attention has been given to the category of product variables (14%) (product and process characteristics).

The main conclusions from this review regarding the exploration of contextual factors and contingencies related to LSM are fivefold. First, this review illustrates the compatibility, applicability, and feasibility of using lean practices in the supply chain (LSM) under different business contexts; multiple papers show diverse settings where the use of LSM practices was empirically explored, and the results determined positive associations with performance. Second, contextual factors and contingencies do matter; they directly impact the implementation of LSM and therefore cannot be neglected. Third, this review also clarifies the need for adaptation and selectivity of LSM practices depending on the context and contingencies; past papers show how practical cases demanded customization of lean solutions based on specific contexts and contingencies. Fourth, although the distinction and separation between context and contingencies are still not clear because previous studies have treated these two terms interchangeably, a differentiation emerged from the literature review when observing contextual factors as reflections of setting considerations, while regarding contingency factors as reflections of potential occurrences; therefore this thesis establishes a domain for each of them. Fifth, from a context consideration (Table 2-6), there is an absence of research considering performance objectives

pursued as the context of LSM and similarly, from a contingency consideration (Table 2-7), past literature has not (well) examined the role of supply challenges, a relevant practical consideration, as contingencies of LSM.

In addition, past literature has acknowledged the need to look at the integration of functioning context and challenges to be addressed. For example, Voss (1995) illustrated how companies usually fail to achieve their performance objectives when adopting best practices in an isolated manner with lack of perspective. As such, considering the nature of the challenges faced should provide the companies with some perspective. Another study, cited by Ketokivi and Schroeder (2004), indicates that the right implementation of manufacturing practices is associated with strategic priorities, thus the importance of the pursuit of specific priorities on the selection of specific operational practices to implement.

In brief, in reinforcing the need for additional considerations when implementing LSM, cited earlier, and incorporating my findings from this section, it is observed that the selection of lean pillars seems to be aligned with contextual factors and contingencies, which influence the implementation process. However, no previous studies have focused on these joint associations and alignments of LSM including context and contingencies simultaneously as separate constructs.

In addition, it is noticed that neither the study of performance objectives pursued, seen as a reflection of an operational/functioning context (or setting), nor the consideration of supply challenges, seen as a reflection of an operational/functioning contingent condition, has been explored, influencing the deployment choice of lean pillars, seen as a reflection of an operational/functioning contingent event. Scholarly value would be created by identifying the role of different factors (e.g., contingent condition such as supply challenges) within an operating setting that management can control (e.g., context such as the pursuit of performance objectives) in enabling/driving the adoption of lean pillars (i.e., contingent event), which previous literature has not examined. More specifically, to advance the understanding of LSM, we need to consider the alignment association of a specific performance objective (context) with a specific supply challenge (contingent condition), which should influence the decision alignment with a specific lean pillar (contingent event).

2.6 Conclusions and limitations

This chapter has reviewed LSM's past studies, with special emphasis on summarizing and evaluating the nature of how LSM is defined, framed, and examined in terms of context and/or

contingency. An examination of 86 articles was presented, which was preceded by the analysis of 11 past literature reviews on LSM. The main conclusions of this study are fourfold.

First, to address the first research question, multiple definitions of LSM were explored to understand the main elements included and their main emphases. Four main foci were identified: (1) objective-based, (2) structure-based, (3) perspective-based, and (4) approach-based. The analysis revealed the need for an updated definition and framework, prioritizing the focus on LSM as an approach with an objective-based focus.

Second, in response to the second research question, this study exposed a variety of LSM practices and frameworks that were categorized in multiple groups based on their common patterns. Findings from the analysis determined: (1) the need for updated LSM frameworks targeting an implementation focus and (2) the need for further exploration of the assumption of selectivity of lean pillars based on performance objectives (context) and supply challenges (contingency).

Third, to respond to my third research question, this study examined papers considering contextual factors and contingencies on the implementation of LSM. The analysis illustrated the most common contextual factors and contingencies studied in past literature and revealed the need for studies clarifying them and their interaction effects on LSM.

Fourth, the need for a new LSM definition and conceptualization can be derived from the tabulated results in the following joint consideration: (1) previous research has omitted the consideration of performance objective as the context, (2) past studies do not address the supply challenges (contingency) consideration, and (3) past studies do not consider the alignment association between supply challenges and performance objectives. In consequence, because past literature is missing the context and contingency elements under this view, there exists a large gap in our LSM knowledge.

In summary, given the accumulated knowledge, to advance the understanding of LSM, it is worthy to refocus LSM on the deployment endeavour, while leveraging the approach-based focus discussed for its definition (Table 2-3) and the need to reconsider an implementation focus discussed for its framework (Table 2-5), besides considering the performance objective pursued as context (Table 2-6) and the supply challenge faced as contingency (Table 2-7).

Like most studies, this research is not without limitations. While two adequate main databases were used for this study (*Scopus* and *Web of Science*), other databases (e.g., *Google Scholar*) may

contain additional articles that have not been examined and could enhance the accuracy of this study. In addition, given our methodology of excluding articles that did not refer to LSM specifically, it is possible that some other highly relevant articles have not been considered. Finally, the selection of articles was based on the presence of specific keywords in the title of the paper or in the abstract (disregarding more generic keywords such as “lean production” or “lean management”), which automatically disqualified papers that may have been relevant in their main text.

For the scholarly community, this chapter expands the body of knowledge regarding fundamental ideas about LSM. The main significance of this study for practitioners is the offering of a thorough review of LSM's past literature to better understand its elements and overcome any barriers during the implementation of LSM. Finally, future avenues of research to enhance the conceptualization of LSM should aim for a new LSM definition and LSM framework that explicitly incorporate context and contingency and include the role of performance objective as context and supply challenge as a contingency to influence the selection of lean pillars to be adopted.

CHAPTER 3

3. Conceptualization and theorization of lean supply management: A Delphi study (Essay 2)

3.1 General Introduction

Lean management has emerged over the last three decades as a significant operational philosophy that has been widely adopted by firms across a broad range of industries and has become the focus of extensive academic research. A core tenet of lean management is that firms should work closely with their key suppliers to eliminate waste in the supply chain. However, currently absent from the scholarly literature is a clear, coherent, and compelling conceptualization of lean supply management (LSM).

Prior research has identified the relevance of LSM across a wide variety of industry contexts, including automotive (Wee & Wu, 2009), aerospace (Ruiz-Benitez et al., 2017), and healthcare (Khorasani et al., 2015). However, the literature provides a variety of definitions of LSM, most of which are structural in focus, and offers competing framings containing varying constitutive elements (Khorasani et al., 2015; Nimeh et al., 2018). Thus, an opportunity exists to make a contribution to the scholarly and practitioner literatures by advancing a unifying conceptualization and theorization of LSM (Jasti & Kodali, 2015). Given the current lack of consensus on what constitutes LSM, this paper provides a novel conceptual development of LSM with the purpose of improving management practice by identifying contextually specific supply challenges that firms face in fulfilling their LSM performance objectives (i.e., traditional competitive priorities) (cf. Geyi et al., 2020; Pozo et al., 2017).

Complicating this effort to offer a consensus conceptualization and definition of LSM are the varied views on what constitutes lean. As a managerial concept, lean has traditionally been considered an operating state, a performance objective, or a set of methods. First, viewed as an operating state, lean is characterized by the operational system in which non-value-added work elements viewed as waste are continuously reduced or eliminated (Ciccullo et al., 2017). Second, viewed as an operational objective, lean has been described as an opportunity to improve competitiveness in terms of quality, cost, reliability, speed, flexibility, and innovation, such as that found in nascent LSM studies that provide evidence of performance improvements based on the

implementation of LSM practices (Tortorella et al., 2017a; Nimeh et al., 2018). Third, viewed in terms of a set of method(s), previous studies argue that lean encompasses a set of practices encapsulated in bundles or aligned to key processes as a method to achieve desired performance goals (Drohomeretski et al., 2012). This study adopts a combinative view, such that lean constitutes a practice-based operations approach involving the systematic and ongoing paring of waste and its sources from operational systems in order to improve throughput flows and increase the value-add ratio of all work critical to advancing firm competitiveness (cf. Liker & Franz, 2011; Shah & Ward, 2007).

Consistent with MacInnis' (2011) typological highlighting of the need for conceptual research contributions that "see something that has been identified in a new way; to reconfigure, shift perspectives, or change" (p. 138), our revised envisioning conceptual development of LSM is based upon a contextual contingent view that explores the alignment among supply challenges, LSM performance objectives, and lean pillars. Lean pillars represent a general category of lean concepts, tools, and practices (CTPs), where CTPs are first-order management elements and pillars are second-order CTPs classification categories (Pozo, et al., 2017; Soni & Kodali, 2013).

The core supposition behind this revised envisioning conceptual development of LSM is that it is the contextually specific linkage between supply challenges and lean pillars—which in this study generally represent specific lean-based CTPs—contingent upon fulfilling five overarching LSM performance objectives (i.e., productivity, visibility, consistency, learning, and variability reduction) that determine LSM performance outcomes. We then specify, based upon this core supposition, a practically relevant definition of LSM.

For our revised envisioning theorization of LSM, we draw on strategic insights emanating from the practice-based view (PBV) (Bromiley & Rau, 2016). The PBV asserts that the suitably selective use of imitable business practices impacts firm performance. These selected practices become suitable provided they are oriented towards specific ends; therefore, our contingency approach states that the adoption of lean pillars (i.e., the deployment of lean CTPs) becomes more valuable if utilized to address specific supply challenges that are aligned with particular performance objectives.

This study's underlying conceptualization question is:

What constitutes LSM when examined using a contextual contingent approach? Contextual relates to the "setting" for operating within (i.e., the pursuit of a performance objective) (Ginsberg

and Venkatraman, 1985), and contingencies are seen in two different ways: contingent conditions as potential occurrences related to LSM (i.e., supply challenges) and a contingent event as the actions to address those occurrences (i.e., lean solutions) (Netland, 2016). Additionally, this study empirically validates the practical applicability of our contextual contingent LSM conceptualization through the use of a Delphi survey (Landeta, 2006) using a panel of experts from the Canadian agri-food sector. The Delphi method "is suited to explore areas where controversy, debate or lack of clarity exists" (Iqbal and Pippon-Young, 2009, p. 1). Although the agri-food sector is a critical contributor to the Canadian economy, there has been limited exploration of the lean operations approach in that operating context despite its high potential to be leveraged (cf. Costa et al., 2018), which motivates our interest.

Therefore, this study's empirical question is:

> *What constitutes the supply challenges, LSM performance objectives, and lean pillars in the Canadian agri-food sector?*

Findings highlight the practical application of our contextual contingencies framed LSM conceptual framework by identifying the critical supply challenges faced by Canadian agri-food processors and ascertaining the lean pillars viewed as being useful by Canadian agri-food processors vis-à-vis fulfilling specific LSM performance objectives.

The scholarly and managerial contributions resulting from this study are three-fold. First, based upon our conceptualization question, this effort will reorient scholarly examination and advance theorization on the topic of lean management in the supply context. Second, examination of our empirical question results in meaningful descriptive insights on (1) what critical supply challenges, related to specific LSM performance objectives, are faced by Canadian agri-food firms and (2) which lean pillars are actually being advocated and leveraged by Canadian agri-food sector processors. Advancing both scholarly and managerial understanding of (1) and (2) is urgently needed (cf. Vlachos, 2015). Third, the findings from this research will prescriptively aid managers in clarifying what constitutes productive decision-making and action-taking with regards to minimizing supply related costs and maximizing service responsiveness through the implementation of LSM.

The remainder of this paper is structured as follows. First, we review the scholarly literature concerning LSM. Second, we present our revised envisioning LSM conceptualization and theorization. Third, with regards to the empirical validation of our LSM conceptualization, we

review the research methods before reporting and discussing our descriptive research findings. Finally, we summarize the contributions of this research before concluding.

3.2 Literature review

While the extension of lean to the supply chain has been ongoing, scholars have acknowledged the need for a more nuanced understanding of that extension given the complex nature of managing external relationships (Moyano-Fuentes & Sacristán-Díaz, 2012). However, previous studies (e.g., Mason-Jones et al., 2000; Afonso & Cabrita, 2015; Bailey, 2015; Tortorella et al., 2017a; Nimeh et al., 2018) have mainly provided diverse conceptual examinations of LSM resulting in an array of definitions and no clear consensus guidance on what specific aspects of lean would productively benefit supply management.

It has been argued that a productive lean supply arrangement should include the suppression of boundaries between firms to provide a flow of goods, services, and information from supplier to customer with minimal operating waste (Lamming, 1996). LSM, from a structural perspective, has been defined as "a set of organizations directly linked by upstream and downstream flows of products, services, information and funds that collaboratively work to reduce cost and waste by efficiently pulling what is needed to meet the needs of individual customers" (Vitasek et al., 2005, p. 40). Adamides et al. (2008) characterized the lean supply network as a system formed and maintained by collaborative relationships among its components. Nightingale (2005), in contrast, considered lean supply as a new way of thinking that requires a balance between cooperation (e.g., collaborative relationships and coordination mechanisms) and competition. Khorasani et al. (2015) further suggested that LSM requires long term strategic supplier partnerships and a highly-integrated supply chain management system. Other scholars, as highlighted in Table 3-1, have stated that LSM focuses on cost reduction and flexibility using continuous improvement processes to target the elimination of waste or non-value added activities related to excess time, labour, equipment, space, and inventories across the supply chain in order to improve quality and customer service (Perez et al., 2010; Drohomeretski et al., 2012).

These previous definitions present some commonalities in terms of the search for an optimal flow of materials and information, the elimination of waste, and cost reduction to meet customer needs. Subtle, yet inferentially confounding, definitional differences exist in terms of the processes employed, the nature of partnering relationships, and performance objectives.

Table 3-1. Sample of LSM definitions

Study	Definition of LSM	Focus
Lamming, 1996	An operating attitude aim to identify cost deviations from perfection, needed for customer satisfaction	Objective-based
Nightingale, 2005	LSM is a new way of thinking that requires a good balance between cooperation (collaborative relationships and coordination mechanisms) and also competition	Relational
Vitasek et al., 2005, p. 40	"a set of organizations directly linked by upstream and downstream flows of products, services, info and funds that collaboratively work to reduce cost and waste by efficiently pulling what is needed to meet the needs of individual customers"	Structural Transactional
Adamides et al., 2008	LSM is characterized by supply chains and networks formed and maintained by collaborative relationships among its components	Structural Relational
Perez et al., 2010 *Mason-Jones et al., 2000*	LSM focuses on elimination of waste and valueless activities through continuous improvement to reduce cost and achieve flexibility in already available products	Objective-based Transactional
Drohomeretski et al., 2012 *Mason-Jones et al., 2000* *Naylor et al., 1999*	LSM focuses on cost reduction and increased flexibility and uses continuous improvement to eliminate waste and non-value-added activities	Objective-based Transactional
Myerson, 2012	Lean supply emphasizes on the "minimization of all resources used in supply chain management" by using lean practices to reduce waste, complexity, and error	Objective-based
Afonso and Cabrita, 2015	LSM focuses on optimizing supply chain processes by simplification and by reducing waste and non-value-added activities	Objective-based
Bailey, 2015	LSM is not only a set of tools to reduce inventory and wastes, but it implies a cultural shift to collaborate and solve supply chain problems	Relational
Singh and Pandey, 2015, p.39	"LSM literature highlights the managerial application of lean practices that integrate lean and agile operations"	Transactional Relational
Khorasani et al., 2015	LSM is a new approach to supplier networks based on long term strategic partnership within a solid integrated supply chain management	Relational
Nimeh et al., 2018	LSM represents an optimal strategy for…manufacturers to improve efficiency and flexibility of operations	Objective-based

Our review of the literature identified an emphasis on waste elimination, long term partnerships, collaboration, and continuous improvement. However, the definitions generally disregard LSM as an operational approach involving the deployment of LSM performance objectives-based practices

utilized to create shared value for partnering organizations. The empirical relationship between LSM practices and performance has attracted scholarly attention (Nimeh et al., 2018; Tortorella et al., 2017a); nevertheless, these studies report contradictory results with inconsistent construct operationalizations resulting from imprecise conceptualization and theorization. Therefore, we observe several conflicting issues: LSM is mainly considered as an extension of lean or as a collection of specific practices, lacking an integrative framework. A major problem is the lack of consensus among scholars regarding a unique understanding of LSM. Our novel view aims to resolve that conflict and aid in comprehending LSM, providing a coherent and compelling theorization.

Despite the current relevance of LSM as a sub-topic for operations management study, there is still a prevalence of different scholarly-derived conceptual frameworks (Jasti & Kodali, 2015; Singh & Pandey, 2015). These frameworks varyingly encompass a common array of elements to conceptualize LSM, such as the inclusion of the core principles of waste elimination and inventory reduction (Khorasani et al., 2015), listings of main lean principles, attributes, and dimensions of LSM (Vitasek et al., 2005; Perez et al., 2010; Bailey, 2015), and LSM implementation factors (Cudney & Elrod, 2010; Tortorella et al., 2017b). As conceived and presented, we believe there exists in the literature an implicit supposition that LSM is generalizable across different settings, implying that the form and function of LSM is invariant to any study/application context (or contingency), inferring therefore that lean supply management in one context (e.g., organization or industry) equates with lean supply management in another context.

These distinctive conceptual frameworks have generated an array of LSM definitions, though most are structurally (transactional or relational) focused or objective-based, with an implicit evolution ranging from an operational to a more strategic point of view (see Table 3-1). This lack of definitional consensus on what constitutes LSM limits advancement of scholarly theorization and managerial understanding. As such, opportunities exist for the specification of a revised envisioning of LSM (e.g., our contextual contingent conceptualization) that more clearly, coherently, and compellingly aligns specific supply challenges with lean pillars to fulfill particular LSM performance objectives.

Scrutiny of the limited extant research on LSM in the agri-food sector (e.g., Dora et al., 2014; Lopes et al., 2015) highlights several notable features. First, most of these publications are UK-based or India-based and the prevalent sectors examined include animal processing, bakery, and

sugar-confectionary. Second, the use of case studies, involving both interviews and surveys, has been the preferred method of research, which suggests that this area of research is in its initial stages given the generally conservative, slow to change, and limited investment in innovation nature of this industry in those study contexts (Costa et al., 2018; Tatsis et al., 2006). Third, the intrinsic characteristics of the agri-food industry in terms of variability of supplies and perishability present additional challenges (Rábade & Alfaro, 2006). Dora et al. (2016) depict the distinct operational features of the agri-food sector using three categories: product - short shelf-life, high variability, continuous measurements; process - variable yield and processing times, short processes, limited automation; and plant - long set-up and changeover times, separate packaging process, batch processing in some cases.

Consistent with Dora et al.'s (2014) observations, our review of the literature on lean in the agri-food sector highlights the following: there is ambiguity about the main supply challenges for lean implementation in this sector, the appropriate lean tools used to address the challenges are context-based and need to be more clearly identified, a lack of consensus about the benefits of lean in the agri-food sector exists, there are limited empirical studies about the field and a constant claim for further research, and past studies use a fragmented approach based on few lean practices instead of a systemic view of lean. As such, additional conceptualization, theorization, and empirical insight are required to better understand LSM in the agri-food sector, utilizing a context-specific framework aligned to the intrinsic characteristics of the food-processing industry.

3.3 Conceptualization and Theorization of Lean Supply Management

Building upon Danese et al.'s (2018) call for more clarity on "lean-x" processes such as "lean supply management", our proposed revised envisioning conceptual development of LSM is based on an "intersectionist" constitutive conceptualization perspective (Larson & Poist, 2007). This perspective differs from the "unionist" conceptualization approach that broadly aggregates, without necessarily providing a narrowed phenomenological view, generalized facets of constructs. In contrast, a more focused integration of specifically associated constructs considerations in our proposed intersectionist model dictates the refined boundaries of the new conceptualization. Our intersectionist conceptual development of LSM, as such, allows us to highlight the integrated association of specific lean operations approach pillars with contextually specific supply challenges through their contingent alignment to fulfill specific LSM performance objectives. The contextual contingent nature of our LSM conceptualization implies that what

constitutes LSM depends on the specific supply challenge, performance objective, and lean pillars deemed to be practically relevant, which represents a paradigm shift relative to extant LSM conceptualizations.

Past studies have already suggested a contextual approach to understanding lean (Shah & Ward, 2003; Dora et al., 2013; Tortorella et al., 2017a), which constitutes the foundation for our revised envisioning conceptualization supposition that differences exist among LSM applications under distinct scenarios and institutional factors. As such, we advocate that the contextual contingent nature matters and that the application differs across settings such that LSM in one context may not equate to LSM in another context.

Central to our intersectionist conceptual development is aligning LSM performance objectives, which, according to the lean operations approach, primarily focuses on productivity, visibility, consistency, learning, and variability-reduction considerations. These integrating LSM performance objectives dictate the appropriate lean pillars (see Jasti and Kodali's (2015) conceptualization), or more precisely, the associated lean operations approach CTPs that address particular supply challenges. Table 3-2 summarizes the three key components of our conceptualization from prior research.

Table 3-2. Supply challenges, LSM performance objectives and lean pillars

Dimension	Variable	Source
▪ Supply challenges	Cost	*Shin et al., 2000;*
	Limited suppliers	*Zsidisin and Ellram, 2001;*
	Logistics issues	*Chen et al., 2004;*
	On-time deliveries	*Melnyk et al., 2009.*
	Quality	
	Communication	
	Quantity issues	
	Supplier selection	
	Relationship with suppliers	
▪ LSM performance objectives	Productivity	*Cagliano et al., 2004;*
	Visibility	*Pozo et al., 2017;*
	Consistency	*Legenvre et al., 2020;*
	Learning	*Geyi* et al., *2020.*
	[Variability]	
▪ Lean pillars	Information Technology	*Jasti and Kodali, 2015;*
	Supplier management	*Soni and Kodali, 2016;*
	Elimination of waste	*Argiyantari et al., 2020;*
	Just-in-time deliveries	*Hasan et al., 2020*
	Logistics management	
	Top mgmt. commitment	
	Continuous improvement	

Previous research has attempted to cluster lean practices into bundles (Shah & Ward, 2003; Tortorella et al., 2017a) or lean pillars (Argiyantari et al., 2020; Hasan et al., 2020; Jasti & Kodali, 2015; Soni & Kodali, 2016). This paper refers to lean pillars, which represent specific lean-based CTPs, and allows for their applicability to the broader operational contexts, such as the supply chain, as well as facilitates analytical generalizability to our revised envisioning of LSM. For example, it is reasonable to view the lean pillar of information technology, which includes—but is not limited to—Industry 4.0 and Agriculture 4.0 technology advancements, including advanced robotics, the internet of things (IoT), e-procurement, drone technology, or blockchain as a solution to reduce operational waste, improve traceability, and leverage continuous improvement (Tatsis et al., 2006; De Clercq et al., 2018; Schmidt & Wagner, 2019).

Viewed from an intersectionist perspective, and to further highlight the practical relevance of our conceptual development, the supply challenge of cost may be contextually related to the LSM performance objective of productivity, which from a contingent standpoint, can be fulfilled through the use of lean pillars such as information technology (IT) or elimination of waste (Liu et al., 2013), and specifically by deploying related practice-based elements (e.g., IT or elimination of waste CTPs). Similarly, the supply challenge of quality might be contextually associated with the LSM performance objective of consistency, which can be addressed through deployment of the lean pillar of continuous improvement or supplier management (Zarei et al., 2011). However, in terms of contextual contingencies, there are business and operating contexts where a particular lean pillar can beneficially align with several LSM performance objectives in order to address multiple supply challenges. For example, IT, as a lean pillar used in the engineering industry, has proven critical to achieve, simultaneously, LSM performance objectives of flexibility, consistency, and productivity (Cagliano et al., 2004). Similarly, the same lean pillar in the food industry has enhanced productivity and visibility by providing improved traceability (Legenvre et al., 2020).

The extant scholarly literature has examined multiple supply challenges, for example, cost, limited suppliers, logistics issues, on-time deliveries, quality problems, lack of communication, quantity issues, supplier selection, relationship with suppliers, and so forth (Chen et al., 2004; Melnyk et al., 2009; Shin et al., 2000; Zsidisin & Ellram, 2001). To address these challenges, lean proponents highlight the generalized benefits for upstream and downstream supply partners when LSM is adopted. Toyota, Dell, and Boeing have achieved improved supplier responsiveness, inventory reductions, and increased cooperation from their LSM initiatives (Fields, 2006; Leitner,

2005; McIvor, 2001). However, the generalized application of LSM conceptualizations implicit in the extant literature requires further empirical scrutiny (cf. Jasti & Kodali, 2015). Given that this paper's intersectionist perspective is founded upon relevant supply challenges being aligned with lean pillars, LSM likely encompasses distinct elements whose constitution depends upon the specific context and contingency associations being investigated and managed. For example, Tortorella et al. (2017b) discussed how different supply chain factors impact LSM implementation efforts.

3.4 The Practice-Based View and LSM

Scholarly examination of LSM, as with the general study of lean management, commonly fails to leverage existing theoretical frameworks and arguments (Jasti & Kodali, 2015; Danese et al., 2018). To advance theorization for our revised envisioning conceptual development of LSM, we apply strategic insights from the practice-based view (PBV) (Bromiley & Rau, 2014), which in contrast to the resource-based view of the firm (or RBV, see Barney & Arikan (2001)), offers a more practically relevant explanation for the associations specified in this study. Compared with RBV tenets, PBV considers the leveraging of well-established and known practices, whether viewed broadly (e.g., adoption of lean pillars) or specifically (e.g., deployment of lean CTPs)—which are not protected with isolating mechanisms and are amenable to transfer across firms—as the basis for improving business performance. In our conceptual development, the deployment of lean pillars-based practices influences performance. PBV also claims that what differentiates firms in terms of achieving higher or lower performance is bounded rationality. Thus, despite the ready availability of lean pillars, firms may not be capable of identifying or using the most suitable lean pillars to address particular supply challenges. Therefore, the contextual contingent nature of our LSM conceptualization reflects the manifestation of this bounded rationality.

In addition, PBV strongly rejects the common approach found in the extant LSM literature that firms should use all their available practices to obtain desired benefits. Past studies (King et al., 2008; Simons & Zokaei, 2005) have identified that the adoption of lean pillars and implementation of lean CTPs in manufacturing processes with continuous operations may be problematic. For example, the use of pull replenishment systems or just-in-time practices may be detrimental to certain contexts: agri-food continuous processes require high utilization of capacity rates that usually tend to drive overproduction; therefore, lean pillars may force lower use of resources and negatively impact operational performance.

Therefore, we theorize that not all lean pillars-based CTPs are beneficial to address all supply challenges, but instead, firms should be contingently selective to maximize the effectiveness of their LSM choices. It is the contextual contingent association between supply challenges and LSM performance objectives that influences the selection of suitable lean pillars (Figure 3-1).

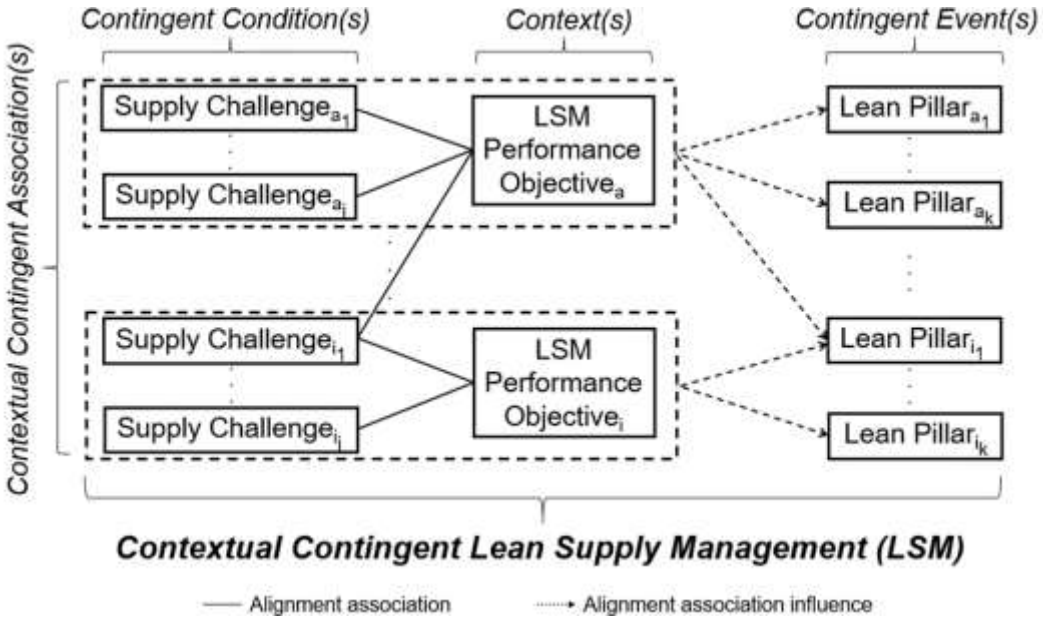


Figure 3-1. Contextual contingent conceptual framework of LSM

Further, given this contextual contingent association, PBV also supports our theorization that some lean pillars, if misaligned from a supply challenge and LSM performance objective influence standpoint, may harm performance. For example, Apple's initial inability to fulfill demand for the iPhone X was due to its suppliers' reliance on just-in-time (JIT) production (Mims, 2017). In this case, the application of a lean principle by a supplier proved to be unfavourable to respond to an unexpected surge in the initial demand by customers, specifically the decision to maintain low supply chain inventories was misaligned with the LSM performance objective of consistency, which requires on-time deliveries. Another illustration of misalignment occurred with Airbnb, which relies upon an outsourced supply arrangement connecting service suppliers (hosts) with service buyers (guests); however, the company struggled with the challenge of achieving consistent hospitality service and resorted to instituting standard work policies and practices, to the consternation of many of its partnering hosts (Benner, 2017). Essentially, the lean practice of standard work advocated by Airbnb, aimed to achieve one LSM performance objective

(consistency), had an initial negative impact on another LSM performance objective (productivity).

Finally, managerial preferences may influence the contextual contingent elements chosen and subsequently determine the most appropriate lean pillar to deploy to achieve the desired performance outcome. Corporate strategy will prioritize performance objectives and define the appropriate lean pillar to be leveraged.

Our LSM conceptual framework establishes that depending on the operating context (LSM performance objective), an operating contingency (supply challenge) may align with a single operating context (e.g., Supply Challenge$_{a1}$ is only associated with fulfilment of LSM Performance Objective$_{a}$) while another operating contingency may align with multiple operating contexts (e.g., Supply Challenge$_{i1}$ is also associated with fulfilment of LSM Performance Objective$_{a}$).

In addition, depending on the contextual contingent association, a contextual contingent choice (Lean Pillar) may align with a single contextual contingent association (e.g., use of Lean Pillar$_{a1}$ is only influenced by LSM Performance Objective$_{a}$ | Supply Challenge$_{a1}$) while another contextual contingent choice may align with multiple contextual contingent associations (e.g., use of Lean Pillar$_{i1}$ is also influenced by LSM Performance Objective$_{a}$ | Supply Challenge$_{a1}$).

The implication of our conceptual framework suggests that LSM is characterized by a contextual contingent approach that requires adaptations and critical selection of lean elements to maximize their efficiency. In other words, LSM is not common to every context (i.e., company, industry). Firms should identify the specific supply challenges associated with the particular LSM performance objective and identify the most suitable lean pillars to address the supply challenges based on the LSM performance objective chosen. Following this logic, we suggest that the selection of specific lean pillars contingent on the LSM performance objective anticipated will enable managers to effectively manage specific supply challenges.

It should be clarified, however, that lean pillars are broad practice categories, not specific practice-related CTPs, and at the manufacturing (service) operation, it is those specific practice-based CTPs falling under specific broad categories that are the basis for generating lean-based benefits. Explicitly, in our framework (see Figure 3-1) Lean Pillar a_1, for example, could be operationalized in terms of CTP a_{1_1} to CTP a_{1_q}, while Lean Pillar a_i could be operationalized in terms of CTP a_{i_1} to CTP a_{i_r}. As noted previously, the aligning LSM performance objectives to be achieved include increasing supply-related productivity, visibility, consistency, and learning,

in addition to decreasing variability. Thus, based on our LSM conceptualization and theorization as diagramed in Figure 3-1, we offer the following revised envisioning conceptual definition:

Lean supply management entails the adoption of suitable lean pillars—and deployment of related lean concepts, tools, and practices—to achieve prioritized/pursued productivity, visibility, consistency, variability-reduction, or learning lean performance objective (s) while addressing emergent supply challenge(s).

The functionality focus of the lean pillars and related lean CTPs is the elimination of waste and its sources from operational systems (e.g., supply network) in order to improve (1) the productivity of throughput flows and (2) the value-add ratio of all work activities on an ongoing basis.

The definition and the model offered in Figure 3-1 indicate a sequential approach to view LSM in the following terms: the alignment association between supply challenge(s) (i.e., contingent condition) with the performance objective (i.e., context) determines an alignment association influence on the adoption of suitable lean pillars (i.e., contingent event). Thus, in any business context there may be different combination sets of supply challenges, LSM performance objectives pursued, and lean pillars, depending on the operating context examined or managed. Heeding Jasti and Kodali's (2015) call for more empirical research that examines the utility of LSM conceptual models, part of any framework's/model's utility is the demonstration of how it is to be applied or implemented. The empirical validation that follows is intended to demonstrate the derivation of our novel conceptualizations' contextual contingent elements.

3.5 Research Methods

To highlight the practical relevance of our novel LSM conceptualization's contextual contingent framing, we empirically validate its implementation within the context of the Canadian agri-food sector. Recent reports have identified excessive waste generation resulting from inefficient and ineffective processes in the agri-food sector (Weber, 2019). However, scholarly examination of lean management in the agri-food sector is limited, with those published on the topic being more exploratory and descriptive in nature (see Perez et al., 2010; Costa et al., 2018). As such, the need exists for greater scholarly theorization on and empirical study of agri-food focused lean management (Psomas et al., 2018), especially because this sector favours the implementation of a lean operations approach (Melin & Barth, 2018) that incorporates a contextual contingent perspective (Costa et al., 2018).

3.5.1 Delphi Study Design

The Delphi method, or more specifically, the Delphi survey approach, was utilized to validate the practical relevance of our novel LSM conceptualization given the general ambiguity around and lack of consensus about LSM (Iqbal & Pippon-Young, 2009). Under the Delphi approach, a sequence of surveys are administered, where the first round entails exploratory focused querying of a panel of experts and the subsequent rounds are more evaluative in nature based on a refined understanding of the experts' feedback obtained previously in order to arrive at consensus or near-consensus understanding of the phenomenon studied (Fletcher & Marchildon, 2014). We followed the Delphi approach presented by Hallowell and Gambatese (2010) to adopt specifically the stages/steps diagramed in Figure 3-2.

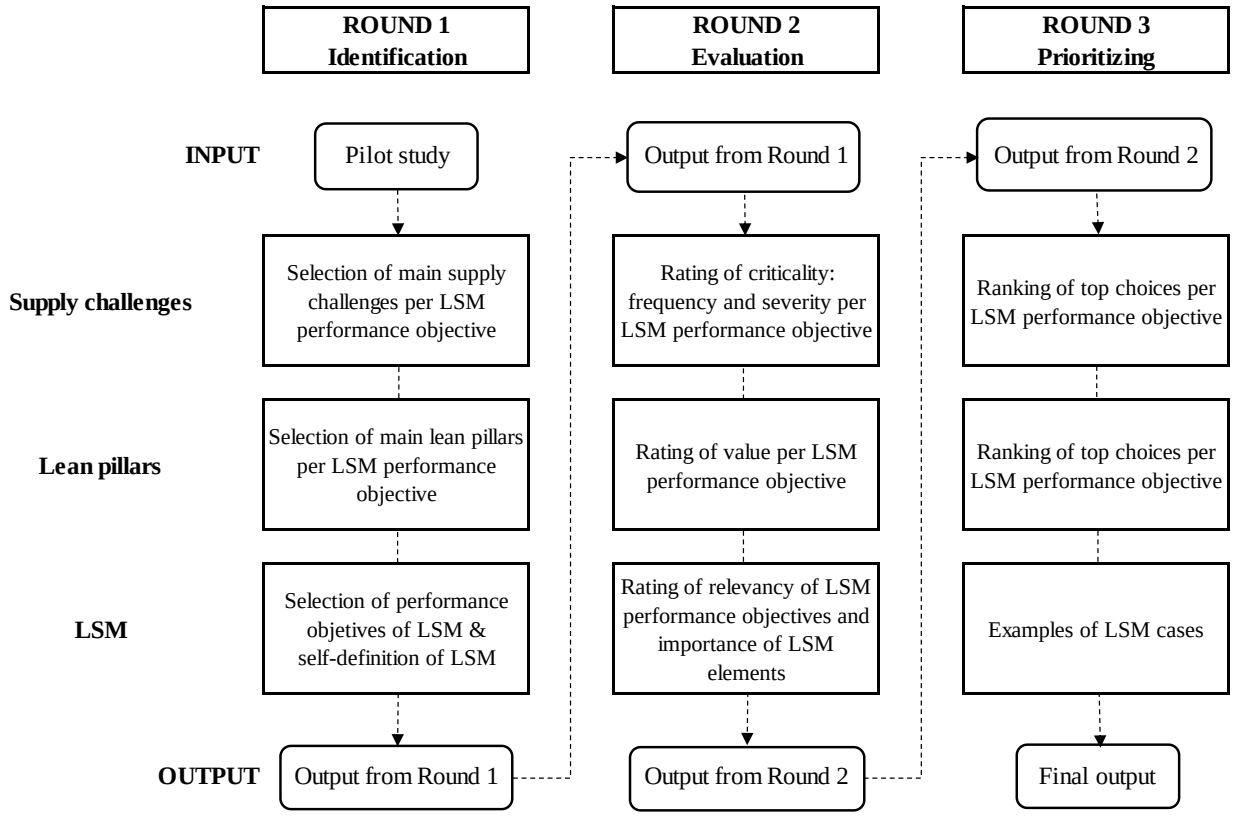


Figure 3-2. Delphi survey data collection process

Research guidelines to enhance Delphi survey rigour were carefully established following past literature (Hasson et al., 2000; Iqbal and Pippon-Young, 2009; Toronto, 2017), namely those related to anonymity (Fletcher & Marchildon, 2014), obtaining experts' input, and iteratively generating consensus. In addition, to make this study methodologically more robust, four strategies were used to guarantee trustworthiness (reliability-validity term for qualitative studies): 1) credibility: participants' reviews and continuous feedback; 2) dependability: inclusion of a diverse panel of representative experts; 3) confirmability: detailed description of our procedures; and 4) transferability: verification of applicability of our findings (see next chapter) (Hasson & Keeney, 2011).

3.5.2 Selection of Experts

While no specific rules exist around the definition of the specific number of panel members to employ or their expert profiles, we heeded the guidance of Keeney et al. (2006), who suggested that common sense and practicalities should influence the numbers and profiles of experts, contingent on the study design. To select our panel of experts, we followed the guidelines presented by Okoli and Pawlowski (2004), with slight simplifications, such as excluding sub-panels and not ranking experts based on their qualifications.

The initial sampling frame of Delphi panel experts consisted of 800 agri-food sector practitioners with at least three years of experience in lean implementation projects (cf. Tortorella et al., 2017b), who were identified as a varied panel with different perspectives to enhance credibility and dependability from multiple sources, including agri-food associations, private companies, government agencies, and consulting firms. These practitioners were sent an invitation via email and social media to participate in the study. Out of the 800 experts invited to participate, 179 (22%) expressed initial interest in contributing to this Delphi study. Based on follow-up discussions, that clarified definitions and expectations, some interested participants were excluded for not fitting the sampling frame (i.e., unreachable or unwilling to collaborate) and a final list of 76 potential experts was derived. The final numbers of contributing panel experts for our three rounds of Delphi survey administration were, respectively, 43, 39 and 36 participants. Only panellists who cooperated in each round remained in the study. Continuous communication with participants guaranteed their high involvement and full commitment, which resulted in low attrition rates between rounds—9% and 8%—similar to values observed in previous studies (Fletcher & Marchildon, 2014; Toronto, 2017).

The experts' profiles of the final panel indicate a generally even distribution among Canadian agri-food sectors (animal 23%, grains 21%, dairy 23%, horticulture 21%, other 12%), similar to the initial sampling frame, which suggests that no single agri-food sector overly biases the representativeness of the empirical findings. Information about the composition of the panel is provided in Table 3-3.

Table 3-3. Composition of the Delphi panel (by position)

Round	*Respondents*						
	CEO	Plant and Production	Supply Chain and Operations	Purchasing	Quality	Consulting	**Total**
Round 1	13	6	7	8	3	6	**43**
Round 2	12	5	6	7	3	6	**39**
Round 3	11	5	6	6	3	5	**36**
Total	36	16	19	21	9	17	**118**

3.5.3 Delphi Survey Data Collection

Before administering the Delphi surveys to participating panel experts, we conducted a pilot test for every round to verify the substantive precision and quality of the designed survey instruments (Richardson et al., 2016). Pilot testing of each round used a protected online survey platform (Qualtrics) and involved a selected team of Canadian scholars and international supply chain practitioners (from Canada, US, Mexico, and Ecuador), who assessed the clarity of the instrument. Once the pilot was successfully completed, the survey was implemented over three rounds during a period of four months until insights saturation was obtained without diminishing response rates and panelists' enthusiasm. Appendix 3-1 provides a summary of the survey questions used in the three rounds.

The structure of the first round Delphi survey consisted of three main sections. First, the panel of experts were asked to identify the main supply challenges specifically faced by their firms. The panelists were offered several options to choose from in relation to each LSM performance objective. Second, the panelists were asked to identify relevant lean pillars to address specific supply challenges associated with each LSM performance objective. Finally, the panel of experts were asked to provide their own perspective-based understandings of the concept of LSM.

Content analysis was used to assess ratings provided by the panelists in round 1. This analysis helped guide development of the survey instrument used in round 2, as recommended by Fletcher and Marchildon (2014). Round 2 data collection asked respondents to rate the criticality of identified supply challenges in terms of their frequency and severity, as well as the value placed on specific lean pillars, using a 5-point Likert scale (Melnyk et al., 2009). Additionally, respondents were requested to evaluate the relevance of elements of our conceptual definition of LSM.

For the final round, participants received the summary findings from the second round, which provided summarized data with the aggregated means of responses from round 2 in graphical format (e.g., bar charts) for them to review and reflect on their personal answers. Respondents were requested to prioritize their selection of critical supply challenges and preferred lean pillars using an ordinal scale to refine their understanding of LSM and its associations. The survey was divided into two sections with the first focused on selecting the three most pressing supply challenges associated with LSM performance objectives and the second requiring the ranking of the top three lean pillars relative to the LSM performance objectives.

3.6 Results

We followed the guideline provided by Hasson et al. (2000) to report the Delphi survey results emanating from each round separately. This sequenced reporting allows us to illustrate the effectiveness of our systematic approach in revealing more refined findings and nuanced insights emanating from successive rounds of data collection (Landeta, 2006). For round 1 and round 3, multiple tests of independence (Chi-square) were performed to examine the null hypothesis of no association between supply challenges (lean pillars) and LSM performance objectives. For round 2, one-way ANOVA tests were used to test for differences among LSM performance objectives means and among LSM elements, which were complemented with the Tukey post-hoc procedure to analyze pairwise comparisons of means differences.

3.6.1 First Round Results

The first-round results are reported in Tables 3-4 and 3-5. Table 3-4 quantifies the nature of LSM problems (i.e., the associations between supply challenges and LSM performance objectives) while Table 3-5 quantifies the association between lean pillars and LSM performance objectives. The lean pillars selected for each performance objective were chosen with respect to previously identified supply challenge(s) – LSM performance objective association. These tables illustrate, in

brief, the following empirical insights. First, the distributions of supply challenges and lean pillars do not occur at random in relation to the specified LSM performance objectives. Second, from a contextual contingent standpoint, each LSM performance objective was linked in distinct ways to specific supply challenges and lean pillars, such that some supply challenges and lean pillars showed both unique and joint relationships with particular LSM performance objectives. Third, some supply challenges were deemed less relevant (e.g., safety, returns, ordering challenges, and food damage) and were therefore removed from the subsequent rounds of the Delphi survey administration.

Table 3-4. Supply challenges relative to LSM performance objectives: Round 1

LSM Performance objectives	*Supply challenges*								
	Cost	Limited suppliers	Logistics issues	On-time deliveries	Quality	Communication	Quantity issues	Supplier selection	Relationship with suppliers
Productivity	29(16)[a]	23(13)	28(15)	30(16)	25(14)	13(7)	14(8)	10(5)	11(6)
Visibility	20(13)	19(12)	29(19)	25(16)	18(12)	17(11)	13(8)	7(4)	8(5)
Consistency	16(12)	19(15)	13(10)	18(14)	21(16)	9(7)	18(14)	11(8)	6(5)
Learning	8(7)	18(16)	10(9)	6(5)	10(9)	23(21)	2(2)	12(11)	21(19)
[Variability]	20(14)	18(13)	17(12)	18(13)	25(17)	10(7)	15(10)	12(8)	8(6)

[a] Frequency (n, (row %)). Row % may not add up to 100 due to rounding.

Inferential categorical data statistical analyses were conducted to examine if there was an association between supply challenges and LSM performance objectives, and between lean pillars and LSM performance objectives. The null hypothesis for these statistical analyses is that the selection of supply challenges (lean pillars) is distributed at random with respect to the LSM performance objectives.

To examine the contextual contingent general association between supply challenges and LSM performance objectives (see Table 3-4), we computed the Chi-square statistic, which indicated a statistically significant association $\chi^2\ (32) = 80.24,\ p < 0.001$ and allows us to reject the null hypothesis. Specifically, cost, limited suppliers, logistics issues, on-time deliveries, and quality were consistently the most frequently selected challenges across the five LSM performance objectives. Cramer's V (φ_c) was calculated to assess the strength of this relationship at $\varphi_c = 0.17$, which corresponds to a small-size effect.

To examine the general association between lean pillars and LSM performance objectives (see Table 3-5), the $\chi^2\ (24) = 32.76,\ p = 0.11$ finding indicates, contrary to our intuition, a failure to reject the null hypothesis. The generally uniform selection of lean pillars showing common

patterns of frequencies among two identified groupings—(1) productivity, visibility, and consistency (e.g., relatively lower for elimination of waste and JIT deliveries relative to the other five pillars) and (2) learning and variability-reduction (e.g., relatively lower for elimination of waste, JIT delivery, and logistics management relative to the other four pillars)—likely explains this sample's non-significant χ^2. However, the next round of Delphi survey results illustrates how the study's panel of experts relates these two LSM conceptualization elements when the contingent association was assessed using an alternative approach.

Table 3-5. Lean pillars relative to LSM performance objectives: Round 1

LSM Performance objectives	*Lean pillars*						
	Information Technology	Supplier management	Elimination of waste	Just-in-time deliveries	Logistics management	Top mgmt. commitment	Continuous improvement
Productivity	27(16)[a]	29(17)	22(13)	20(12)	27(16)	24(14)	24(14)
Visibility	31(22)	28(20)	12(9)	11(8)	17(12)	24(17)	17(12)
Consistency	23(16)	32(22)	15(10)	10(7)	18(13)	22(15)	24(17)
Learning	27(19)	31(22)	7(5)	5(3)	11(8)	36(25)	27(19)
[Variability]	26(18)	32(23)	17(12)	8(6)	12(8)	23(16)	24(17)

[a] Frequency (n, (row %)). Row % may not add up to 100 due to rounding.

Regarding the clarification of an agri-food contextual understanding of LSM, the Delphi survey panel of experts generally agreed on the practical importance for considering all the LSM performance objectives other than for visibility. Table 3-6 depicts the constitutive elements of LSM specific to the Canadian agri-food context as selected by the panel of experts. The relatively low selection frequency of visibility resulted in its elimination from the studied performance objectives set examined in subsequent Delphi survey rounds.

Table 3-6. Conceptual understanding of main LSM performance objectives: Round 1

Performance objectives	Frequency	Percent
Productivity	31	25%
Consistency	31	25%
[Variability]	26	21%
Learning	21	17%
Visibility	15	12%

3.6.2 Second Round Results

The Delphi survey second round results related to supply challenges and lean pillars are shown in Figure 3-3 and Table 3-7. When tasked with further clarifying the associated differences between lean supply challenges and LSM performance objectives, Delphi experts' classifications of the frequency and severity of supply challenges revealed intriguing contextual distinctions.

First, based upon the median-split frequency and severity matrix portrayed in Figure 3-3, cost, limited suppliers, and on-time delivery were major challenges for key informants, especially when considered in terms of the productivity and consistency LSM performance objectives. Second, quality and quantity issues—when considered in terms of the productivity, consistency, and variability-reduction LSM performance objectives—were next identified as generally being critical (i.e., being, or on the cusp of being, infrequent but severe challenges). Third, except for three other supply challenges-LSM performance objectives associations (i.e., logistics issues-productivity, cost-variability, and communications-learning), all other supply challenges and LSM performance objectives associations were deemed to be relatively minor challenges. Collectively, these findings suggest that when managerial attention and effort are required to address supply challenges, not all problems are equally critical. Indeed, Figure 3-3 highlights that the majority of supply challenges identified relative to the productivity and consistency LSM performance objectives were deemed to be more severe in their impact.

Further, when tasked with clarifying the alignment between lean pillars and LSM performance objectives, panelists' classifications of the perceived value of lean pillars solutions (on a 1-irrelevant to 5-critical scale) revealed intriguing contingent insights (Table 3-7). Specifically, for each of the four LSM performance objectives, lean pillars-based practices associated with continuous improvement were identified as being most valuable, while supplier management related lean pillars-based practices were next identified as being generally valuable. The value of other commonly identified lean pillars solutions varied greatly depending on the particular LSM performance objective focused on (e.g., information technology, top management commitment, elimination of waste), which empirically validates our supposition that the selection of suitable lean pillars solutions is contingent on the LSM performance objective pursued.

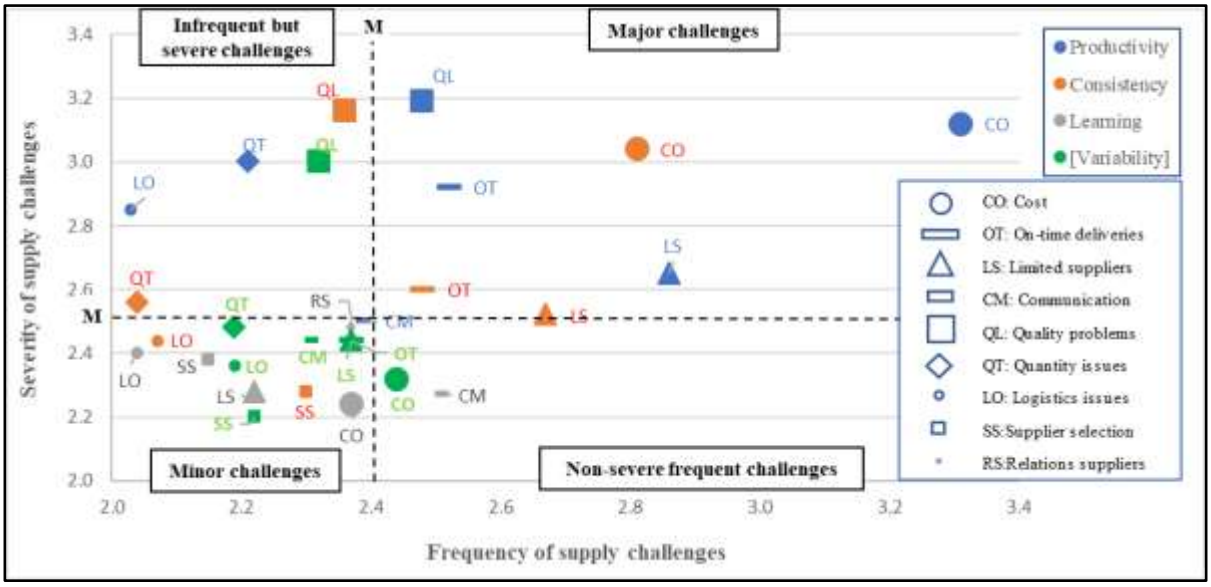


Figure 3-3. Frequency-severity matrix of supply challenges by LSM performance objectives: Round 2

Considering that panelists exclusively focused on the value of lean pillars for each performance objective, disregarding in this section the role of supply challenges, rating results from Table 3-7 were used in conjunction with frequencies derived from Table 3-5 to pinpoint specific beneficial lean pillars to pursue (e.g., for productivity: supplier management; for consistency: continuous improvement; for learning: top management commitment; and for variability-reduction: supplier management). Empty cells appearing in Table 3-7 represent combinations that were excluded from the instrument based upon low frequency selections in the previous round.

Table 3-7. Value of lean pillars relative to LSM performance objectives: Round 2

Performance objectives	*Lean pillars*						
	Information Technology	Supplier management	Elimination of waste	Just-in-time deliveries	Logistics management	Top mgmt. commitment	Continuous improvement
Productivity	3.8(1.1)[a]	3.9(1.1)	3.7(1.0)	3.4(0.9)	3.6(1.1)	3.6(1.2)	3.9(1.1)
Consistency	3.4(1.1)	3.8(0.9)			3.6(0.9)	3.5(1.2)	3.9(0.9)
Learning	3.8(1.0)	3.8(1.1)				3.8(1.2)	3.9(1.1)
[Variability]	3.5(1.1)	3.8(0.9)	3.4(1.1)			3.4(1.1)	3.9(1.0)

[a] Mean (Standard Deviation)

Finally, in terms of evaluating the relevance of each performance objective in our conceptual definition of LSM, participants concurred on high levels of importance of every entry (Table 3-8),

which was also observed in the results obtained from their assessment of different elements extracted, using qualitative content analysis to identify the main themes from their LSM self-definitions in the previous round (Table 3-9). A one-way between-subjects ANOVA was performed to compare the mean scores for each table. Prior to the analysis, the Levene test was used to verify that no serious violation of homogeneity of variance across groups was present. In both cases, no significant violation was found; for LSM performance objectives: $F(3,120) = 0.78$, $p = 0.51$ and for LSM elements: $F(7,240) = 1.58$, $p = 0.14$. The one-way ANOVA test for comparison of relevancy of LSM performance objectives means (Table 3-8) did not detect any statistically significant differences: $F(3,120) = 0.57$, $p = 0.63$. On the contrary, the one-way ANOVA for comparison of means for LSM definitional elements (Table 3-9) indicated that there is a statistically significant difference in means in terms of the relative importance of LSM elements: $F(7,240) = 4.27$, $p < 0.001$. This corresponded to an effect size of $\eta^2 = 0.11$, a small effect. In addition, all possible pairwise comparisons using the Tukey HSD test were performed at a $p < 0.05$ significance level, and it was found that low inventories ($M = 3.81$) scored significantly lower on importance for LSM than cost reduction ($M = 4.68$) and consistent quality ($M = 4.71$). The importance means of the rest of the elements were not found to be significantly different. Overall, consistent quality and cost reduction were selected as the most important LSM elements.

Table 3-8. Relevancy of LSM performance objectives: Round 2

Performance objectives	Minimum	Maximum	Mean	SD	Variance
Productivity	2	5	4.29	0.84	0.84
Consistency	1	5	4.21	0.94	0.94
[Variability]	1	5	4.14	1.03	1.03
Learning	1	5	3.96	0.87	0.87

Table 3-9. Importance of LSM elements based on practice: Round 2

Elements of LSM	Minimum	Maximum	Mean	SD	Variance
Consistent quality	3	5	4.71	0.58	0.34
Cost reduction	3	5	4.68	0.64	0.41
Elimination of non-value-added activities	2	5	4.39	0.79	0.62
Streamlined flow	1	5	4.29	0.85	0.72
Elimination of waste	3	5	4.26	0.76	0.58
Integrated relationship with suppliers	1	5	4.19	0.93	0.87
Relationship with few suppliers	2	5	4.10	0.78	0.60
Low inventories	2	5	3.81	0.90	0.80

3.6.3 Third Round Results

The third-round results are depicted in Tables 3-10 and 3-11. In this round, each respondent was prompted to prioritize their selection of critical supply challenges and preferred lean pillars using an ordinal scale (top-three choices) for each LSM performance objective. For comparative purposes, the results (absolute frequencies) were tabulated and converted to categorical data (weighted frequencies) by the use of ranking factors that were multiplied by absolute frequencies. Entries in these tables, therefore, represent weighted frequencies of each combination selected as one of the top three choices. Empty cells indicate combinations that were not preferred by participants. No violation of the chi-square test assumptions occurred; the number of expected countless cells was below the recommended threshold. Compared to results obtained in the first round, we observe a more fragmented and specific distribution of supply challenges and lean pillars, reinforcing our conjecture of unique alignment associations with LSM performance objectives.

Table 3-10. Supply challenges per LSM performance objective: Round 3

LSM Performance objectives	*Supply challenges*								
	Cost	Limited suppliers	Logistics issues	On-time deliveries	Quality	Communication	Quantity issues	Supplier selection	Relationship with suppliers
Productivity	49(22)[a]	40(18)	28(13)	25(11)	40(18)	23(10)	17(8)		
Consistency	39(19)	29(14)	24(12)	22(11)	56(27)		15(7)	20(10)	
Learning	25(12)	35(16)	22(10)			58(27)		22(10)	54(25)
[Variability]	26(12)	35(16)	20(9)	20(9)	59(27)	22(10)	23(11)	11(5)	

[a] Frequency (n, (row %)). Row % may not add up to 100 due to rounding.

Table 3-11. Lean pillars per LSM performance objective: Round 3

LSM Performance objectives	*Lean pillars*						
	Information Technology	Supplier management	Elimination of waste	Just-in-time deliveries	Logistics management	Top mgmt. commitment	Continuous improvement
Productivity	28(13)[a]	51(24)	22(10)	8(4)	15(7)	25(12)	67(31)
Consistency	35(16)	60(28)			21(10)	35(16)	65(30)
Learning	49(23)	51(24)				56(26)	60(28)
[Variability]	33(15)	61(28)	25(12)			26(12)	71(33)

[a] Frequency (n, (row %)). Row % may not add up to 100 due to rounding.

Similar to the first-round analysis, we explored the contextual contingent general association between supply challenges and LSM performance objectives by using the Chi-square test of

independence. This analysis of the Table 3-10 data revealed a statistically significant association $\chi^2(27) = 401.88, p < 0.001$. The strength of the relationship using Cramer's V was $\varphi_c = 0.39$, a medium-size effect. A statistically significant association was also observed regarding the general association between lean pillars and LSM performance objectives data (see Table 3-11), given $\chi^2(18) = 136.15, p < 0.001$ and $\varphi_c = 0.23$.

Such results allowed us to reject the null hypothesis of a random association between supply challenges (lean pillars) and LSM performance objectives; therefore, we conclude that the association (selection) of supply challenges (lean pillars) in response to LSM performance objectives is not distributed at random, which reinforces our LSM contextual contingent framework (i.e., specific contingent associations do exist in each particular context).

The third-round findings related to the alignment of specific Canadian agri-food sector supply challenges with distinct lean pillars given associated LSM performance objectives, using a 15% or more selection level in Tables 3-10 and 3-11, are shown in the descriptive model in Figure 3-4.

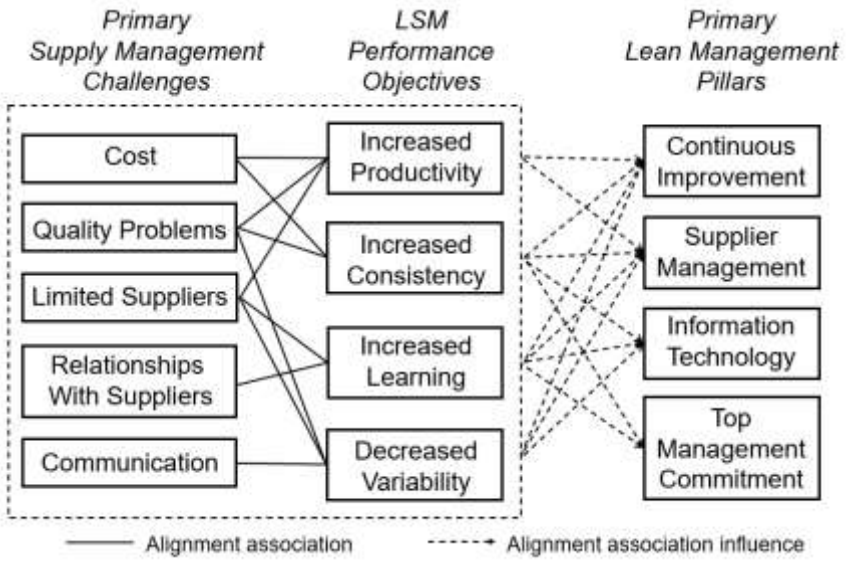


Figure 3-4. Descriptive model of LSM for the Canadian agri-food sector

As noted earlier, the third-round panelists were presented with our revised envisioning conceptual definition of LSM as well as second round findings on the contextual criticality of supply challenges and the contingent value of lean pillars. The panelists were tasked with prioritizing—for each of the four remaining LSM performance objectives—the top three supply challenges faced, and the top three lean pillars pursued. Figure 3-4 confirms that after three rounds

of querying, the criticality of supply challenges contextually differs depending on which LSM performance objective is focused upon.

Further, other than for continuous improvement, which was most highly prioritized by the panelists as noted in Figure 3-4, the relative perceived value of specific lean pillars solutions was contingent upon which LSM performance objective is pursued. Overall, these final round Delphi survey findings empirically validate, as conceptualized and theorized in the framework found in Figure 3-1, the importance of and need for viewing LSM in terms of contextual contingent alignments between supply challenges, LSM performance objectives, and lean pillars.

3.7 Discussion of Results

Much like Cohen et al. (2018), who used a survey to generate a practice-informed understanding of global production sourcing decisions, we employed a Delphi survey to further our exploratory understanding of the practical relevance of our novel conceptualization of LSM. We found contextually specific supply challenges firms face in fulfilling their LSM performance goals and objectives. Our results, when viewed along with the revised envisioning LSM conceptualization and theorization observations and arguments offered earlier, provide several noteworthy scholarly and managerial understanding insights.

First, authors of previous research studies implicitly argue that their respective LSM conceptual frameworks are generalizable to any operating context. However, our findings illustrate that LSM, as an approach, is contextually specific given our identified contextual association of supply challenges with LSM performance objectives and contingent alignment of lean pillars with those associations. In conceptualizing LSM, our findings indicate that the business context and operating contingencies matter. Our specific Canadian agri-food sector finding that LSM is a contextual phenomenon that depends on the LSM performance objectives pursued complements findings offered by Costa et al. (2018), who demonstrated that the agri-food industry's characteristics (i.e., context) require the usage of specific lean-based tools and practices (i.e., contingency). Hence, viewed as a managerial responsibility, not all LSM endeavours are the same given that managers functioning in distinct business contexts and facing distinct operating contingencies will view, relative to LSM performance objectives, supply challenges and lean pillars in different ways. Notwithstanding this finding, we believe our revised envisioning conceptual definition of LSM is generalizable.

Second, our novel conceptual development of LSM depicts the alignment associations and alignment influences between supply challenges, LSM performance objectives, and lean pillars. Those specific alignment associations and alignment influences govern the selection of suitable (i.e., contextual contingent) lean pillars which, per the PBV, are the basis for influencing—either positively or negatively—business-level performance (e.g., strategic, operational, marketplace, financial). Our empirical validation framed the LSM performance objectives-based alignment influence selection of lean pillars and associated practices in terms of perceived value, so the deployment of contextual contingent selected lean "solutions" to address associated supply challenges is likely to lead to beneficial business performance outcomes. In contrast, and consistent with PBV arguments, firms that employ lean pillars without due consideration of the alignment association between supply challenges and LSM performance objectives will likely be constrained in realizing intended beneficial business performance outcomes. Our empirical findings illustrate how the selection of the most suitable lean pillars aimed to achieve specific LSM performance objectives to target specific supply challenges supports the principles of PBV and allows the appropriate application of PBV as a solid foundation for our new revised envisioning of LSM.

Third, our revised envisioning conceptualization and theorization on LSM is predicated on a view of lean being a managerial approach and not a functioning state or an objective. As such, our findings provide processual guidance to managers tasked with the challenge of identifying the most appropriate lean pillars to adopt (and lean CTPs to deploy) to pursue LSM productivity, consistency, learning, and variability-reduction performance objectives. The selection of these specific LSM performance objectives, as well as supply challenges and lean pillars, was idiosyncratically determined based upon the evolving conceptual understanding of the authors and the experienced empirical insights of the Canadian agri-food panel of experts. In the end, the contextual contingent underpinning of the LSM conceptualization and definition offered in this research is construct specification-wise robust, though individual elements constitutive-wise are adaptable to validly reflect the business sector and operational requirement reality. As such, our PBV theorization on LSM allows for the study of a greater array of supply challenges, LSM performance objectives, and lean pillars than what was considered in this reported empirical validation. For example, the recent coronavirus pandemic has highlighted the potential throughput constraints in protein processors' operational systems resulting from workforce absenteeism and illness (Maher et al., 2020). When that COVID-19 throughput challenge is aligned with the

additional LSM performance objective of increased safety, that contextual contingent association will likely influence agri-food processors' deployment or increased usage of lean safety CTPs such as 5S, standardized work, visual management, and kaizen events.

Results from the Delphi survey aligned well with our revised definition of LSM, with high rates of agreement in terms of our selected LSM performance objectives, especially in the areas of productivity and consistency. Responses showed how different lean pillars were related to diverse LSM performance objectives to target specific supply challenges. In addition, our definition benefits the advancement of scholarly theorization and managerial understanding of LSM from the introduction of a new lean contextual contingent approach that differentiates LSM comprehension from past studies. Previous research efforts have mainly focused only on structural elements of LSM (Lamming, 1996; Vitasek et al., 2005; Moyano-Fuentes & Sacristán-Díaz, 2012) or on transactional features of LSM (Adamides et al., 2008; Singh & Pandey, 2015), or have seen LSM exclusively as an optimization strategy (Afonso & Cabrita, 2015; Nimeh et al., 2018). In contrast, our definition captures the core nature of LSM by incorporating which critical elements constitute LSM, why they should be used, and when they need to be applied from a scholarly point of view, and simultaneously by enabling practitioners to make more appropriate decisions to select the most suitable lean pillars when implementing LSM, depending on the context where managers operate.

3.8 Conclusions

To achieve our main research objective—which was to offer a revised envisioning conceptualization, theorization, and definition of LSM and to address our empirical validation research question (i.e., what constitutes LSM in the Canadian agri-food sector)—we commenced with a thorough review of the scholarly literature, including those general focused and those agri-food focused, to highlight the strengths and shortcomings of previous LSM frameworks and definitions. Based on insights from PBV, which is rooted in the use of suitably selected imitable business practices to achieve business performance outcomes, we introduced a novel perspective to conceptualizing and defining LSM that is based upon contextual contingent associations between supply challenges, LSM performance objectives, and lean pillars. Given that purchasing and supply management is multidisciplinary in nature (Wynstra et al., 2019), our LSM conceptual development inherently views the lean approach as a transformational operations management bridge to relevant physical, contractual, and relational considerations critical to supply chain

management (cf. Figure 1 in Ellram et al., 2020). We then validated the practical relevance of our LSM revised envisioning through the reporting of a Delphi survey-based study of LSM efforts in the Canadian agri-food sector.

The general implications from this study, in terms of scholarly and managerial contributions, are two-fold. First, this research has advanced a novel conceptualization and theorization on the topic of lean supply management that, given its contextual contingent underpinning, should help to reorient future scholarly investigations. Second, given the specific empirical context utilized to validate this novel LSM conceptualization, the insights derived from the reported Delphi survey should prescriptively aid Canadian (and beyond) agri-food sector practitioners in the selection of suitable lean pillars to address their most critical supply challenges while enabling fulfillment of strategically and operationally important LSM performance objectives.

Like all research, this study has its limitations. For example, the inferential statistics adopted assumed that the different options in the contingency tables were mutually exclusive for the utilization of the Chi-square test of independence. Additionally, this research does not comparatively demonstrate the descriptive, explanatory, or predictive superiority of our revised envisioning of LSM given that we do not explicitly investigate the pragmatic veracity of existing conceptual frameworks or definitions. Instead, building on insights derived from some of those conceptual frameworks, it was our scholarly intent to specify a more analytically generalizable structure to relate important yet overarching LSM considerations. Further, the focused empirical validation of the practical relevance of our LSM conceptualization may limit the generalizability of the reported descriptive findings. Future research may explore the conceptual framework's application to different business and operating contexts in order to highlight both the analytically robust and inferentially adaptive elements of our contextual contingent conceptualization of LSM. Additionally, further empirical exploration is necessary to assess the proposed alignment associations and alignment influences on performance.

CHAPTER 4

4. Lean Supply Management: Multiple case studies in the Canadian agri-food sector (Essay 3)

4.1 General Introduction

The Canadian agri-food industry has been an important economic force for the country; however, its global competitiveness has been impacted by multiple supply challenges in the last decade (Sparling et al., 2014). The application of LSM principles in this sector may be beneficial to achieve specific performance objectives and address those supply challenges. However, there has been limited research about the implementation of LSM in the agri-food sector, and most articles have focused on lean production or lean manufacturing within the boundaries of the plant (Perez et al., 2010). Possible misconceptions and lack of knowledge about implementation issues may have prevented firms from further exploiting the capabilities of lean, despite the potential benefits to be achieved (Melin & Barth, 2018); therefore, further research is needed.

To fill this gap, this study examines the application of LSM in the Canadian agri-food sector, specifically, how and why lean concepts, tools, and practices (CTPs) are deployed by Canadian agri-food processors to address the challenges they face in fulfilling their supply requirements. The central part of this research explores how these firms determine the most suitable lean solutions when facing supply challenges in pursuit of specific performance objectives by using a contextual contingent framing (Naranjo et al., 2020). By leveraging OM practice contingency research (OM PCR) proposed by Sousa and Voss (2008), this paper examines the alignment association between one type of operational context (performance objective pursued) with a contingency condition that may arise (supply challenge) and the alignment association influence on a contingency event (selection of lean CTPs) needed to address it. To guide the empirical exploration of this contextual contingent framing and to explain the use of LSM in this particular Canadian industry, two research questions were defined:

1) How is the LSM approach being utilized by Canadian agri-food processors to address supply challenges?
2) Why is the LSM approach being utilized by Canadian agri-food processors to address supply challenges?

To examine these two research questions, this descriptive exploratory research presents the analysis of multiple case studies, which were founded on a preliminary contextual contingent framework defined by Naranjo et al. (2020) that guided the research design (Eisenhardt, 1989; Rowley, 2002), and it is aimed towards the contribution of "theory elaboration" (Bluhm et al., 2011) because its findings are derived from some previous conceptual ideas and a pre-existing model.

The main contributions of this paper are twofold: 1) the description of the use of lean CTPs by Canadian agri-food processors and the identification of common patterns across multiple cases and 2) the empirical exploration of LSM in the agri-food sector to better understand the construct of LSM and how its elements are associated. This paper is organized as follows: Section 2 presents the literature review; section 3 shows the methodology used in terms of research design, data collection, and analysis; sections 4 and 5 present the results and discussion; section 6 explains the limitations; and finally, section 7 offers the conclusions of this study.

4.2 Literature Review of LSM in the Canadian agri-food sector

This section is divided into three main subsections: (1) an overview of the Canadian agri-food industry, (2) lean in the agri-food sector, and (3) LSM as a contextual contingent approach.

4.2.1 Overview of the Canadian agri-food sector

The Canadian food manufacturing sector has been the largest manufacturing employer in Canada and second by revenue for the last decade (Sparling et al., 2014). It is characterized by the presence of global head offices and increasing foreign ownership of food processing, and the major subsectors are the following: grains (and oilseeds), horticulture, livestock, dairy, and poultry (CAPI (Canadian Agri-food Policy Institute), 2016; Sparling & Thompson, 2011).

This industry has shown low variability regarding revenue and high resilience to external crises. Nevertheless, since the last decade, the sector has also experienced some challenges related to supply management, including fluctuations of the value of the Canadian dollar, higher commodity prices (grains), tight operational margins, and increased competition among food retailers (Sparling et al., 2014). To overcome these difficulties, the sector has embarked on the reorganization of supply chains and distribution facilities incorporating new technologies, systems, and skilled labour (Sparling et al., 2014).

However, the main stakeholders have also identified the need for more efficiency, innovation, and modernization of the sector, plus the importance of increasing processed production and not

only focusing on raw products (Sparling & Thompson, 2011). There is still a concerning lagging behind compared to international supply chain competitors; for example, regarding investment in industrial research and development and improving productivity, "processing in Canada is losing ground internationally" (Sparling & Thompson, 2011, p. 5).

4.2.2. Lean in the agri-food sector

A recent systematic literature review of lean, six sigma, and lean six sigma (not LSM exclusively) in the agri-food sector conducted by Costa et al. (2018) identified 58 publications, with the majority of papers focusing on lean manufacturing (74%), followed by six sigma (16%), and the fewest on lean six sigma (10%). Most publications in the field have appeared in the UK and India, and the prevalent sectors have been animal processing, bakery, and sugar-confectionery. The use of case studies involving interviews and surveys has been the preferred method of research, which confirmed that this type of research is at its initial stages in the sector.

Aligned to the contextual contingent framing of this study, a discussion of previous LSM studies in terms of context, supply challenges, and lean CTPs investigated is presented next.

First, in terms of context, most authors coincide on the limited existent research regarding the application of lean in the agri-food sector and have called for a better understanding of LSM in the agri-food sector, with a context-specific framework aligned to the intrinsic characteristics of the food-processing industry, seen in Table 4-1 (Dora et al., 2016).

Table 4-1. Characteristics of the food processing industry

Component	Main characteristics
Product	Short shelf-life (perishability) High variability (price, quality, availability) Continuous measurements (not discrete)
Process	Variable yield and processing times Short processes Limited automation (manual processes)
Plant	Long set-up times and changeover times Processing and packaging are separate processes Batch processing in some cases

However, past literature has mainly focused on gaining insights into lean adoption by examining the use of lean CTPs in different subsectors (business contexts) of the agri-food sector, analyzing, for example, challenges, barriers, and benefits of lean deployment in different countries and industries, as summarized in Table 4-2.

Most of the studies argue that the application of lean in the agri-food sector is lagging, despite favourable results shown in past literature in different business contexts; for example, Lopes et al. (2015) examined the application of lean concepts in two Portuguese companies of the food and beverage industries and showed significant gains in productivity. Another study by Powell et al. (2017) focused on the application of lean six sigma (LSS) in the food processing industry by conducting a longitudinal case study at a Norwegian dairy producer and demonstrated positive effects of combining LSS with the environmental sustainability dimension. In the red meat sector, Perez et al. (2010) assessed the operation of the Catalan pork sector to implement lean supply chain strategies to create sustainable competitive advantages and found suitable conditions. Similarly, Simons and Zokaei (2005) concluded that lean practices improved the quality and productivity of British red meat cutting plants, whereas Taylor (2006) presented a model of an integrated supply chain using lean principles and highlighted opportunities for change in the UK pork sector, where he described an industry contaminated by adversarial relationships, self-interest, and short-term profit maximization.

Additional studies have also recognized opportunities to increase the use of LSM in the industry when examining diverse geographic and supply chain contexts such as food SMEs in Greece (Psomas et al., 2018), a sauce contract manufacturer in Finland (Lehtinen and Torkko, 2005), process industries in India (Panwar et al., 2015), and an entire bakery supply chain in the UK (Shah & Ganji, 2017).

Second, in terms of supply challenges, many of the reviewed studies (Costa et al., 2018; Dora et al., 2016; Powell et al., 2017; Shah & Ganji, 2017) have discussed the operational challenges that specifically constrain fulfillment of supply requirements in the food sector, some of them inherent to the industry, for example, short shelf life, seasonality, variability of raw materials, supply-demand uncertainty, and quality assurance requirements. Additional studies have also identified health and safety issues, demand amplification effects, long lead times, diverse cycle times, and fragmented supply chains, resulting in lack of trust, suspicion, and conflict, as supply challenges for supply chain efficiency (Heymans, 2015; Panwar et al., 2015; Taylor, 2006).

Table 4-2. Context of articles about LSM in the agri-food sector

Study	Method	Context	Lean CTPs studied	Contribution
Lehtinen and Torkko (2005)	Case study	Food contract manufacturer (Finland)	VSM	Lean concept appropriate for food companies. VSM first step for leanness
Simons and Zokaei (2005)	Multiple case studies	Red meat cutting plants (Beef-pork)(UK)	Takt time, standardized work	Lean practices improve quality and productivity of red meat cutting plants
Taylor (2006)	Action research	Pork supply chains (UK)	VSM, integration	Industry contaminated with adversarial relationships
Perez et al. (2010)	Multiple case studies	Catalan pork sector (Spain)	Demand management, specification of value, process-product std., value chain efficiency, KPI, alliance, cultural change	Beneficial applicability of lean in the sector
Dora et al. (2014)	Surveys	Food SMEs in Europe (Belgium, Germany, Hungary)	Pull, flow, set up, SPC, TPM, suppliers, employees, customers	Slow adoption of lean by food processing SMEs. Barriers and benefits
Heymans (2015)	Conceptual	Food industry	Kaizen, JIT, TPM, TQC	Multiple challenges and benefits of lean in the food sector
Lopes et al. (2015)	Multiple case studies	Food-beverage industry (Portugal)	5S, SMED, Batch size, Kaizen	Sector lags behind in lean implementations
Panwar et al. (2015)	Surveys	Process industries (India)	5S, TPM, visual control, SPC, CI, TQM, work standardization	Focus on higher quality-waste elimination. Modest adoption. Large batches preferred
Dora and Gellynck (2015)	Mixed	Organizational factors Food-sector-specific factors	Pull, flow, set up, SPC, TPM, suppliers, JIT, customers	Framework to implement lean in food SMEs
Dora et al. (2016)	Multiple case studies	Food SMEs (Belgium)	Multiple lean practices	Enabling and obstructing determining factors in lean implementation
Powell et al. (2017)	Case study	Continuous process industry (Dairy)(Norway)	Lean Six-sigma, VSM waste elimination, DMAIC Process	Positive effects when using lean-green approach
Shah and Ganji (2017)	Mixed	Service industries (Bakery)(UK)	VSM, JIT, 5S, Kaizen, Pokayoke, Jidoka, Kanban	Huge variability, complexity, and heterogeneity in the sector
Costa et al. (2018)	Systematic literature review	NA	Multiple lean practices	Lean six-sigma initiatives are effective in the food industry
Psomas et al. (2018)	Multiple case studies	Food SMEs (Top quality mgmt.) (Greece)	Multiple lean practices	Opportunities for lean in the industry

CI: Continuous improvement, DMAIC: Define/Measure/Analyze/Improve/Control, JIT: Just-in-time, KPI: Key performance indicators, SME: Small-medium enterprises, SMED: Single-minute exchange of die, SPC: Statistical process control, TPM: Total productive maintenance, TQC: Total quality control, TQM: Total quality management, VSM: Value stream mapping

Third, in terms of lean CTPs explored, past studies used a fragmented approach, targeting few lean CTPs, instead of a systemic view of lean. As such, concerning the lean CTPs most studied in the agri-food sector, Costa et al. (2018) cited the universal practices: Ishikawa diagram, VSM, 5S, visual management, standardized work, and kaizen, and also identified specific tools for particular industries: SMED to reduce set-up times in batch type industries, kanban for discrete products in early stages, and JIT, mainly for big companies that face less demand uncertainty. They also mentioned the difficulties in using cellular manufacturing or pull systems in the beverage industry, where TPM may be more convenient.

In brief, as illustrated above, the analysis of contextual factors directly impacting LSM in the agri-food sector has barely been studied. Only recently, a few studies (Dora & Gellynck, 2015; Dora et al., 2016; Dora et al., 2014) have considered the effect of organizational factors and contextual factors specific to the food processing industry. Nevertheless, the main general focus has been on business context considerations (environmental and organizational factors), with no major emphasis on operational context considerations (work, functional characteristics), which is the main interest of this research. Additionally, no previous studies of LSM in the agri-food sector have utilized a contextual contingent framework that incorporates supply challenges, performance objectives, and lean pillars, which will be discussed in the following section. Performance objectives represent traditional competitive priorities (cf. Geyi et al., 2020; Pozo et al., 2017) and lean pillars represent a general category of lean concepts, tools, and practices (CTPs), where CTPs are first-order management elements and pillars are second-order CTPs classification categories (Pozo, et al., 2017; Soni & Kodali, 2013).

4.2.3 LSM as a contextual contingent approach

The terms contingency and context in current research have been used interchangeably with no major distinctions, especially in the operations management field (Marodin et al., 2016). However, some differences exist between these concepts; therefore, this study makes a distinction between context and contingencies and considers that the context is the setting of an occurrence (i.e., the Performance Objective) (Ginsberg & Venkatraman, 1985), while the contingency is two-fold: (1) a contingent condition or possible circumstance (i.e., Supply Challenges) and (2) a contingent event (i.e., Lean Pillar selection) (Netland, 2016).

Past studies have discussed the role of contextual factors and contingencies on the implementation of lean (Bortolotti et al., 2016; Netland, 2016; Stonebraker & Afifi, 2004),

acknowledging the influence of contextual factors and contingencies on the selection of lean CTPs. The understanding of the contingent conditions under which OM practices are effectively associated with performance outcomes has been called "OM practice contingency research (OM PCR)" (Sousa & Voss, 2008).

For this study, I leveraged OM PCR and the framing offered by Naranjo et al. (2020) that presents LSM as a contextual contingent approach, entailing the alignment associations and influences between supply challenges, performance objectives, and lean pillars. Their proposed LSM definition follows:

Lean supply management entails the adoption of suitable lean pillars—and deployment of related lean concepts, tools, and practices—in order to achieve prioritized/pursued productivity, visibility, consistency, variability reduction, and learning lean performance objective (s) while addressing emergent supply challenge(s).

Their LSM contextual contingent conceptual model is depicted in Figure 4-1, where:

1) Depending on the operating context (LSM performance objective), an operating contingency (supply challenge) may align with a single operating context (e.g., Supply Challenge_{a1} is only associated with fulfilment of LSM $\text{Performance Objective}_{a}$), while another operating contingency may align with multiple operating contexts (e.g., Supply Challenge_{i1} is also associated with fulfilment of LSM $\text{Performance Objective}_{a}$).
2) Depending on the contextual contingent association, a contextual contingent choice (Lean Pillar) may align with a single contextual contingent association (e.g., use of Lean Pillar_{a1} is only influenced by LSM $\text{Performance Objective}_{a} \mid \text{Supply Challenge}_{a1}$), while another contextual contingent choice may align with multiple contextual contingent associations (e.g., use of Lean Pillar_{i1} is also influenced by LSM $\text{Performance Objective}_{a} \mid \text{Supply Challenge}_{a1}$).

The definition and the model offered in Figure 4-1 indicate a sequential approach to view LSM in the following terms: the alignment association between supply challenge(s) (i.e., contingent condition) with the performance objective (i.e., context) determines an alignment association influence on the adoption of suitable lean pillars (i.e., contingent event).

The functionality focus of the lean pillars and related lean CTPs is the elimination of waste and its sources from operational systems (e.g., supply network) in order to improve (1) the productivity of throughput flows and (2) the value-add ratio of all work activities on an ongoing basis.

The LSM definition presented above and the contextual contingent LSM conceptual model displayed in Figure 4-1 served as the preliminary foundation to guide this qualitative study, where descriptive insights from multiple cases were built upon to derive theory-forming propositions as per Eisenhardt and Graebner (2007).

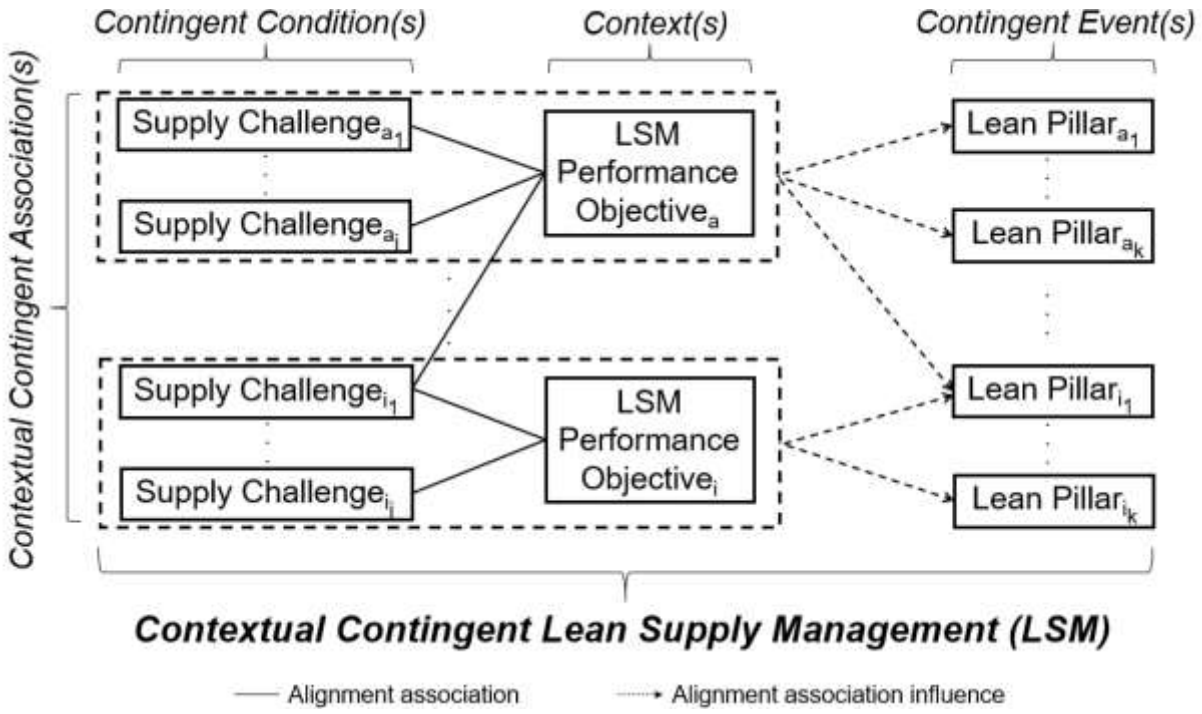


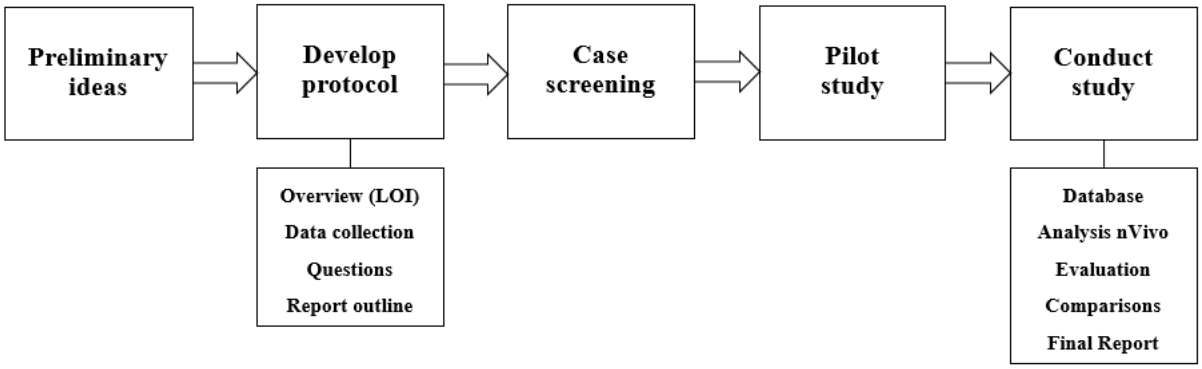
Figure 4-1. LSM contextual contingent conceptual model

4.3 Methodology

4.3.1 Research design

This study uses multiple case studies to guarantee the availability of sufficient data, to maximize the exploration of individual cases, to augment external validity, and to help guard against researcher bias (Voss et al., 2002). There is a trade-off between depth and breadth when selecting the use of single or multiple case studies; the latter were preferred to obtain more clear and convincing findings that could be enriched by the analysis of data using literal replication to identify similarities and theoretical replication via contrasting differences (Yin, 2018).

Case studies involve the execution of multiple stages, including the design of the study, the collection of case study evidence, the analysis of case study data, and the report of findings (Yin, 2018). These stages were disaggregated in a set of five main activities, displayed in Figure 4-2.



LOI: Letter of Information

Figure 4-2. Flowchart for case studies (Adapted from Yin, 2018)

The protocol of the study was prepared and submitted to the Western University Non-Medical Research Ethics Board; the submission contained an overview of the study, data collection procedures, interview questions, and structure of the anticipated report. The detail of the questionnaire used for the interviews is included in Appendix 4-1. Regarding the time boundaries of the study, the simultaneous process of data collection and analysis extended over nine months, a suitable time to visit sites, conduct interviews, and review archival data in all companies. However, the study length was cross-sectional (snapshots) for each company, and the data was collected during the course of the events in real-time (Runfola et al., 2017).

To enhance the rigour of the study, I followed the positivist quality criteria for case research (Beverland & Lindgreen, 2010). For construct validity, to ensure correct operational measures, I used triangulation by integrating multiple sources of data collection, and I submitted draft reports to key informants for review. External validity was achieved via a clear description of the agri-food context where the data collection occurred plus a transparent identification of the population of interest. Reliability was guaranteed through a standardized and well-defined protocol and the development of the case study database, so as findings could be replicated by others (Rowley, 2002). Additionally, rigour was enhanced through multiple decisions and outcomes along with this study, such as the use of primary data and the offering of a detailed narrative of the case-selection,

the data-collection process, and the coding process (Beverland & Lindgreen, 2010). Regarding the generalizability of this study, I followed Yin (2018), who suggested that in case studies, the use of analytic generalizations instead of statistical generalizations is more applicable given the absence of statistical sampling. Therefore, the selected cases are aimed to increase our learning from them and lead to greater comprehension of the how and why questions posed in the design.

4.3.2 Case selection

In this paper, the underlying principle for sampling was the selection of information-rich cases. The main approach used was purposeful sampling, based on Patton's list of 15 kinds of sampling (Patton, 1990). The initial criterion for selection was to focus on answering the research questions defined earlier to understand how and why LSM is used in the Canadian agri-food sector. Therefore, two clear categories—confectionery and protein subsectors—were established in the study design as most suitable to lean implementations (Costa et al., 2018). The adherence to a single strategy would have limited the collection of information needed; therefore, it was appropriate to combine multiple strategies. First, *operational construct sampling* was used to sample case studies on the basis of their representation of the theoretical constructs previously defined, which is based on an *a priori* definition of LSM as an alignment/association between supply challenges and lean CTPs. This approach allowed me to sample real-world examples of the constructs of interest. Second, *intensity sampling* was used to not only identify information-rich cases but also those that manifested the phenomenon of interest intensely, in this case, food processors displaying high levels of implementation of LSM principles in the agri-food sector without being unusual cases. Finally, another sampling strategy used was *confirming cases sampling*, when leveraging the insights that resulted from a prior Delphi study (Naranjo et al., 2020), offering a descriptive model. The selected cases fit some emergent patterns and confirmed previous findings, adding rigour and credibility to this study.

Furthermore, following Sandelowski et al. (1992), whose taxonomy separated sampling into *theoretical sampling* and *selective sampling*, the latter approach was used here by deciding the cases prior to the beginning of the study according to an initial set of logical criteria and a preconceived theoretical framework.

Therefore, for this study, as explained above, the companies were purposely selected using multiple strategies, and the unit of analysis was defined as lean agri-food processors at the plant level located in Canada. A total number of six lean companies agreed to participate, which is a

reasonable number for case study research (Rowley, 2002; Yin, 2018). High-level managers from different functional units of each company were invited to contribute with multiple points of view. Table 4-3 shows the demographics of the companies selected for this study.

Table 4-3. Demographics of selected case studies

Company	Sub-sector	Number of Employees	Plant Annual Sales	Organizational Structure	Function of respondents
K	Confectionery	300-500	$50-100 million	Decentralized	Senior Director of Quality Assurance Director of Food Safety and Quality Purchasing Manager Head of Continuous Improvement
F	Confectionery	100-300	$40-80 million	Decentralized	Director of Operations Supply Chain Manager Quality Manager
N	Confectionery	100-300	$40-80 million	Centralized	Supply Chain Manager Purchasing Manager Quality Manager
C	Protein	500-1000	$150-200 million	Centralized	Supply Chain Director Distribution Manager Head of Continuous Improvement Plant Manager
M	Protein	500-1000	$150-200 million	Centralized	Purchasing Manager Procurement Director Continuous Improvement Manager Quality Manager
S	Protein	300-500	$80-150 million	Centralized	Senior Manager, Strategic Sourcing Director of Continuous Improvement Procurement and Logistics Manager

In the preliminary stages of this study, two single pilot study cases, shown in Table 4-4, were conducted to gain a better understanding of the dynamics of the industry (Taylor, 2006). The instrument was tested during this formative stage to improve the line of inquiry using the same questionnaire over a representative number of interviewees and maintaining the conditions that were replicated for the real study (Yin, 2018). Minor amendments to the protocol were necessary after the pilot was terminated (i.e., some items were revised and refined in terms of structure).

Table 4-4. Demographics of pilot case studies

Company	Sub-sector	Number of Employees	Plant Annual Sales	Organizational Structure	Function of respondents
P1	Protein	500-1000	$150-200 million	Centralized	Senior Director of Quality Assurance Purchasing Manager Quality Manager
P2	Flowers	100-300	$40-80 million	Centralized	General Manager Purchasing Manager Production Manager

4.3.3 Data collection and analysis

Following Yin (2018), the process of data collection and subsequent analysis followed three main principles: a) use of multiple sources, b) separation of data and report to provide easier accessibility and better organization, and c) integration and alignment of the different components to maintain a chain of evidence. Using a semi-structured questionnaire, a total of 3-5 face-to-face and online interviews per case were conducted, following the case study protocol and a systematic procedure, for a total of 26 interviews (plus 6 during the pilot phase); each lasted between 60 and 120 minutes, and in some cases, follow-up interviews were required with some participants. All interviews were recorded, with the permission of each participant. Researcher bias and respondent bias were prevented by assuring an appropriate instrument design and controlling acquiescence and social desirability (Quinlan, 2011). Interviews were finalized when no new insights were derived from additional participants, ensuring theoretical saturation.

The study was enriched by incorporating additional secondary sources of information, including annual reports, bulletins, company records, official reports, brochures, news, and web information, integrated into the database to be triangulated with the primary sources of information. Concurrently, once each interview was completed and recorded, the data was transcribed using the software “Descript” and prepared to be consolidated and analyzed using the software “NVivo”, which facilitated the content analysis of interviews and documents (database).

For the analysis, the process of coding the data was conducted simultaneously with the data collection in an iterative process, and initially, more than one hundred codes were identified. Then, multiple first-order categories resulted from the merging of nodes with similar content, after which

second-order themes were identified, and finally, three aggregate dimensions were obtained related to LSM. The next step consisted of the elaboration of case profiles to carry out within-case analyses using a linear-analytic approach by extracting the most relevant information from each company (Beverland & Lindgreen, 2010). Cross-case scrutiny was performed using comparative analysis to identify similarities and differences in patterns of LSM across the cases (Eisenhardt & Graebner, 2007). Finally, the results were reported, including quotes from the interviewees to support the interpretation of findings (Simons & Zokaei, 2005) that derived in the development of propositions.

4.4 Findings (Within case analysis)

Following Eisenhardt (1989), this section presents the results that emanated from the within-analysis of each case. It involves a series of write-ups that are simply pure descriptions of each company, related to supply challenges, lean pillars, and performance objectives; these descriptions are critical to understanding how companies are using LSM.

4.4.1 Company K

Company K is a leading manufacturer of high-quality frozen desserts for retail and food service customers. The company focuses on innovation, safety, and consistent quality to satisfy its customers.

The selection of suppliers is a strict process and preference is given to local suppliers, but the choice of suppliers is contingent on the type, volume, and origin of the product sourced. Suppliers are regarded as strategic partners and close long-term relationships are established with core suppliers. Open and fluid communication allows them to solve problems together and develop new products in an integrated way. Policies are predetermined in a written contract and performance is reviewed on a monthly basis to make adjustments. Forecasts are shared, and pull practices and JIT deliveries are common to reduce inventories. Suppliers are encouraged to deliver small quantities in high frequencies and to keep safety stocks or use vendor-managed inventory. Seasonality of demand is managed through level production procedures.

The philosophy of lean is well embedded in the company and extended to its suppliers. Continuous improvement is ingrained in the mindset of the company, so the use of quality tools and kaizen projects are numerous. The selection of lean CTPs responds to two factors: desired outcomes and specific problems to be addressed. There exists a contingent choice based on

performance objectives and the nature of the supply challenge. The company emphasizes consistency and productivity as main priorities.

4.4.2 Company F

Company F is one of the largest Canadian manufacturers of chocolate and candy serving international markets. It manufactures industrial chocolate ingredients and panned chocolate products using sugar, cocoa powder, cocoa butter, and chocolate liquor as raw materials.

The selection of suppliers considers the different levels of the criticality of the products needed, which categorizes core suppliers. Suppliers are evaluated using an ABC system and performance indicators. Certified and local suppliers are preferred, and the company maintains long-term relationships with them. For some products, for example, liquid ingredients, the company requires quick and frequent replenishments in small quantities. Also, international providers are encouraged to reduce lead times and in-transit inventory levels. The company faces seasonal demand.

Multiple lean CTPs are used in the company and across its supply chain. The selection of lean CTPs is contingent on the nature of each specific problem; however, their choice also depends on the size and severity of each case as well as on the expertise of the users. Lean is considered a methodology, but multiple efforts are made to convert it into a strategic philosophy. The company has multiple performance objectives; consistent quality and cost are vital for customer service. Nevertheless, the company recognizes that its main three priorities are health and safety, productivity, and engagement of employees.

4.4.3 Company N

Company N is one of the leading chocolate manufacturers in the world and headquartered in Spain. The company has a strong commitment to excellence, safety, high-quality standards, and people. Its main commercial portfolio includes cocoa products, fillings, powder, and tablets.

The purchasing department has recently been centralized in the headquarters and is responsible for the selection of suppliers, whose number is contingent on the nature and criticality of each product. The company deals with local and international suppliers, with whom ample communication is maintained to improve the visibility of the supply chain and share main objectives and results. Cooperative and long-term relationships with its suppliers are preferred in general; however, the approach differs based on the product and volume.

The company embarked on a re-engineering program last year, prioritizing the lean approach and reinforcing continuous improvement initiatives focused on consistency of products and

processes. It uses isolated lean principles across the plant and many lean practices have already been extended to suppliers. The selection of lean CTPs is usually contingent on the specific problem to be targeted, and joint lean projects with suppliers are common. The company focuses on maintaining the consistency of its products and improving the productivity of its processes, aiming to provide high-quality products at competitive prices.

4.4.4 Company C

Company C is a global company whose headquarters is in the United States. Its multiple manufacturing facilities process meat, eggs, malt, and oilseed, and manufacture livestock feed. The plant under analysis is a poultry facility with high standards of quality.

Some years ago, the corporation deployed a unified global approach to qualify suppliers and centralized the operation, creating a strategic sourcing group. Few key suppliers are selected, but back-up suppliers also exist for emergencies. Relationships are long-lasting, and there is a high degree of collaboration and integration with suppliers. Because of the strong emphasis on cost reduction initiatives, the communication is agile and flexible, and the company offers technical assistance to its suppliers so they can improve production yields and efficiencies and reduce lead times. There is also a strong commitment to animal welfare and sustainability and a shared responsibility with suppliers to ensure safety and quality to satisfy customers.

The company has established a solid lean culture. Multiple projects are coordinated by the continuous improvement team and incorporate multidisciplinary teams. The main goals are the optimization of processes and products and the reduction of cost. The selection of lean CTPs is contingent on the nature of the issue or the specific problem to be addressed. The main motivation for the use of the lean approach is the elimination of waste in internal and external processes to achieve higher efficiencies.

4.4.5 Company M

Company M is the largest prepared meats and poultry producer in Canada. Its main products are prepared meats, chicken, turkey, pork, and plant-based protein.

The purchasing unit is centralized, using a strategic sourcing approach. It defines one specific internal leader for each of the three buying categories: ingredients, meat, and packaging. The selection of suppliers depends on each product sourced, and 20% of the total number of suppliers delivers about 80% of the total products sourced, so consolidation of suppliers has helped with economies of scale and higher buying power over suppliers. However, some exclusive suppliers

of unique products have created rigid dependencies. The frequency of deliveries is based on each product and the geographic location of each supplier.

Relationships with suppliers are solid and long-lasting and based on honesty, transparency, and trust, which allows for open book negotiations, joint-cost-saving initiatives, joint-problem solving, information exchanges, and the sharing of common goals regarding cost and quality targets. Assistance to suppliers and periodic meetings are common.

The company considers lean a way of living, as part of its culture; accordingly, the lean philosophy has also been extended to suppliers. Regular kaizen initiatives are practiced to increase yields, reduce costs, and improve quality across the organization and its suppliers. The selection of lean CTPs is based on each context, being contingent on multiple factors, such as each particular process, the magnitude of the project, industry regulations, managerial commitment, and employees' engagement. The main goal is to permeate the lean culture across the organization and suppliers, in order to attain the lowest possible costs, improve productivity, and increase efficiency by reducing waste.

4.4.6 Company S

Company S is one of the leading Canadian manufacturers of primary and further processed protein products with multiple locations across Canada. It offers a wide variety of food products, including chicken, turkey, pork, meat, and fish.

The company uses a centralized system for purchasing and procurement. A few suppliers are in charge of serving multiple plants. For each product, the company usually has two main suppliers plus a third local supplier to acquire minor quantities from. Long-term relationships with suppliers are common, based on trust and confidence, and characterized by information and forecasts sharing, joint analysis of future price trends and variations, frequent mutual plant visits, and integrated problem-solving and product development.

The company has established a solid culture of lean management across the organization, led by top management. Such practices have gone beyond the boundaries of the company to include its suppliers. Lean is seen as an approach based on permanent learning from daily operations to improve efficiencies. The selection of different lean CTPs is contingent on the nature of each specific problem and specific key performance indicators (KPIs). The main motivation for the use of lean is the goal to achieve quality improvements (consistency), cost reductions (productivity), and higher safety to prevent sanitary problems.

4.5 Discussion of findings (Cross-case comparative analysis)

This section presents the findings obtained from a comparative analysis of all cases investigated. The interview transcripts garnered from the software "Descript" and the secondary data collected were entered into "NVivo" to be organized and analyzed. Hundreds of codes were identified by extracting the most relevant information from the data. Following Nag and Gioia (2012), the data were structured in three levels, shown in Figure 4-3. First-order concepts were obtained from those concepts meaningful to the informants, second-order themes were induced by the researcher by combining nodes to establish categories, which finally led to the generation of the aggregate dimensions. The final aggregate dimensions that emerged from the data analysis were threefold: 1) supply challenges aligned to performance objectives, 2) lean pillars influenced by the alignment association between supply challenges and performance objectives, and 3) LSM performance objectives related to operational outcomes, as presented in Table 4-5.

4.5.1 Supply challenges (What LSM)

This section sheds case-based descriptive insights on supply challenges (what are the supply challenges described in the case sample?) and the model alignment association with performance objectives. This dimension had two main themes: 1) main supply challenges in the sector, and 2) the impact of those supply challenges in the operation.

Main supply challenges. This theme subsumes five constituent second-order subthemes representing diverse types of supply challenges. *Cost challenges* are characterized by the fluctuation of prices in the commodity markets, forcing companies to fix prices for extended periods of time, use formulas for adjustments, and maintain ongoing negotiations with suppliers.

Delivery challenges are represented by the high dependency on unique suppliers and the extended lead times exacerbated by stringent quality controls or unanticipated disruptions of supply chains. Related to cost and delivery challenges, two managers commented:

"For one company, we have quarterly prices and with the other company, it is ongoing prices. It is built on a formula. If the bird is this, and if the export markets are this and the exchange is this and this. So, it is a formula approach depending on multiple factors." (Company S)

"I do not think we have issues with quantities. I think what we are currently experiencing issues with lead times since March. So really, the biggest problem is not the quantity within the orders, is just the lead time jumped from two to four weeks…So I think lead time is the part of that actually is becoming more difficult to manage now." (Company N).

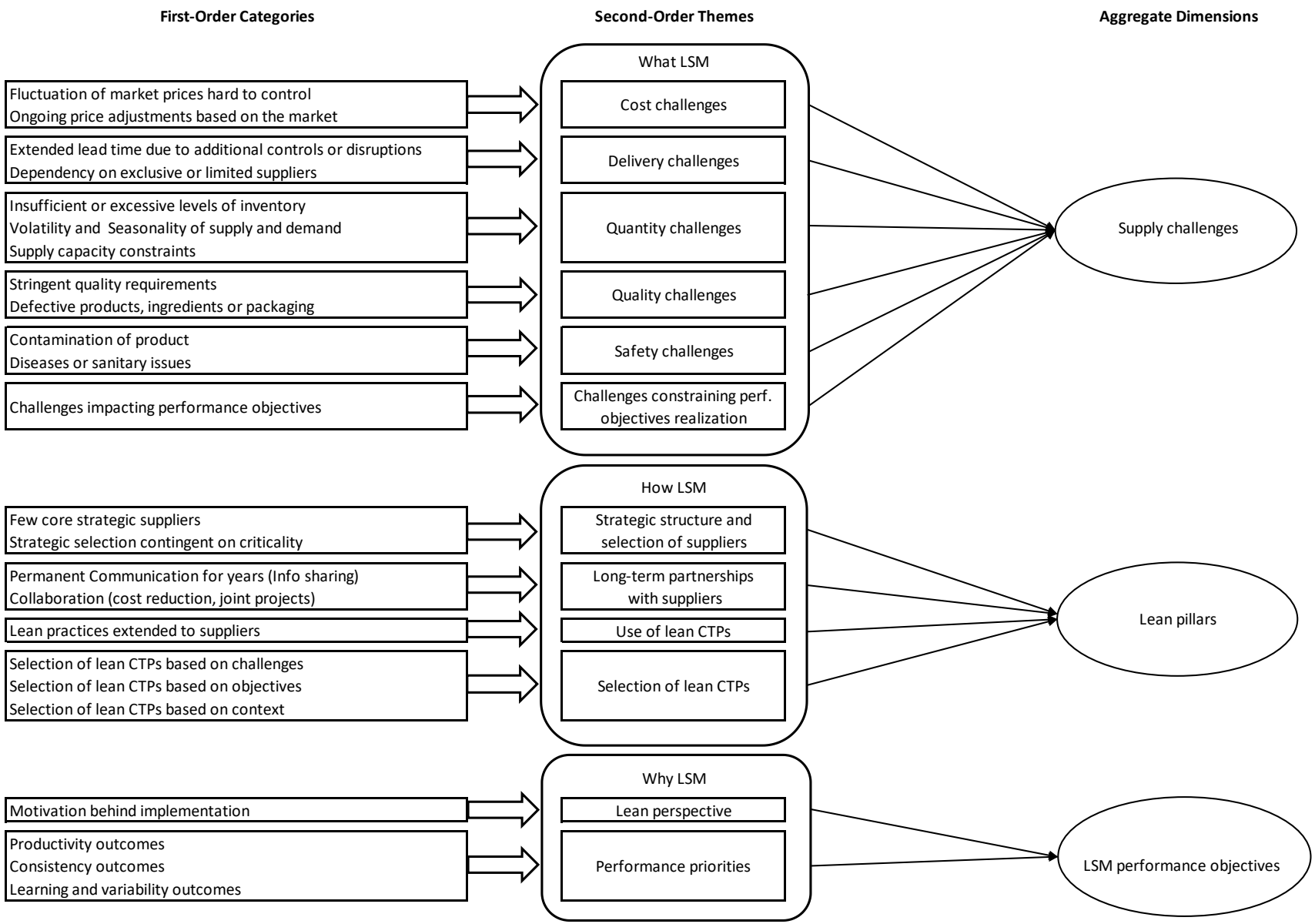


Figure 4-3. Data Structure

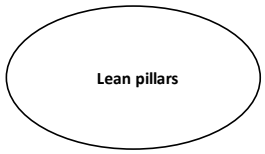
Table 4-5. Representative quotes underlying Second-Order Themes

First-Order Categories		Second-Order Themes	Aggregate Dimensions
		Cost challenges	
Fluctuation of market prices hard to control	F	We can't influence the price, but we can influence how much we buy and when, to make sure that we can run steady state all year round	
Ongoing price adjustments based on the market	M	Once we negotiated the contract and finance contract, the cost was fixed, subject to escalate just points for a two to three year program period	
	K	You're negotiating on an ongoing basis. You are able to determine who you should buy from and establish pricing agreements along with the contracts	
		Delivery challenges	
Extended lead time due to additional controls or disruptions	K	They might need to send a product out to do micro testing before they can ship it to us, which adds to the lead time	
	N	So I think lead time is the part that actually is becoming more difficult to manage	
Dependency on exclusive or limited suppliers	F	They could be short on a crop or other things then this is more limiting to the business	
	N	You have to be in an excellent relationship with them because there's not really many suppliers	
		Quantity challenges	
Insufficient or excessive levels of inventory	N	Inventory seems to be depleted faster than suppliers can reposition, it is dealing with a market that is in high demand with our limited supply	
	N	I think that the challenge that everybody right now is facing as you increase inventory, is where do you put that inventory?	
Volatility and Seasonality of supply and demand	K	We try to smooth our fluctuations, but we are a seasonal business by nature, we have two strong seasons	
	F	A lot of the raw materials we purchase are seasonal there. They have seasonality based on their growing seasons	
Supply capacity constraints	F	The biggest constraint is the size of the tanks, we have to work backwards from their capacity, depending on what we're manufacturing at that time	
	N	The supplier hasn't been able to raise their capacities. I'm only one of their 25 customers that actually are demanding the same product	**Supply challenges**
		Quality challenges	
Stringent quality requirements	K	We have a very demanding quality requirements, so we need to ensure that all the raw materials are meeting those standards at all the time	
	M	In the food business there is a very strict checklist that the procurement person has to go through	
Defective products, ingredients or packaging	N	They have swept colors, they are inverted. So if something is supposed to be white with red letters, what we received is red with white letters	
	F	The most challenging part is mother nature that defines the characteristics of our raw materials, too much rain or too much sun	
		Safety challenges	
Contamination of product	K	With one of our suppliers that had a contamination in their product we were able to find the root cause in their facility and solve the situation	
	K	Foreign material contamination could be one of the food safety issues. If so, the situation will go to what is a claim	
Diseases or sanitary issues	S	We invited them (our supplier) to our plant as we had issues with salmonella and stuff	
	S	Salmonella was the big pain for us. We needed to make sure that the supplier was using the acid-dipping process right	
		Challenges constraining performance objectives realization	
Challenges impacting performance objectives	K	Is it more efficient to buy small quantities and receive weekly or to put it off site in a warehouse and pull it from there. It is the total costs that we are after	
	K	We emphasize the importance of them informing us ahead of time if they're going to have supply issues	
	F	If there's a delay, it impacts our ability to produce. We had incidents where we had to cancel lines	
	K	We have seen cases where some suppliers might not have the capacity to supply us the volumes that we need	
	K	Depending on the volumes we use, risk assessment could be physical, chemical or microbiological to protect our organization	
	F	Sometimes they have some quality variations and we cannot accept that. That's not the quality we are expecting to get delivered to us	

Continued

Table 4-5. (Continued)

First-Order Categories		Second-Order Themes	Aggregate Dimensions
		Strategic structure and selection of suppliers	
Few core strategic suppliers	M	We consolidated the supply base from hundreds to dozens or fewer than dozens. Usually two or three per item, per category	
	M	Obviously suppliers are a key part of the supply chains. So we couldn't do this on our own. We had to enlist the aid of our suppliers	
	C	They are all strategic suppliers. We don't deal with one-offs because the product is very specific	
	K	They must have the capacity to supply us, so that's the reason why we have formed alliances with key suppliers to be able to support us as we grow	
Strategic selection contingent on criticality	M	We have specialists by division, who better understand each sector, and can select the best suppliers	
	K	You would have one supplier or you might have dual suppliers. It's all dependent on the category and location	
	F	Like with critical parts for maintenance, we do criticality analysis to identify critical ingredients and critical suppliers	
		Long term partnerships with suppliers	
Permanent Communication for years (Info sharing)	F	We gather together (with our supplier) and discuss issues using some different lean tools, for example we use root cause analyses	
	K	we believe that continuous and open communication in timely manner is the best solution to avoiding raw materials or supplier-related issues	
	C	We've got longstanding relationships, and there's great value in establishing a good relationship based on ongoing communication.	
	K	I mean, most of our suppliers have been here for over 10 years	
	N	The clearer our communication with suppliers, the bigger their commitment as they're always aware of what we're doing	
Collaboration (cost reduction, joint projects)	M	it's a two way street of how can we improve or reduce the cost as a team. And if that team works together, there are definitely opportunities	
	C	They (our suppliers) are in our plants, a lot of them are in our plants helping to develop the product	
	C	So our R&D teams also work really closely with some of our ingredients suppliers, to make sure that they're helping us formulate new products	
	C	Each supplier gets forecast from our inventory group and they build to that supply. They maintain that inventory and we draw from it	
		Use of lean CTPs	
Lean practices extended to suppliers	M	Together with our suppliers, we followed the Kaizen methodology to improve yields all the way from formulation to packaging	
	M	So we needed to set up Kanbans to reduce transportation waste and basically in terms of having supplies available, they always had it available	
	K	Sort of VMI, we had our suppliers holding inventory on their floor for us, and when we need it, they can deliver to us immediately	
	K	We use continuous improvement tools with our suppliers on a regular basis	
	K	When it comes to health and safety and nonconformances from suppliers, we do have a standardized processes and documentation that we all follow	
	M	We make efforts to reduce lead times because the shorter the lead time the shorter the inventory levels and the smaller working capital	
		Selection of lean CTPs	
Selection of lean CTPs based on challenges	M	It depends on the particular problem and the process that you want to follow. When it comes to implementing change will depend on the industry	
	F	If you have a big problem, then you use multiple tools, fishbone, VSM, or Kaizen, so it really comes down to the nature of the problem	
	C	The solutions are generated by both organizations. it's just different depending on the item or specific issue	
	C	The selection of the lean tool depends on the problem and on what the issue is and on what steps we would take	
Selection of lean CTPs based on objectives	K	The selection of these tools, like Just in Time, Six Sigma, Deming cycle, depends on the specific objective that we pursue	
	C	If it is quick wins that we're looking for, then we're going to run more of a Kaizen if we want to eliminate some waste	
Selection based on context (LSM1 ≠ LSM 2)	M	Each industry is different. They have different needs, different levels of maturity when it comes to continuous improvement	
	M	It depends on the context and whether you need to choose from lean what you're looking for	



Continued

Table 4-5. (Continued)

First-Order Categories		Second-Order Themes	Aggregate Dimensions
		Lean perspective	
Motivation behind implementation	M	This is the new way of doing things and as they were getting more involved, they started to see the benefits	
	M	We were convinced of the benefits so since we began we wanted lean to be permeated in all the departments following the new methodology	
	K	I think that continuous improvement has been in the core of our business, so we always strive for bettering ourselves	
		Performance priorities	
Productivity outcomes	M	We improved forecasting so that we could pass it on to suppliers. We don't want inventory sitting around for a month or six weeks	LSM performance objectives
	F	Lean is a methodology we use to drive productivity and improvement and engagement	
Consistency outcomes	K	I think that we want to increase our consistency in our products. We are in business because our customers value what we do, high quality products	
	C	from a supplier relationship, we'd be looking specifically at the live birds supply to get more consistency in weight	
Learning and variability outcomes	C	Our priority? definitely cost and quality are the two big ones	
	M	It depends on the project, in some cases it is cost driven, in other cases it is quantity driven	
	F	Health and safety is the top priority really, then productivity and then engagement and retention of people	

Quantity challenges are related to the seasonality of the industry, which prevents a smooth demand throughout the year. Companies experience dramatic fluctuations in the level of inventory, going from excess inventory that causes storage-capacity issues to scarcity of material when the inventories are depleted at a faster rate than the suppliers' capacities to restock products.

Quality challenges are common in the industry given the strict quality requirements of ingredients and components (packaging). Informants acknowledged the high sensitivity of raw material characteristics contingent on environmental natural conditions that are difficult to control (weather, climate, temperature, pressure, moisture, etc.). Additional challenges exist in terms of potential contamination and perishability, which have demanded risk assessment processes and refrigeration technologies.

Safety challenges were also identified as critical, and therefore, stringent requirements to assure freshness and safety are usually imposed on suppliers. Most companies prefer suppliers certified in international safety standards, such as HACCP. The latest trends in the sector are sustainable initiatives, such as policies for animal care and welfare, and environmental practices along the supply chains. Quotes related to quantity, quality, and safety challenges follow:

"So, we try to smooth our fluctuations, but we are a seasonal business. So, by nature we have them. So, we've got two strong seasons, one is Christmas and the other one is around May or June." (Company K)

"Quality is very important, so we have very demanding quality requirements. We are a certified organization, so we need to ensure that all the raw materials are meeting those standards all the time." (Company K)

"We had issues with salmonella and stuff. So, we would be very much involved. My QA department would go there and talk to them, and then we looked at common solutions. So it was, it was a lot of involvement. A lot of information sharing." (Company S)

Challenges constraining performance objectives realization. This second theme represents the impact of the supply challenges identified above on performance objectives described by respondents. Cost challenges related to price uncertainty from suppliers affect the financial performance of the operation (productivity). Delivery challenges represented by the unavailability of products cause production cancellations or alterations (variability). Quantity challenges, when not receiving in-full orders due to limited capacity of suppliers, generate production interruptions (visibility, productivity). Quality challenges caused by defective or out-of-specification raw materials provoke yield reductions, delays, or rejections (consistency). Safety challenges originating in contaminated ingredients or products infected by diseases, such as salmonella, may threaten human lives in the case of negligence or lack of inspection (learning).

A cross-case comparison of supply challenges and performance objectives for each company is displayed in Table 4-6. It is observed that supply challenges of quality and delivery associated with performance objectives of consistency and variability reduction are predominant for all cases. Whereas delivery challenges are observed for both subsectors, quality challenges are more typical of the confectionery sector. For both sectors, these two challenges are associated again with consistency and variability reduction objectives. These results reflect the inherent attributes of the industry, which is characterized by the use of natural raw materials (vegetable and animal), whose availability and quality may be unpredictable and variable. Different supply challenges are associated with different performance objectives in each company.

Table 4-6. Cross-case comparisons of supply challenges impacting perf. objectives

Sub-sector	Company	What challenges in LSM Top supply challenges	Associated perf. objectives
Confectionery	K	Quality challenges Safety challenges Cost challenges	Consistency Productivity Learning
	F	Delivery challenges Quantity challenges Quality challenges	Variability Visibility Consistency
	N	Quality challenges Safety challenges Delivery challenges	Consistency Productivity Variability
Protein	C	Quality challenges Delivery challenges Safety challenges	Consistency Variability Learning
	M	Cost challenges Delivery challenges Quantity challenges	Productivity Variability Visibility
	S	Quantity challenges Quality challenges Cost challenges	Variability Consistency Visibility

In brief, it was observed that supply challenges of different natures in the agri-food industry are associated with particular performance objectives pursued by the companies in terms of productivity, consistency, visibility, variability reduction, and learning; therefore, I propose:

Proposition 1 (contingent condition consideration): The business unit's specific supply challenges require managerial consideration relative to specific performance [functionality] objective(s) whenever pursuing LSM. There is an association alignment between supply challenges and performance objectives pursued.

4.5.2 Lean pillars (How LSM)

This section sheds case-based descriptive insights on lean pillars (what are the lean pillars described in the case sample?) and the model alignment influence by the performance objectives-supply challenges alignment association. This dimension is fundamental for understanding how agri-food processors are using lean CTPs to achieve specific outcomes. Four main subthemes were identified in the analysis, illustrating the application of LSM in the Canadian agri-food sector.

Strategic structure and selection of suppliers, the first subtheme, reflected the critical role played by suppliers viewed as an extension of the focal company. Informants reported on the high commitment and involvement of top management, demonstrated by their developing strategic sourcing programs to guarantee an optimal selection of suppliers. In recent years, the number of suppliers for all the companies in the sample has been dramatically reduced or consolidated to strive for simplicity and to achieve economies of scale. Local suppliers are usually favoured; however, additional factors impact the selection of suppliers, such as the characteristics of sourced raw materials, the level of criticality of supplies for the operation of the focal firm, and the availability of resources. For the supply of critical items, in terms of value and volume, these companies have opted for having two core suppliers plus one for emergencies. In some cases, vertical integrations upstream were observed, particularly in the protein subsector, for example, the poultry company acquiring the hatchery operations. Regarding the selection of suppliers, one manager commented:

"For most of our critical suppliers (of ingredients, packaging, transportation), we have defined pretty much the same set of rules and standards, but main decisions are driven by our strategic sourcing groups. So, if we have certain suppliers that they selected for us who were having some issues or deviations of any form, whether they are supply shortages or quality problems, then we will feed that information back to them so that they can correct those issues or make appropriate changes." (Company C)

Long-term partnerships with suppliers, the second subtheme, refers to the relations established with core suppliers once a solid structure has been built. The companies studied showed a compact integration with suppliers. Aligned to the lean approach, core suppliers have been identified, with whom long-term relationships have been established based on principles of trust, respect, and confidence. Two main elements were identified as fundamental underpinnings of this theme: communication and collaboration. In terms of *communication*, the existence of cooperative relationships seeking mutual benefits was clear. Several managers interviewed explained how frequent meetings occur on an ongoing basis and multiple channels of communication are used with suppliers, not only to tackle problems but also to share process indicators, forecasts, market fluctuations, and new continuous improvement initiatives. Two managers explained the importance of communication and long-term relations:

"The relationships are good. What it really comes down to is not only pricing, it is really to service. So, when a supplier scores above and beyond the standard service, that gives them the

edge over the competition and a point of differentiation. We value suppliers who are transparent and open, so we make this kind of a partnership rather than a relationship." (Company F)

"(You ask me) if we have long-term relationships with our suppliers? We sure do. So, let me give you an example of our dedicated service; we typically have a three to five-year contract that is updated or renewed on a certain frequency, but it is a long-term commitment…we have got longstanding relationships, and there is great value in establishing a good relationship…so they understand our needs and our business." (Company C)

Regarding *collaboration*, frequent visits to each others' facilities are common; this has facilitated a solid integration between multiple departments of suppliers and buyers. Informants also revealed technical assistance programs and the high degree of involvement of their suppliers with their R&D departments to design, formulate, and create new products, ingredients, and processes. Joint projects have proved beneficial to reduce costs and improve quality, for example, by improving yields and productivity or by better handling inventories. A manager stated:

"Together with our suppliers, we look at a lot of trends, we compare variables over time, we use regressions on different aspects and different data to see what the relationships are. We have a huge data set that we are constantly looking for trends and patterns and different things that we can identify to make improvement by eliminating non-value-added activities." (Company C)

Use of lean CTPs, the third subtheme, refers to the identification of the main lean CTPs being used by Canadian agri-food processors when dealing with their suppliers to achieve performance objectives.

In general terms, common lean CTPs for all companies were kaizen blitzes, elimination of waste, and continuous improvement as part of their daily operations. Regarding the flow of products along the supply chain, these companies prefer a pull strategy, using small batches and frequent deliveries when possible, kanban cards, and levelled production. Concerning inventory management policies, companies use just-in-time (JIT), aim for lower levels of inventory and lead time reduction, carry minimum levels of safety stocks, and use vendor-managed inventory (VMI). Regarding their processes, the use of standard practices and documentation, 5S, and certification of their operations was observed. In terms of quality, to guarantee safety and compliance with specifications, these companies have integrated inspections with their suppliers, using, for example, quality at the source of incoming materials in addition to multiple quality control tools, such as statistical process control (SPC), Ishikawa diagrams, Deming cycle, control charts, Pareto analyses, and even six sigma deployment programs in the most advanced companies. Finally, concerning respect for people, these companies show high respect for their vendors, collaborative

relationships with suppliers, and permanent engagement of workers in continuous improvement projects. Some illustrative quotes of the use of lean CTPs follow:

"With the implementation of lean, we are looking into our processes as well through our whole supply chain practices. To make sure that we standardize the way we do things, across the entire N network. So, the way we manage in Europe should be the same way that we're managing here, with the distinct characteristics of every geographical region." (Company N)

" ..continuous improvement has been fundamental in the last three-five years…then as we grow, we need to make sure we are aligned with lean suppliers that can provide us with the kind of innovation and R&D expertise that we need in order to continuously develop and introduce new products to the market…as we grow, we need lean suppliers that have the capacity to supply us, so that's the reason why we have formed alliances with key lean suppliers in order to be able to support us as we grow." (Company K)

"Vendor-managed inventory (VMI) is similar to what Costco does. We do not pay for the product until we use it, so our suppliers store their products in our building in our plants, which makes them visible to us and the supplier, then the supplier manages the level of inventory and replenishes it when the reorder is reached and a new order is placed." (Company M)

More specifically, following Argiyantari et al. (2020), Table 4-7 shows a cross-case comparison of the different lean CTPs implemented, categorized in each of the eight lean pillars adopted (Jasti & Kodali, 2015). The tabulated data reveals that supplier management (SM) and top management commitment (TMC) were the lean pillars most implemented, whereas customer relationship management (CRM) was the least common pillar used. Across the two subsectors studied, there are some differences in terms of preferred lean pillars, and the confectionery sector seems to lag behind the protein sector, as evidenced by the use of fewer lean CTPs implemented.

Selection of lean CTPs, the fourth subtheme, refers to the approach used by companies to select the best lean CTPs when implementing LSM. Three main elements were identified: selection based on supply challenges, selection based on performance objectives, and selection based on context. The first element, *selection based on supply challenges* was common for many companies; multiple managers explained that they usually start identifying the problem clearly to next define the optimal lean CTPs to be used. The nature, size, and severity of each supply challenge were the factors most considered for the selection. This approach reflects a reactive decision-making style by waiting until a supply challenge is visible to, only then, decide the most suitable lean CTPs. The next quotes by two managers from different companies expand this point:

Table 4-7. Cross-case comparison of lean pillars and lean CTPs

Pillars	Lean CTPs	Confectionery			Protein		
		K	F	N	C	M	S
IT	Use of EDI to communicate between departments	x	x	x	x	x	x
	Centralized database for documentation	x	x	x	x	x	x
	Enterprise resource planning system	x		x	x	x	x
	Information technology employed at customer base					x	
	Effective and transparency information flow throughout supply chain	x	x	x	x	x	x
	Use of bar coding and scanner in logistics systems	x	x	x	x	x	x
	Electronic commerce	x			x	x	x
	Modelling analysis and simulation tools					x	
	Computer-aided decision making supporting systems					x	
SM	Strategic supplier development	x	x	x	x	x	x
	Supplier evaluation and certification	x	x	x	x	x	x
	Long-term supplier partnership	x	x	x	x	x	x
	Supplier involvement in design	x	x	x	x	x	x
	Supplier feedback	x	x	x	x	x	x
	Supplier proximity	x	x	x	x	x	x
	Single source and reliable suppliers or few suppliers	x	x	x	x	x	x
	Cost-based negotiation with suppliers	x			x	x	x
	Manage suppliers with commodity teams					x	
EW	Standard products and processes	x	x	x	x	x	x
	Standard containers	x	x	x	x	x	x
	Focused factory production						
	Design for manufacturing						
	Flexible manufacturing cells or U-shape manufacturing cells						
	Visual control	x	x	x	x	x	x
	Single minute exchange of die						
	Andon						
	5S	x	x	x	x	x	x
	Point of use tool system						
	Seven wastes throughout supply chain	x	x	x	x	x	x
JIT	JIT deliveries throughout supply chain	x	x	x	x	x	x
	Single piece flow						
	Pull production	x		x	x	x	x
	Kanban					x	
	Production levelling and scheduling	x				x	
	Synchronized operational flow	x	x	x	x	x	x
	Plant layout	x	x	x	x	x	x
	Point of usage storage system	x	x	x	x	x	x
	Pacemaker						
	Small lot size					x	

Continued

Table 4-7. (Continued)

Pillars	Lean CTPs	Confectionery			Protein		
		K	F	N	C	M	S
CRM	Specification of value in terms customer point of view	x	x	x	x	x	x
	Post sales service to customer	x	x	x	x	x	x
	Customer involvement in design	x			x	x	x
	Continuous evaluation of customers feedback	x	x	x	x	x	x
	Customer enrichment						
	Concurrent engineering				x	x	
	Group Technology						
	Delivery performance improvement	x	x	x	x	x	x
	Takt time						
	Quality function deployment						
	Failure mode and effect analysis						
LM	Time windows delivery requirements or tight time windows	x			x	x	
	Effective logistics network design	x	x	x	x	x	x
	Consultants as logistics managers						
	Consignment inventory or vendor managed inventory	x				x	
	Advance material requirement planning and scheduling structure	x	x	x	x	x	x
	Use of third party logistics for transportation system	x	x	x		x	
	Milk run or circuit delivery					x	
	Master the demand forecasting process	x	x	x	x	x	x
	Postponement						
	A,B,C material handling	x	x	x	x	x	x
	Elimination of buffer stocks						
TPM	Create vision and objective to lean supply chain	x	x	x	x	x	x
	Employee training and education in LSCM	x	x		x	x	
	Organisation structure and associated relationships	x	x	x	x	x	x
	Cross-enterprise collaborative relationships and trust	x	x	x	x	x	x
	Joint planning of processes and products with suppliers	x			x	x	x
	Resources allocation				x	x	
	Develop learning culture specific organization	x				x	x
	Holistic strategy for integrating system or organizational policy deployment				x	x	
	Employee empowerment	x	x	x	x	x	x
	Stable and long-term employment		x			x	x
	Leadership development					x	
CI	Multi-skilled workforce						
	Built in quality system	x	x	x	x	x	x
	Value stream mapping through supply chain	x	x			x	
	New product development	x	x	x	x	x	x
	Statistical process control	x	x	x	x	x	x
	Quality improvement teams or quality circles	x	x	x	x	x	x
	Cross functional teams within the organization	x			x	x	x
	Use of flat hierarchy						
	Value engineering						

IT: Information technology management, SM: Supplier management, EW: Elimination of waste, JIT: Just-in-time production
CRM: Customer relationship management, LM: Logistics management, TMC: Top mgmt. commitment, CI: Continuous improvement

"Our selection of lean tools basically depends on a problem, which can be resolved right on the spot or demand more effort. Sometimes the low hanging fruits can be solved right away, but if there is a bigger problem, we will use other lean tools." (Company F)

"Our selection of continuous improvement tools depends on each specific problem we need to tackle." (Company N)

The second element, *selection based on performance objectives*, was mentioned by several companies that instead preferred a more proactive approach. First, they define the desired outcome and then they select the optimal lean CTPs; therefore, the performance objective to be achieved influences the choice of lean CTPs. One manager explained:

"…it all (the selection of lean CTPs) depends on what results we are trying to achieve…so ultimately it is results based! It depends on the specific objective that we pursue." (Company K)

Finally, the third element, *selection based on context*, shows how the optimal selection of lean CTPs is also contingent on additional internal and external factors, intrinsic to each specific industry; for example, the commitment of top management and budgetary implications in some cases determine the availability of lean CTPs to be employed. Also, the engagement level and degree of expertise of employees were mentioned as important factors influencing the selection of lean CTPs. Another manager clarified this:

"Some industries may be more flexible or more stringent than others, so lean principles can be applicable, but they need adjustment and the right selection in each case. Each industry is different, they have different levels of maturity when it comes to continuous improvement." (Company M)

"Necessities are different in each industry so different approaches are needed per industry. Some factors to consider are the magnitude of the continuous improvement project, industry regulations, managerial assistance, and employees' engagement. All depends on the contexts, different industries, different levels of maturity, different needs, so is a combination of many factors, some industries may be more flexible or more stringent than others, so lean principles can be applicable, but they need adjustment and the right selection in each case." (Company M)

Table 4-8 displays a cross-case comparison of the factors that determine the selection of lean CTPs for each of the companies participating in this study. The tabulation of results shows a strong preference of all companies to select the most convenient lean CTPs contingent on the specific supply challenges they need to address as well as dependent on the specific performance objective they want to achieve, with less emphasis on the particular context. However, these elements are associated, there is an alignment association between supply challenges and performance

objectives for each subsector, which determines the selection of lean CTPs, reinforcing my contextual contingent model of LSM.

Table 4-8. Cross-case comparison of factors determining the selection of lean CTPs

	Confectionery			Protein		
	Company K	**Company F**	**Company N**	**Company C**	**Company M**	**Company S**
Nature of the supply challenge	X	X	X	X	X	X
Size of the supply challenge		X	X	X	X	X
Severity of the supply challenge		X	X	X	X	X
Desired outcome	X	X			X	X
Management commitment			X		X	X
Employees engagement					X	
Employees expertise		X				

A cross-case comparison of the subthemes discussed in this section is presented in Table 4-9, which illustrates how companies are using LSM. There exists uniformity across companies and subsectors regarding a simplified structure, careful definition of suppliers, integrated long-term relationships with suppliers based on trust and collaboration, and systematic selection of CTPs.

In brief, when implementing LSM, the selection of the most efficient lean CTPs by all the companies in the sample responds to the need for addressing specific supply challenges associated with specific performance objectives; therefore, I propose:

Proposition 2 (contingent event consideration): The business unit's specific lean pillars adopted (and CTPs deployed) require managerial alignment with the association of specific performance [functionality] objective(s) and supply challenges whenever pursuing LSM. There is an alignment association influence between lean pillars adopted (and CTPs deployed) and the alignment association of supply challenges and performance objectives.

4.5.3 LSM performance objectives (Why LSM)

This section sheds case-based descriptive insights on the criticality of considering performance objectives and also on adopting a contextual contingent view of LSM. My data and analyses suggested this final aggregate dimension which was characterized by different elements justifying the need for using the lean approach and the identification of the main priorities in terms of

performance objectives preferred by each company when implementing LSM principles. Therefore, two subthemes emerged from the data: lean perspective and performance priorities.

Table 4-9. Cross-case comparison of how companies are using LSM

Subsector	Company	How companies are using LSM Structure, selection and relation with suppliers	Main lean pillars	Selection of lean CTPs
Confectionery	K	Strict suppliers selection Few suppliers Close and long-term relations Lean extended to suppliers Open communication and info shared	Supplier management Top mgmt. commitment Just-in-time Continuous improvement	Based on desired outcomes and supply challenges
	F	Certified suppliers preferred Core suppliers of critical ingredients Positive integration Long-term relationships Joint-problem solving efforts	Supplier management Top mgmt. commitment Elimination of waste	Contingent on nature size, severity of supply challenge Based on expertise of user (Desired outcomes)
	N	Cooperative, long-term relations Number of suppliers depends on nature and criticality of product Relations contingent on importance of raw-material supplied	Supplier management Information technology Logistics management	Contingent on each specific problem
Protein	C	Strategic sourcing group Long-lasting relations Very specific and few suppliers High integration Sense of urgency to address problems	Top mgmt. commitment Supplier management Information technology Continuous improvement	Contingent on the nature of each supply challenge Depends on each problem
	M	Supplier selection based on each item Unique, single and multiple suppliers Strategic sourcing for consolidation Solid partnerships based on honesty, transparency and trust Best practices shared among suppliers	Top mgmt. commitment Supplier management Continuous improvement Just-in-time	A combination of factors: Contingent on each problem magnitude of project managerial commitment employees' engagement (Desired outcomes)
	S	Few core suppliers Unique, single and multiple suppliers Long term relationships Joint problem solving efforts Integrated market analysis	Supplier management Top mgmt. commitment Logistics management	Depends on each case Related to KPI (Desired outcomes)

Lean perspective, the first subtheme of this dimension reflected a consistent pattern among companies that all agreed on the multiple benefits of the lean approach. Managers explained their motivations for embarking on the lean journey to achieve radical transformations and establish a lean culture extended to suppliers. In one company, employees embraced the lean mentality and completely changed their mindsets to become advocates of continuous improvement initiatives as a daily part of their operation. Some managers commented:

"I think lean is a way of living!... continuous improvement has been in the core of our business, so we always strive for bettering ourselves and continuous improvement has always been part of it!" (Company K)

"Lean is looking at every process every day to determine if there are a better way and a cheaper way to do it." (Company C)

"We are continuous improvement costs reduction freaks, I would say, our mentality is to never be satisfied where we are today, to improve for tomorrow. This has become a whole different strategy." (Company M)

This subtheme was identified as the initial motive behind the implementation of LSM for these companies, reflecting a high degree of advocacy and commitment to lean. They understand the importance of seeing lean as an approach that should be embedded in the culture of each organization. Top management support to lean was also seen as fundamental to guide the transformation and sustain the new lean culture.

Performance priorities, the second subtheme, encompassed the identification of the most critical performance objectives that were pursued by the agri-food processors and motivated the implementation of LSM. Preferred performance objectives were productivity, consistency, learning, and variability reduction, with greater emphasis on the first two, as shown in Table 4-10. In terms of productivity, managers described, for example, cost reduction priorities pursued by lowering inventory levels along the supply chain or by shortening lead times from suppliers. Regarding consistency, managers highlighted the use of lean CTPs to ensure uniform quality to satisfy stringent legal requirements and demanding customer expectations. Two managers had this to say:

"Our suppliers have to make money to stay in business, so it is a two-way street of how we can improve a process or product to reduce the cost as a team. And when that team works together, there are definitely opportunities." (Company M)

"From a supplier relationship, we look at mostly the farmer and the hatchery relationship, looking specifically at the live birds supply, and by using the lean approach with suppliers, whether we can get it in at different weights, different breeds, more consistency in weight." (Company C)

Regarding performance objectives of learning, managers described the sharing of best practices with suppliers to improve internal processes, technical field assistance to suppliers, and training programs to prevent sanitary issues. In terms of variability reduction as a performance objective, informants explained their use of joint forecasting techniques with suppliers to minimize fluctuations in supply and demand.

Table 4-10. Cross-case comparison of preferred performance objectives when using LSM

	Confectionery			Protein		
	Company K	**Company F**	**Company N**	**Company C**	**Company M**	**Company S**
Productivity	X	X	X	X	X	X
Consistency	X	X	X	X	X	X
Learning		X		X		X
[Variability]		X	X	X	X	

A cross-case comparison summary of the subthemes discussed in this section is presented in Table 4-11, which illustrates why companies are using LSM. Across cases, the companies in the protein subsector seem to better understand LSM as an approach that should be embedded in the culture of the whole organization and their suppliers, which most likely has contributed to higher levels of implementation compared to the confectionery subsector.

The companies studied have embraced the lean approach, which has become the essence of their daily operations, and they have also identified the need for a specific selection of the best lean CTPs aligned to the main performance objectives to be pursued. In brief, the multiple lean CTPs implemented by all these companies to manage their relationships with suppliers were originated by the need for achieving particular and favourable outcomes; therefore, I propose:

Proposition 3 (contextual consideration): The business unit's performance [functionality] objective(s) is a necessary commencing managerial consideration whenever pursuing LSM.

Important contributions to scholarship and practice have emanated from this qualitative inquiry. First, scholars can benefit from this study to better understand a new conceptualization of LSM that implies a contextual contingent approach, which has been empirically illustrated. Agri-food scholars can build upon the notion of contextual factors and contingencies associated with the LSM construct to advance their own investigation by exploring additional contingencies intrinsic to the agri-food sector, for example, weather-related disruptions affecting food supply or harvesting conditions. This study also shows the application of a contextual contingent model in the agri-food sector, which, as far as I know, has not been explored before, and therefore, expands the body of knowledge in this specific industry and may serve as a foundation for future avenues of research related to LSM.

Table 4-11. Cross-case comparison of why companies are using LSM

Subsector	Company	Why companies are using LSM Lean perspective	Performance priorities	
Confectionery	K	Lean is embedded in the culture Considered key to success Lean is an ongoing mindset and not a simple project	**Consistency** **Productivity**	High quality is a priority for customer satisfaction Cost reduction efforts
	F	Lean seen as a methodology to drive productivity up Aimed to become a philosophy	**Productivity** **Consistency** **Learning**	Levels of criticality High quality ingredients Health and safety, engagement
	N	Lean culture is developing Recent Re-engineering process Focus on continuous improvement Lean ideas shared with suppliers	**Consistency** **Productivity**	Never compromising quality Standardization of processes Price negotiations based on market and volume Shared cost-saving outcomes
Protein	C	Lean serves as foundation of customized tools Lean seen as an approach	**Productivity** **Consistency** **Learning**	Cost take-outs with suppliers Higher yields of meat Animal welfare and yields Technical assistance to suppliers
	M	Lean is a way of living Lean is part of the culture People live and breathe CI Lean approach extended to suppliers Goal is to permeate lean philosophy in and out of the company	**Productivity** **Consistency**	Increase efficiency and yields Joint-cost-saving initiatives Freshness and safety Quality standard products
	S	Solid lean culture Main focus continuous improv. Lean seen as an approach Lean extended to suppliers	**Consistency** **Productivity**	Quality and safety prioritized On-time delivery highlighted Focus on price negotiations Optimization of routes

Second, practitioners can also benefit from this study by observing these results when selecting the best lean CTPs when dealing with their suppliers, meaning that LSM demands the identification of the objectives to be pursued and the supply challenges being exposed before an optimal selection of lean CTPs can proceed.

The LSM contextual contingent approach presented in this study is analytically generalizable, and therefore, the associations, alignments, and influences discussed throughout this paper should prevail in other sectors, with specific changes inherent to each industry.

4.6 Conclusions

This essay has presented a descriptive exploratory study of multiple cases to examine how and why the LSM approach is being utilized by Canadian agri-food processors to address supply challenges, illustrating the application of a contextual contingent model.

An initial framework was used as a template to establish the elements and associations of LSM, which oriented the investigation to conclude with propositions derived from the results of the case study (Eisenhardt, 1989). Each case was considered a different experiment and not a case within an experiment (Rowley, 2002), and replication of findings across multiple cases helped to increase the rigour of this study.

The findings of this study offer two important contributions. First, a rich description is provided of the use of lean CTPs in the Canadian agri-food sector to clarify the research questions: how and why LSM in this sector. By using triangulation of the data collected, a condensed narrative of each company was presented related to its use of LSM, and commonalities among cases were identified in terms of structure and selection of suppliers, relationships with suppliers, use and selection of main lean CTPs, main lean perspectives, and performance priorities behind the lean approach. Second, this empirical study illustrates the contextual contingent conceptual LSM model suggested by Naranjo et al. (2020). The evidence provided by managers of eight companies shows the alignment association of supply challenges with performance objectives and their alignment association influence on the selection of lean pillars. The rigour of the study was increased by following Yin (2018) in terms of assuring validity and reliability during the data collection and analysis.

4.7 Limitations and future research

Even though this study has captured abundant information regarding the utilization of LSM by eight companies in the agri-food sector, some limitations of this paper exist. The scope of this study did not include the examination of specific outcome ramifications derived from the contextual contingent adoption of lean pillars and deployment of lean CTPs by each of the companies, limiting the exploration to the alignment association among three specific constructs. Future avenues of research may extend the findings of this study to investigate such outcomes using detailed performance indicators aligned to the performance objectives defined in this study, requiring the operationalization of new constructs and further statistical analyses using structural equation modelling.

Another limitation of this paper is the industry-specific focus on qualitative inquiry by restricting the analysis to exclusively the agri-food sector. Future research should look at other industries and explore the contextual contingent model of LSM that has been empirically examined in this paper. Different supply challenges may be observed, and other performance objectives may be pursued,

which should determine a different selection of lean CTPs, therefore, illustrating the workings of this contextual contingent approach. A similar methodology to the one used in this study may be followed (i.e., using multiple case studies, or alternatively using questionnaires to increase the sample size).

Finally, another shortcoming of this study was the difficulty of incorporating direct observations via on-site visits, which were part of the initial design but had to be excluded due to external circumstances (global pandemic). Nevertheless, to enhance the quality of results, the use of triangulation by using interviews and archival data from multiple sources compensated with rich information for the lack of observations.

CHAPTER 5

5. Conclusion, main learnings, and future research

5.1 Conclusion

This thesis has presented a novel conceptualization and operationalization of lean supply management (LSM) and investigated its practical relevance for the Canadian agri-food sector.

The factors that motivated this research were fourfold: (1) lack of consensus about the definition and frameworks of LSM, (2) scarce investigation of LSM in the agri-food sector, despite its potential opportunities (Perez et al., 2010; Melin & Barth, 2018), (3) no previous exploration of performance objectives as a linkage to connect supply challenges and lean solutions, and (4) incorrect assumptions regarding the association between supply challenges and lean solutions.

The main objectives of this study have been fulfilled and the research questions have been addressed in the following points:

(1) I have clarified the domain of LSM via a systematic literature review of its current state of research regarding its definition, practices and frameworks, and related context and contingencies, and offered a novel definition.

(2) I have empirically explored, via multiple case studies, and determined how and why Canadian agri-food processors are using LSM,

(3) I have incorporated specific performance objectives pursued and identified for the Canadian agri-food processors, their most critical supply challenges faced, and their best lean solutions used via the adoption of lean pillars and the implementation of lean concepts, tools, and practices (CTPs), and

(4) I have clarified the associations and alignments of supply challenges, performance objectives, and lean solutions via an alternative framework.

To address the aforementioned shortcomings in the LSM literature and achieve the main objectives defined above, this thesis offered three integrated essays, intended to advance the LSM scholarly theorization and managerial understanding.

Essay 1 presented a systematic literature review of LSM definitions, practices and frameworks, and context and contingencies, incorporating 86 articles. No previous studies had explored performance objectives as a reflection of an operational/functioning context (or setting), nor had

they considered supply challenges seen as a reflection of an operational/functioning contingent condition, influencing the selection of lean pillars seen as a reflection of an operational/functioning contingent choice; this gap demanded the need to explore further these associations and alignments to better conceptualize LSM. All these shortcomings determined the need for a revised envisioning conceptualization and definition of LSM (MacInnis, 2011) that sees lean as an approach and considers context and contingencies.

Essay 2 offered a new conceptual development of the LSM construct, building upon the results obtained in the previous essay and presenting a new contextual contingent definition and model. The proposed model was supplemented by an empirical validation of its practical utility through a Delphi study, structured in three rounds, that enabled agri-food experts to discuss and identify the main supply challenges faced and the main lean pillars adopted when pursuing specific performance objectives. Findings of this study resulted in a descriptive model of LSM for the Canadian agri-food sector.

Essay 3 offered a qualitative inquiry to deepen the understanding of LSM in the Canadian agri-food sector, using multiple case studies to specifically explore how and why the LSM approach is being utilized in this industry. Findings revealed descriptive insights from the data collection and analysis of the case studies, which were reported by displaying the data structure and multiple quotes from informants, which helped to identify first-order categories, second-order categories, and aggregate dimensions during the coding process. These empirical findings and the conceptual contextual contingent model results were finally built upon to derive three theory-forming propositions, following Eisenhardt and Graebner (2007).

Referring to the empirical studies of this thesis, special attention was given to rigour throughout the process as a fundamental aspect of this research and considering that past literature has acknowledged the difficulty in determining the accuracy and reliability of the Delphi method due to its wide variation of characteristics (e.g., number of rounds, level of feedback provided, inclusion criteria, sampling approach, and method of analysis). Therefore, my methodology followed specific guidelines that helped to ensure reliability, for example, during the selection of respondents and their expertise, the design and administration of the questionnaire, and the feedback.

Additionally, because the Delphi method overlaps quantitative and qualitative ideals, I aimed at establishing trustworthiness to gauge the effectiveness and appropriateness of the Delphi method

(Hasson & Keeney, 2011). Therefore, to make the study more methodologically robust and guarantee trustworthiness, four strategies were determined: (1) credibility, by using member checks via feedback after each round, (2) dependability, by including a representative panel of participants, (3) confirmability, by maintaining a detailed database of data collection and analysis, and (4) transferability, by the use of the Delphi findings in my subsequent research (multiple case study).

In terms of robustness of findings from the multiple case studies, I also enhanced rigour by following specific guidelines (Voss et al., 2015; Yin, 2018) to ensure reliability and validity and to improve the quality of the case research; these guidelines are: (1) justification for research approach, by stating why the case method was adopted, (2) clarification of unit of analysis, by explicitly stating my focus on Canadian agri-food processors, (3) construct validity, by using multiple sources of evidence, inviting key informants to review preliminary reports, and explaining clearly my data collection and data analysis procedures, (4) external validity, by clearly identifying the context of the research and population of interest where findings could be generalized, and (5) reliability, by using a case study protocol and developing a database to facilitate replication.

Furthermore, when taken together, these three essays offer a new perspective on LSM research that advances both scholarly and practical understanding of LSM.

5.1.1 Scholarly contributions

The results derived from this thesis contribute to the maturation of the field of LSM by offering new direction and reorienting the scholarly investigation of LSM. A broader and more conceptually comprehensive focus of LSM has been offered by expanding the investigation of the domain of LSM to the study of the inner workings among its proposed elements. A new definition was presented, and a new framework was displayed and illustrated via empirical studies.

This deeper investigation was motivated by the need for developing a more robust understanding of LSM, of its domain and its elements, and of the mechanisms underlying how its elements are related. This construct operationalization was encouraged by the findings of the systematic literature review, which reflected some opportunities to advance the knowledge of LSM in specific areas that had not been explored before. In that context, the review of past definitions reflected diverse approaches and foci and the existence of different elements to define the domain of LSM, showing a lack of consensus. The review of practices and frameworks also revealed a lack of

standardization in the extant literature. Ultimately, the review of different contexts and contingencies when implementing LSM determined the need for clarification. The existence of this vast array of diverse definitions, practices, and frameworks justified the need for theory specific to LSM to establish its own boundaries and identity and be differentiated from lean management in general. Lamming (1996) observed, several decades ago, that while a significant amount of the practice-focused research that led to the development of lean production revolved around the supply system, "lean supply does not lend itself to straightforward implementation" (p. 194).

These antecedents enticed the identification and examination of a new operationalization of the LSM construct. Therefore, this thesis comprises a more comprehensive conceptual development that tries to encapsulate additional elements not previously explored. Similar to Hopp and Spearman (2020), who investigated the definition of lean under different lenses, this thesis offers an analysis of previous studies focused on LSM by using an examination of multiple facets.

Collectively these studies provide a new level of theorization as they allow advancing a novel (contextual contingent) LSM middle-range theorizing (MRT) (Stank et al., 2017) by targeting a specific phenomenon of interest and by considering the data collection and analysis aimed at establishing relationships among the elements of LSM, which generated and consolidated knowledge within a particular domain. This thesis can be considered a MRT effort because I have focused on the inner workings of the associations and alignments of the elements of LSM to develop a deeper understanding of the mechanisms underlying how lean pillars are selected to address supply challenges.

This study has contributed to the LSM research at the middle-range level by providing a contextual contingent model and definition to integrate an operating context (reflected in performance objectives) and a mechanism-based approach that identifies suitable lean pillars to address specific supply challenges (as reflection of contingencies). In this case, MRT precisely focused on LSM rather than on more broad areas, such as supply chain management or lean management, and the main aim of this research was directed at understanding context and mechanisms (involving contingencies) within the LSM domain.

Specifically, the systematic literature review recognized gaps in past literature and informed on some elements that were missing. Next, the conceptual contextual contingent model, validated by the Delphi study, identified the foundational building blocks of the LSM domain (the "what" of

LSM). Then, the multiple case studies clarified the inner workings among the context and mechanisms of LSM (the "how and why"). Such inner workings drive actual outcomes that need to be investigated in future studies because they were beyond the scope of this thesis.

Furthermore, the propositions that have been established in this thesis may serve as a theoretical framework for new research on LSM, for example, on how, why, and when these alignment associations operate in different contexts. Findings from the empirical studies of this thesis (i.e., those emanating from the Delphi surveys and from the multiple case studies) are analytically generalizable, which aligns well with MRT's hypotheses and analyses that are contextually specific and therefore limited in generalizability.

In addition, the approach followed by MRT that accommodates inductive and deductive research was also observed in this thesis by inducing a definition and conceptual model as a result of the systematic literature review, which was subsequently empirically validated through the Delphi surveys when several experts identified the elements and mechanisms of LSM within a particular context, and more specifically, illustrated later via the multiple case studies following an inductive-deductive approach (Eisenhardt & Graebner, 2007). Similar to MRT, data collection and analysis of this thesis aimed at establishing associations and alignments among a limited subset of phenomena (supply challenges and lean pillars) in a particular context (performance objectives) within a given domain (LSM). All these arguments indicate how this thesis provides a middle-range theorizing on LSM.

5.1.2 Practical contributions

The lack of research on LSM in the agri-food sector was another important motivator to conduct the empirical studies presented in this thesis.

In that context, as an important practical contribution of this work, I highlight that the Delphi survey resulted in a descriptive model of LSM for Canadian agri-food processors, which is beneficial for managers when implementing LSM in their companies. These results will prescriptively aid managers in making suitable decisions when selecting lean CTPs and considering their associations with supply challenges to be addressed in pursuit of specific performance objectives. The specific selection of lean pillars to be adopted and specific lean CTPs to be deployed should be associated with supply challenges faced and performance objectives pursued.

The results derived from the Delphi study, depicted in a descriptive model, reflected the main supply challenges faced, the lean pillars preferred, and the main performance objectives pursued by Canadian agri-food processors. Such results were enriched by displaying their associations, alignments, and influences and convey an important practical significance for managers in their efforts to succeed in their LSM implementations, threefold.

First, managers could leverage these particular results and assign extra effort and/or additional attention and resources to address specific potential anticipated supply challenges to be faced. Specifically, the main supply challenges identified in this thesis and derived from the descriptive model were cost, quality problems, limited suppliers, relationships with suppliers, and communication, all of which showed distinct pathways in their association with specific performance objectives. Therefore, managers may benefit from prioritizing their efforts to focus on the supply challenges mentioned above. For example, (1) cost challenges may be associated with dramatic price fluctuations of critical ingredients, exchange rates risks exposure, and tighter margins, (2) quality challenges may be related to products out of specification, perishability of food, safety issues involving contamination or diseases, or defects present in packaging, (3) limited suppliers may create shortages of raw materials or risky dependencies on a concentrated reduced number of vendors, (4) relationships with suppliers, if not collaborative, may jeopardize deliveries and interrupt flows, and (5) communication challenges may be present if appropriate channels of interaction are not well established with suppliers.

Second, findings of this thesis showed that these supply challenges were associated and aligned to specific performance objectives, namely increased productivity, increased consistency, increased learning, and decreased variability. Therefore, these results may orient managers when selecting their desired performance objectives to be pursued and in the identification of the supply challenges associated with such performance objectives. The results revealed the following associations: a) the performance objective of increased productivity is associated with supply challenges of cost, quality problems and limited suppliers; b) the performance objective of increased consistency is associated with supply challenges of cost and quality problems; c) the performance objective of increased learning is associated with supply challenges of limited suppliers and relationships with suppliers; d) the performance objective of decreased variability is associated with supply challenges of quality problems, limited suppliers, and communication. Similarly, in the other direction, the presence of the specific supply challenges identified above

may serve as guidance in the association with specific performance objectives that may be impacted in the following ways: a) the supply challenge of cost is associated with performance objectives of increased productivity and increased consistency; b) the supply challenge of quality problems is associated with performance objectives of increased productivity, increased consistency, and decreased variability; c) the supply challenge of limited suppliers is associated with performance objectives of increased productivity, increased learning, and decreased variability; d) the supply challenge of relationships with suppliers is associated with the performance objective of increased learning; e) the supply challenge of communication is associated with the performance objective of decreased variability.

Third, the main lean pillars recognized to address those supply challenges associated with performance objectives were continuous improvement, supplier management, information technology, and top management commitment. Managers in the agri-food sector may benefit from these results and prioritize the adoption of these lean pillars, which are the most commonly used in the industry, selecting the most suitable pillars depending on the performance objective pursued aligned to a specific supply challenge (e.g., the association of supply challenges with performance objectives of increased consistency and increased learning show an alignment association influence with the lean pillar of top management commitment).

The multiple case study then provides further in-depth insights to managers on the processual associations and alignments underlying the contextual contingent view of LSM presented in this thesis. The results of the case studies presented rich descriptions of successful lean implementations that may serve as benchmarks for managers interested in the deployment of LSM. Specific learnings from these results that may be replicated by managers in their agri-food companies include, for example, the identification of critical supply challenges (cost, delivery, quantity, quality, and safety challenges), the application of LSM in relationships with suppliers (strategic and simplified structure of suppliers maintaining long-term partnerships based on efficient communication and effective collaboration), the identification of preferred lean CTPs implemented in association to specific lean pillars adopted (multiple lean CTPs are offered for successful LSM deployments in the agri-food sector), the mechanisms of selection of most suitable lean CTPs in different contexts (optimal selection based on supply challenges faced and performance objectives pursued), and the managerial perspectives in relation to LSM (motivations for embarking on the lean journey). Also, the detailed description of results enriched by personal

quotes illustrates successful LSM implementations that may motivate managers to initiate similar efforts to embrace the lean approach in their firms and provide guidance through that journey.

These examples illustrate how the descriptive findings presented in this thesis, derived from the Delphi study and the multiple case study, can serve Canadian agri-food companies with a decision-making model offering normative insights on selection of appropriate lean pillars adoption and lean CTPs deployment.

In summary, the two empirical studies illustrated the associations of the contextual contingent model presented, from which several propositions were derived. In other words, the use of qualitative research techniques contributed to a better understanding of how and why managers in the agri-food sector are using LSM. Qualitative data analysis helped in the process of generating deeper insights into how and why LSM is used, and specifically, into the interplay of the proposed LSM elements, supply challenges, performance objectives, and lean pillars. As such, this study can facilitate a better understanding of the opportunities of LSM for scholars to expand their LSM research in deeper studies and for practitioners to promote successful LSM implementations.

5.2 Main learnings

Although the execution and successful completion of this thesis has encompassed different challenges, new theoretical and practical knowledge has also been acquired. A detailed description of these experiences is presented next for each of the studies and the whole thesis.

First, the completion of Essay 1 taught me the importance of conducting a systematic literature review to expand my knowledge about all previous relevant publications on LSM. Not only was this study fundamental to become familiar with the important articles and names of researchers interested in this field, but it also allowed me to familiarize myself with bibliometric analysis by investigating sources from where to extract the articles to be analyzed. The comprehensive databases selected for the search of manuscripts (*Web of Science* and *Scopus*) allowed me to gain access to multiple academic journals and conference proceedings. The careful identification of appropriate keywords aligned to the main objectives of my research was critical to synthesize the portfolio of articles. Nevertheless, in this step, the inclusion of additional keywords related to LSM (e.g., adding terms such as “lean production”, “lean manufacturing”, and “lean management”), and expanding the search from other bibliographic sources would have facilitated the obtention of the final portfolio directly and avoided the addition of supplementary articles that were identified indirectly via references from other articles related to lean management (snowballing approach).

The initial analysis of selected manuscripts required critical skills to synthesize each of the selected papers and establish connections among them to categorize them based on common patterns or similar foci. Moreover, the discussion of results forced me to develop my abstract thinking abilities, to identify the main elements missing in the current literature, and to recognize the need for additional inquiry to clarify the understanding of the LSM construct from a contextual contingent approach. The justification of a new systematic literature review was challenging initially, but those challenges were overcome after a thorough and detailed examination of past literature. The main learning from this study was the understanding of how critical a comprehensive review of literature is when embarking on any conceptual or theoretical research study.

Second, Essay 2 constituted the core study of this thesis because it presented a new LSM definition and a new conceptual contextual contingent model. The examination of LSM through this different approach demanded multiple productive discussions with the co-authors of this study. The conceptualization and theorization of LSM implied the review of fundamental concepts in terms of the different forms of reframing a construct (cf. MacInnis, 2011) and determined the need for a revised envisioning of LSM. I learned why a formal conceptual definition of a construct should precede any effort to investigate how to measure it (cf. Wacker, 2004). In addition, the process was dynamic and reflected several modifications of the definition and the model to better capture the association alignment of supply challenges, performance objectives, and lean pillars. The selection of specific terms to name the constructs included in the model taught me the importance of reviewing previously accepted terms that had been used in past literature and acknowledged in academic publications.

The Delphi survey consisting of three rounds helped me to comprehend multiple minor details involved in the process. The design of the instrument of inquiry demanded multiple reviews and adjustments to facilitate the understanding of respondents and to guarantee the rigour of results. The use of specialized software (Qualtrics) to administer the questionnaire and collect the responses proved efficient and effective. Sampling selection and obtaining the approval of informants to participate in this research were the most demanding stages in the process and were surmounted by persistence and patience. Despite the effort to obtain support for referrals and contact names from local organizations, chambers of commerce, or professional associations to reach potential informants, the response received was limited, which demanded different strategies

to build a robust sample of respondents. The main learning from this experience was that the identification and enrolment of an adequate sample may require extra time, effort, and careful attention. A positive experience occurred at the end of the study when sending a token of appreciation (Ivey's memorabilia) to all participants that completed the three rounds of surveys, to demonstrate my gratitude.

Third, Essay 3, as the second empirical study of this thesis, exhibited descriptive insights from multiple case studies. This qualitative inquiry demanded the review of detailed procedures (Rowley, 2002; Yin, 2018) to craft a solid design and guarantee the validity of results. Multiple iterations of the questionnaire to be used for the interviews were necessary before its launch, which was enriched by the testing performed in the two pilot studies. Once again, the selection of the sample, purposeful this time, also implied careful attention, and the search for acceptance to participate by the final six agri-food processors was not an underestimated task.

The main constraint of this study was the current global pandemic (Covid-19) that inhibited the application of direct observations in the field of each case and forced the introduction of virtual interviews. While the data were collected, a simultaneous process of analysis was conducted, which oriented the need for additional data until saturation was reached. Admittedly, this study took several months of data collection and analysis that demanded high levels of perseverance and discipline, which resulted in a complete database from which main findings were obtained following a detailed and painstaking procedure (cf. Nag & Gioia, 2012; Smith, 2015). The formulation of propositions at the end of this study represented a successful culmination of a long but rewarding research process. An important learning from Essay 3 was the need to carefully consider additional time over and above the original plan to account for unexpected delays.

When considering the big picture and reflecting on the whole thesis, some challenges and learnings identified are described next.

As an integrated work, the main challenges in synthesizing the LSM literature were the suitable organization of the retrieved articles and the selection of the most relevant information. Because this thesis set out to explore three different LSM facets, there was the need for classifying each of the selected articles into its corresponding facet and conducting multiple comparisons of articles to detect similar patterns. Also, the generation of the contextual contingent model demanded multiple discussions and changes, especially when trying to identify new elements that had not been incorporated before and could offer a new and different perspective of LSM. However, the

additional effort to frame a new conceptualization of LSM, via a new definition and framework, was compensated when finding empirical support for this conceptual contribution in both studies: (1) in the results of the Delphi surveys and (2) in the data collection during the interviews and the data analysis during the coding process, in the case studies.

The research advice that I would provide to other LSM scholars in their efforts to advance LSM scholarship and practice is the careful attention required for sampling lean experts when conducting surveys and the strategic identification of lean companies if using case studies.

5.3 Future research

Despite the scholarly and managerial insights offered by this thesis to contribute to a better understanding of the LSM construct, there are certain limitations that represent opportunities for future avenues of research.

First, this work did not examine the specific performance ramifications derived from this contextual contingent operationalization of LSM, that is, the evaluation of outcomes resulting from the contextual contingent LSM approach was outside the scope of this thesis. Future avenues of research may conduct explanatory studies to determine causal relations with operational and strategic performance dimensions. Such future studies could leverage the LSM framing discussed in this thesis and could define additional constructs to include performance measures.

Second, this MRT effort, while offering credibly reliable and internally valid insights, may be limited from an external validity standpoint. Specifically, this focused illustration of the LSM conceptualization on the agri-food sector may limit the generalizability of the descriptive findings derived from the empirical studies. Future research may explore the application of the LSM conceptual frameworks offered in this thesis in different business contexts to examine the associations and alignments of the proposed elements of this contextual contingent conceptualization of LSM.

Third, although this thesis has examined the agri-food industry, the unit of analysis was defined as the agri-food *processors* in the sector, constraining the scope of the research to a specific echelon of the agri-food supply chain. Future research may extend the findings of this thesis to incorporate additional entities of the supply chain and investigate the implications and applicability of this new LSM framework upstream and downstream along the supply chain.

Summarizing and describing further the new pathways mentioned above, the results from this thesis may be extended to explore the observation of LSM across a range of different settings and

its influence on particular outcomes to provide researchers testable insights into how and why LSM influences outcomes under specific circumstances. For example, the use of middle-range theorizing (Stank et al., 2017) may be suitable to develop some managerial middle-range theories, starting from a well-established topic of study within the LSM field, such as the different mechanisms and contexts that drive outcomes when using LSM.

Based on the contributions of this paper, this new conceptualization of LSM including supply challenges, performance objectives, and lean pillars may be used as a foundation to explore causality relations with specific outcomes in different contexts. Different contextual factors, such as environmental, organizational, and product contextual variables may be incorporated. Further research needs to explore diverse mechanisms and contexts to examine why, how, and when LSM determines different outcomes, with the additional consideration that mediating or moderating variables may be needed. For example, one pathway may be the examination of this new contextual contingent LSM view impacting different outcomes (e.g., financial performance, marketing performance) mediated by other variables (e.g., supply chain performance, operational performance) (cf. Nimeh et al., 2018) in different contexts. This example may be guided by the "mechanism + context = outcomes" framework (Stank et al., 2017), where the association alignment between supply challenges and performance objectives influencing the selection of lean pillars should define different operational outcomes mediated by different factors.

The next step would be the examination of such relations in different contexts, for example, in diverse industries (automotive, textiles, healthcare, electronics, construction), to explore why, how, when, and under which circumstances LSM improves financial performance and/or market performance. This deductive approach, suggested as future research, may conclude there or alternatively, additional research may be required on the interplay of mechanisms and contexts. As described above, this example illustrates the richness and value of the findings and insights on LSM reported in this thesis, which generates new research pathways that are worth pursuing.

To conclude, I highlight that since 1996, LSM has been a frequently studied topic that to date still requires further examination to advance insights on what constitutes LSM, how LSM is deployed in practice, and why LSM is adopted in practice. This thesis' conceptual insights and empirical findings contribute to advancing theorization and understanding on those three inquiry pathways that future research can build upon.

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Appendices

Appendix 1-1. Approval from Ethics Board (Delphi study)

Western Research

Date: 14 May 2019

To: Prof. Lawrence Menor

Project ID: 113883

Study Title: Conceptualization and Theorization of Lean Supply Management (LSM): A Delphi Study

Short Title: LSM Delphi Study

Application Type: NMREB Initial Application

Review Type: Delegated

Full Board Reporting Date: 07/Jun/2019

Date Approval Issued: 14/May/2019 10:23

REB Approval Expiry Date: 14/May/2020

Dear Prof. Lawrence Menor

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the WREM application form for the above mentioned study, as of the date noted above. NMREB approval for this study remains valid until the expiry date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

Document: Approved:

Document Name	Document Type	Document Date	Document Version
2.5 QUESTIONNAIRE DESIGN DELPHI STUDY LSM	Online Survey	31/Mar/2019	1
2.7 Protocol-Research plan LSM	Protocol	31/Mar/2019	1
3.1.5f Telephone Script LSM V2	Recruitment Materials	27/Apr/2019	2
3.1.6f Recruitment Email LSM V3	Recruitment Materials	13/May/2019	3
4.3 Letter of Information LSM new V2	Implied Consent Assent	27/Apr/2019	2

Document: Acknowledged:

Document Name	Document Type	Document Date	Document Version
2.6 Flow Diagram Study Design LSM	Supplementary Tables/Figures	31/Mar/2019	1

No deviations from, or changes to the protocol should be initiated without prior written approval from the NMREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on, such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Kaselyn Harris, Research Ethics Officer on behalf of Dr. Randal Graham, NMREB Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix 1-2. Approval from Ethics Board (Case studies)

Western Research

Date: 22 August 2019

To: Prof. Lawrence Menor

Project ID: 113863

Study Title: Conceptualization and Theorization of Lean Supply Management (LSM)

Application Type: NMREB Amendment Form

Review Type: Delegated

Full Board Reporting Date: 06/Sep/2019

Date Approval Issued: 22/Aug/2019 10:37

REB Approval Expiry Date: 14/May/2020

Dear Prof. Lawrence Menor,

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the WREM application form for the amendment, as of the date noted above.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
3.4 Letter of Information LSM Interviews-V4	Written Consent/Assent	21/Aug/2019	4
3.4 Letter of Information LSM Observations-V4	Written Consent/Assent	21/Aug/2019	4
4.3 Interview Guide for LSM	Interview Guide	22/Jul/2019	1
4.3 Observation Guide for LSM	Non-Participant Observation Guide	22/Jul/2019	1
4.5.5f Telephone Script LSM	Recruitment Materials	22/Jul/2019	1
4.5.6f Recruitment Email LSM	Recruitment Materials	22/Jul/2019	1

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on, such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Katelyn Harris, Research Ethics Officer on behalf of Dr. Randal Graham, NMREB Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix 2-1. LSM pillars and sub-elements (CTPs) defined by Jasti and Kodali (2015)

S. No	Pillars	Sub-elements
1	Information Technology Managemen	Use of EDI to communicate between departments Centralized database for documentation Enterprise resource planning system Information technology employed at customer base Effective and transparancy information flow throughout supply chain Use of bar coding and scanner in logistics systems Electronic commerce Modelling analysis and simulation tools Computer-aided decision making supporting systems
2	Supplier Management	Strategic supplier development Supplier evaluation and certification Long-term supplier partnership Supplier involvement in design Supplier feedback Supplier proximity Single source and reliable suppliers or few suppliers Cost-based negotiation with suppliers Manage suppliers with commodity teams
3	Elimination of waste	Standard products and processes Standard containers Focused factory production Design for manufacturing Flexible manufacturing cells or U-shape manufacturing cells Visual control Single minute exchange of die Andon 5S Point of use tool system Seven wastes throughout supply chain
4	JIT Production	JIT deliveries throughout supply chain Single piece flow Pull production Kanban Production levelling and schedulling Synchronized operational flow Plant layout Point of usage storage system Pacemaker Small lot size

Continued

Appendix 2-1. (Continued)

S. No	Pillars	Sub-elements
5	Customer relationship management	Specification of value in terms customer point of view Post sales service to customer Customer involvement in design Continuous evaluation of customers feedback Customer enrichment Concurrent engineering Group Technology Delivery performance improvement Takt time Quality function deployment Failure mode and effect analysis
6	Logistics management	Time windows delivery requirements or tight time windows Effective logistics network design Consultants as logistics managers Consignment inventory or vendor managed inventory Advance material requirement planning and scheduling structure Use of third party logistics for transportation system Milk run or circuit delivery Master the demand forecasting process Postponement A,B,C material handling Elimination of buffer stocks
7	Top management commitment	Create vision and objective to lean supply chain Employee training and education in LSCM Organization structure and associated relationships Cross-enterprise collaborative relationships and trust Joint planning of processes and products with suppliers Resources allocation Develop learning culture specific organization Holistic strategy for integrating system or organizational policy deployment Employee empowerment Stable and long-term employment Leadership development
8	Continuous Improvement	Multi-skilled workforce Built in quality system Value stream mapping through supply chain New product development Statistical process control Quality improvement teams or quality circles Cross functional teams within the organization Use of flat hierarchy Value engineering

Appendix 2-2. LSM articles extracted from databases

Author(s)	Title	Journal
Adamides et al. (2006)	Towards an integrated is framework for the design and management of lean supply chains	*ICEIS 2006 - Proceedings*
Adamides et al. (2008)	Supporting collaboration in the development and management of lean supply networks (CO-LEAN)	*Production Planning & Control*
Adebanjo et al. (2016)	Prioritizing lean supply chain management initiatives in healthcare service operations: a fuzzy AHP approach	*Production Planning & Control*
Afonso and Cabrita (2015)	Developing a lean supply chain performance framework in a SME: A perspective based on the balanced scorecard	*Procedia Engineering*
Almutairi et al. (2019)	A framework for implementing lean principles in the supply chain management at health-care organizations: Saudi's	*International Journal of Lean Six Sigma*
Argiyantari et al. (2020)	Pharmaceutical supply chain transformation through application of the lean principle: A literature review	*Journal of Industrial Engineering and Management*
Arif-Uz-Zaman and Ahsan (2014)	Lean supply chain performance measurement	*International Journal of Productivity and Performance Management*
Arkader (2001)	The perspective of suppliers on lean supply in a developing country context	*Integrated Manufacturing Systems*
Azevedo et al. (2012a)	Influence of green and lean upstream supply chain management practices on business sustainability	*IEEE Transactions on Engineering Management*
Berger et al. (2018)	Examining Practices, Barriers, and Contextual Issues in the Literature of Lean Supply Chain Management	*Journal of Management & Engineering Integration*
Chakraborty and Gonzalez (2018)	An integrated lean supply chain framework for U.S. hospitals	*Operations and Supply Chain Management*
dos Santos et al. (2020)	Viewing lean supply from the IMP perspective	*Journal of Business and Industrial Marketing*
Drohomeretski et al. (2012)	Lean supply chain management: practices and performance measures	*IISE 2012 - Proceedings*
Erridge and Murray (1998b)	The application of lean supply in local government: The Belfast experiments	*European Journal of Purchasing and Supply Management*
Erridge and Murray (1998a)	Lean supply: A strategy for best value in local government procurement?	*Public Policy and Administration*
Garcia-Buendia et al. (2020)	22 years of LSCM: a science mapping-based bibliometric analysis	*International Journal of Production Research*
Haq and Boddu (2017)	Analysis of enablers for the implementation of leagile supply chain management using an integrated fuzzy QFD approach	*Journal of Intelligent Manufacturing*
Hasan et al. (2020)	Lean practices in the Bangladeshi ready-made garments industry and global significance	*International Journal of Logistic-Research and applications*
Jasti and Kodali (2015)	A critical review of LSCM frameworks: proposed framework	*Production Planning & Control*
Jasti and Kurra (2017)	An empirical investigation on lean supply chain management frameworks in Indian manufacturing industry	*International Journal of Productivity and Performance Management*
Khorasani et al. (2015)	A structured review of lean supply chain management in health care	*American Society for Engineering Management 2015 - Proceedings*
Khorasani et al. (2020)	Lean supply chain management in healthcare: a systematic review and meta-study	*International Journal of Lean Six Sigma*
Kumar Singh and Modgil (2020)	Assessment of Lean Supply Chain Practices in Indian Automotive Industry	*Global Business Review*
Lamming (1996)	Squaring lean supply with supply chain management.	*International Journal of Operations & Production Management*
Manzouri et al. (2013)	Lean supply chain practices in the Halal food	*International Journal of Lean Six Sigma*
Manzouri et al. (2014)	Increasing production and eliminating waste through lean tools and techniques for Halal food companies	*Sustainability*

Continued

Appendix 2-2. (Continued)

Author(s)	Title	Journal
Manzouri and Rahman (2013)	Adaptation of theories of supply chain management to the lean supply chain management	*International Journal of Logistics Systems and Management*
Manzouri (2012)	How lean supply chain implementation affect Halal food companies	*Advances in Natural and Applied Sciences*
Marodin et al. (2017)	The moderating effect of Lean supply chain management on the impact of Lean shop floor practices on quality and	*Supply Chain Management*
Martinez-Jurado and Moyano-Fuentes (2014)	LM, SCM and Sustainability: A Literature Review	*Journal of Cleaner Production*
Mason-Jones et al. (2000)	Engineering the leagile supply chain	*International Journal of Agile Management Systems*
Moyano-Fuentes et al. (2019)	Development and validation of a lean supply chain management measurement instrument	*Production Planning & Control*
Moyano-Fuentes et al. (2020)	Extending lean management along the supply chain: impact on efficiency	*Journal of Manufacturing Technology Management*
Naylor et al. (1999)	Leagility: Integrating the lean and agile manufacturing in the total supply chain	*International Journal of Production Economics*
Nellore et al. (2001)	Lean supply and price-base global sourcing-the interconnection	*European Journal of Purchasing & Supply Management*
Nimeh et al. (2018)	Lean supply chain management practices and performance: Empirical evidence from manufacturing companies	*International Journal of Supply Chain Management*
Nunez-Merino et al. (2020)	Information and digital technologies of Industry 4.0 and Lean supply chain management: a systematic literature review	*International Journal of Production Research*
Perez et al. (2010)	Development of LSC a case study of the Catalan pork sector	*Supply Chain Management: An International Journal*
Qi et al. (2011)	Lean, Agile, and Legile Supply Chain: A Cumulative Model	*Decision Sciences*
Ruiz-Benitez et al. (2018)	The lean and resilient management of the supply chain and its impact on performance	*International Journal of Production Economics*
Saudi et al. (2019)	Influence of lean practices on supply chain performance	*Polish Journal of Management Studies*
Singh and Pandey (2015)	Lean supply-chain: a State-of-the-art literature review	*Journal of Supply Chain Management Systems*
Soni and Kodali (2016)	Interpretive structural modeling and path analysis for proposed framework of lean supply chain in Indian manufacturing	*Journal of Industrial and Production Engineering*
Soni and Kodali (2012)	Evaluating Reliability and Validity of Lean, Agile and Leagile SC	*Production Planning & Control*
Sousa et al. (2018)	Scientific Production on Lean Supply Chains Published in Journals Indexed by SCOPUS and Web of Science Databases:	*International Journal of Industrial and Manufacturing Engineering*
Stratton and Warburton (2003)	The strategic integration of agile and lean supply	*International Journal of Production Economics*
Tortorella et al. (2017a)	Lean supply chain management: empirical research on practices, contexts and performance	*International Journal of Production Economics*
Tortorella et al. (2017b)	Implementation of lean supply chain: An empirical research on the effect of context	*TQM Journal*
Tortorella et al. (2018a)	Lean supply chain practices: an exploratory study on their relationship	*International Journal of Logistics Management*
Tortorella et al. (2019b)	The moderating effect of Industry 4.0 on the relationship between lean supply chain management and performance	*Supply Chain Management*
Tortorella et al. (2018b)	Supply chain performance: how lean practices efficiently drive improvements	*Journal of Manufacturing Technology Management*
Tortorella et al. (2019a)	Assessment of Lean implementation in Hotels' supply chains	*Production*

Appendix 2-3. LSM articles extracted from additional sources and references

Author(s)	Title	*Journal*
Al-Aomar and Weriakat (2012)	A framework for a green and lean supply chain: a construction project application	*Industrial Engineering and Operations Management 2012 - Proceedings*
Ambe and Badenhorst (2010)	Strategic supply chain framework for the automotive industry	*African Journal of Business Management*
Averill (2011)	Lean Sustainability: creating safe, enduring, and profitable operations	*Taylor&Francis Group*
Bailey (2015)	Lean Supply Chain	*ASQ Six Sigma Forum Magazine*
Barla (2003)	A case study of supplier selection for lean supply by using a mathematical model	*Logistics Information Management*
Camacho-Minano et al. (2013)	What can we learn from the evolution of research on lean management assessment?	*International Journal of Production Research*
Cigolini et al. (2004)	A new framework for supply chain management: Conceptual model and empirical test	*International Journal of Operations and Production Management*
Cudnay and Elrod (2011)	A comparative analysis of integrating lean concepts into supply chain management in manufacturing and service	*International Journal of Lean Six Sigma*
De Steur et al. (2016)	Applying Value Stream Mapping to reduce food losses and wastes in supply chains : A systematic review	*Waste Management*
Dora et al. (2016)	Determinants and barriers to lean implementation in food-processing SMEs - A multiple case analysis	*Production Planning and Control*
Eriksson (2010)	Improving construction supply chain collaboration and performance: A lean construction pilot project	*Supply Chain Management*
Found and Rich (2007)	The meaning of lean: cross case perceptions of packaging businesses in the UK's fast moving consumer goods sector	*International Journal of Logistics Research and Applications*
Found et al. (2007)	Creating a sustainable lean business system within a Multi-National Group Company	*IIE 2008 - Proceedings*
Goldsby et al. (2006)	Modeling lean, agile, and leagile supply chain strategies	Journal of Business Logistics
González and Suárez (2001)	Effect of organizational variables in JIT purchasing implementation	*International Journal of Production Research*
Gueimonde-Canto et al. (2011)	Competitive effects of co-operation with suppliers and buyers in the sawmill industry	*Journal of Business and Industrial Marketing*
Hadid and Mansouri (2014)	The lean-performance relationship in services: A theoretical model	*International Journal of Operations and Production Management*
Jajja et al. (2016)	Supply chain strategy and the role of suppliers: evidence from the Indian sub-continent	*Benchmarking: An international Journal*
Jayaram et al. (2008)	Relationship building, lean strategy and firm performance: An exploratory study in the automotive supplier industry	*International Journal of Production Research*
Karim and Arif-Uz-Zaman (2013)	A methodology for effective implementation of lean strategies and its performance evaluation in manufacturing organizations	*Business Process Management Journal*
Levy (1997)	Lean Production in an International Supply Chain	*Sloan Management Review*
Manrodt et al. (2008)	Lean practices in the supply chain	*Jones Lang LaSalle*
Marodin et al. (2016)	Contextual factors and lean production implementation in the Brazilian automotive supply chain	*Supply Chain Management*
Myerson (2012)	Lean supply chain and logistics management	*McGraw-Hill*
Nightingale (2005)	Lean supply chain management principles and practices.	*Massachusetts Institute of Technology*
QAD (2003)	Streamlining for Success : the Lean supply chain	*QAD Inc.*

Continued

Appendix 2-3. (Continued)

Author(s)	**Title**	***Journal***
Qi and Chu (2009)	The impact of supply chain strategies on supply chain integration	*ICMSE 2009 - Proceedings*
Rahman et al. (2010)	Impact of lean strategy on operational performance: A study of Thai manufacturing companies	*Journal of Manufacturing Technology Management*
So and Sun (2010)	Supplier integration strategy for lean manufacturing adoption in electronic-enabled supply chains	*Supply Chain Management*
Stummer (2009)	Top five ways to lean your supply chain	*Manufacturers' Monthly*
Taylor (2006)	Strategic considerations in the development of lean agri-food supply chains: A case study of the UK pork sector	*Supply Chain Management*
Tortorella et al. (2015)	The impact of contextual variables on learning organization in firms that are implementing lean: a study in Southern Brazil	*International Journal of Advanced Manufacturing Technology*
Vitasek et al. (2005)	What makes a lean supply chain?	*Supply Chain Management Review*
Vlachos (2015)	Applying lean thinking in the food supply chains: A case study	*Production Planning & Control*

Appendix 3-1. Delphi Survey Questions

Delphi Survey Questions: Round One

1. When dealing with suppliers, my agri-food firm typically experiences the following challenges that reduce sourcing and distribution productivity*: (select as many^ that apply)

   *Panelists similarly identified challenges that reduce [generate] sourcing and distribution visibility, consistency, learning, or [variability].
   ^Challenges included: cost, limited suppliers, on-time delivery, food damage, quality, communication, quantity issues, ordering problems, returns, logistics issues, supplier selection, food safety issues, relationship with suppliers, other problems (please specify).

2. When dealing with suppliers, to address the sourcing and distribution challenges selected above, the specific lean pillars that your agri-food firm implemented to increase productivity* are: (select as many^{+} that apply)

   *Panelists similarly identified lean pillars that increase [reduce] sourcing and distribution visibility, consistency, learning, or [variability].
   +Lean pillars included: information technology, supplier management, elimination of waste, just-in-time deliveries, logistics management, top management commitment, continuous improvement, other (please specify).

3. Based upon your previous responses, what does efficient-effective supply management mean in your agri-food business? (select all* that apply)

   *Increase productivity (i.e., efficient use of resources), increase visibility (i.e., observability of lows and operational system functioning), increase consistency (i.e., uniformity of offerings/outcomes), increase learning (i.e., acquisition of useful knowledge), reduce variability (i.e., deviation(s) from standards).

4. In your expert opinion, what constitutes lean supply management in the agri-food business context?

Delphi Survey Questions: Round Two

1. Round one panelists identified these main sourcing and distribution challenges* that reduce productivity^. Please evaluate each productivity challenge in terms of its frequency$^{\#}$ and severity$^{\blacklozenge}$ to your agri-food firm.

   *Challenges included: cost, limited suppliers, on-time delivery, quality, communication, quantity issues, logistics issues, supplier selection, and relationship with suppliers.
   ^Panelists similarly responded to challenges that reduce [generate] sourcing and distribution consistency, learning, or [variability].
   $^{\#}$Scale: never (1), somewhat frequent (2), frequent (3), very frequent (4), always (5)
   $^{\blacklozenge}$Scale: non-severe (1), somewhat severe (2), severe (3), very severe (4), extremely severe (5)

2. Round one panelists identified these main lean pillars* to increase productivity^. Please evaluate each productivity lean pillar in terms of its value$^{\#}$ to your agri-food firm.

*Lean pillars included: information technology, supplier management, elimination of waste, just-in-time deliveries, logistics management, top management commitment, continuous improvement.
^Panelists similarly responded to lean pillars that increase [reduce] sourcing and distribution consistency, learning, or [variability].
#Scale: irrelevant (1), minimal value (2), some value (3), mostly valuable (4), critical (5)

3. Please evaluate the importance* of each LSM performance objective^ for your business.

*Scale: irrelevant (1), minimal importance (2), some importance (3), important (4), very important (5)
^Increase productivity (i.e., efficient use of resources), increase consistency (i.e., uniformity of offerings/outcomes), increase learning (i.e., acquisition of useful knowledge), reduce variability (i.e., deviation(s) from standards).

4. Round one panelists qualitatively identified the following considerations* when defining LSM for their agri-food businesses. Please evaluate the importance^ of each consideration.

*Elimination of waste, elimination of non-value-added activities, cost reduction, low inventories, consistent quality, relationship with few suppliers, integrated relationship with suppliers, and streamlined flow.
^Scale: irrelevant (1), minimal importance (2), some importance (3), important (4), very important (5)

Delphi Survey Questions: Round Three

1. Based upon the provided LSM definition*, please select your top 3 critical (i.e., frequent and severe) productivity^ challenges# facing the Canadian agri-food sector.

*LSM definition provided was: LSM entails the utilization of an array of lean approach concepts, tools, and practices that focuses on the elimination of non-value-added activities in the supply network to streamline the flow of operations, and simultaneously increase productivity, consistency, and learning—as well as decrease variability—with regards to fulfilling (addressing) specific sourcing and distribution responsibilities (challenges).
^Panelists similarly responded to challenges that reduce [generate] sourcing and distribution consistency, learning, or [variability].
#Challenges included: cost, limited suppliers, logistics issues, on-time deliveries, quality, communication, quantity issues, supplier selection, relationship with suppliers.

2. Based upon the provided LSM definition*, and the top 3 critical productivity^ challenges identified in question 1, please select your top 3 lean pillars# to increase productivity^ when addressing those challenges in the Canadian agri-food sector.

*LSM definition provided was: LSM entails the utilization of an array of lean approach concepts, tools, and practices that focuses on the elimination of non-value-added activities in the supply network to streamline the flow of operations, and simultaneously increase productivity, consistency, and learning—as well as decrease variability—with regards to fulfilling (addressing) specific sourcing and distribution responsibilities (challenges).
^Panelists similarly responded to challenges that reduce [generate] sourcing and distribution consistency, learning, or [variability].
#Lean pillars included: information technology, supplier management, elimination of waste, just-in-time deliveries, logistics management, top management commitment, and continuous improvement.

Appendix 4-1. Sample questions of the semi-structured interview guide. Adapted from Blome and Schoenherr (2011)

SECTION A. Initial questions about the context (Relationship with suppliers)

A1. What is the main business activity of your company? (Main products)

A2. How is the purchasing/supply function currently managed? (Centralized-Hybrid-Decentralized)

A3. How many suppliers have you got typically? Are there any core suppliers?

A4. How do you make your sourcing decisions? (Single-dual sourcing / Short-Long term)

A5. What is the nature of interactions with suppliers? (Adversarial-Cooperative / Info-Profit sharing /frequency / negotiations)

A6. What is the degree of involvement of your core suppliers in your business? (R&D processes/Joint Training)

A7. Mention important milestones achieved during the lean implementation process.

SECTION B. General questions about lean and LSM

B1. What is "Lean" for your company? (a state, an outcome, an approach, etc.?)

B2. Which specific concepts, tools and activities do you use as part of LSM?

B3. Which performance objectives do you pursue through LSM? (Productivity, Visibility, Consistency, Learning, Variability reduction, other) What is the purpose of using LSM?

B4. When do you use those specific lean CTAs? (In which cases?)

B5. What is "LSM" for your company? How do you define it?

SECTION C. Specific questions about LSM Framework (Contextual-Contingent)

C1. Regarding the following performance objectives: Productivity, Consistency, Visibility, Learning and Variability reduction, is there any priority for your company when using LSM?

C2. What supply challenges (problems) do you face when aiming to achieve such performance objectives?

C3. What lean CTAs (solutions) do you use to achieve such performance objectives?

C4. What are the outcomes of these events?

C5. Please provide examples of these events that your company experienced (Supply Challenge-Lean solution-outcome) related to each specific performance objective (Why that specific selection).

Curriculum Vitae

Name:	Fernando Naranjo
Post-secondary Education and Degrees:	National Polytechnic School Quito, Ecuador 1993-1998 BSc Mechanical Engineering. Georgia Institute of Technology Atlanta, Georgia, USA 2001-2003 MSc Industrial Engineering. Georgia Institute of Technology Atlanta, Georgia, USA 2001-2003 MBA Western University London, Ontario, Canada 2016-2021 PhD. Business Administration
Honours and Awards:	MITACS Research Program, Ivey Business School, UWO (2020) Collins Grant, Ivey Business School, UWO (2018-2020) Brock Scholarship, Ivey Business School, UWO (2016-2020) Ontario Graduate Scholarship, Ontario, Canada (2016-2020) C.B. (Bud) Johnston Graduate Scholarship, UWO (2016-2020) Fulbright Scholarship, US Secretary of State, USA, (2001-2003)
Related Work Experience	Instructor Huron University College, UWO (2021) King's University College, UWO (2019-2020)

Refereed Conference Proceedings:

Naranjo, F., Menor, L., Johnson, F. (2021). Conceptualization and theorization of lean supply management, IPSERA Proceedings, Virtual Conference.

Naranjo, F., Menor, L., Johnson, F. (2020). Towards a revised conceptualization and theorization of lean supply management, AOM Proceedings, Virtual Conference.

Gavronski I., Klassen, R., Johnson, F., Naranjo, F. (2018). Management temporal orientation: Linking operational investment to Corporate Social Responsibility, Best paper finalist, AOM Proceedings, Chicago, USA.